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Research Artikel

## ARGUMENTATION SKILLS AND SELF-REGULATION OF STUDENTS USING PROBLEM BASED LEARNING COMBINED WITH DEBATES BASED ON SOCIO- SCIENTIFIC ISSUES ON ENVIRONMENTAL CHANGE MATERIAL

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### Abstract

Lack of self-confidence and self-monitoring to think, act and communicate scientifically are related to argumentation skills. This study aimed to determine differences: (1) students' argumentation skills, (2) students' self-regulation, (3) argumentation skills and students' self-regulation using Problem Based Learning (PBL) combined with debates based on Socio-scientific issues (SSI) on environmental change material. The method used is a quasi-experiment with a posttest only control group design. The population in this study was class X SMA N 2 Karanganyar 2022/2023, and the sample used was class XE2 and class XE7. The sample technique used is cluster random sampling. Collecting data on argumentation skills uses a test, while collecting data on self-regulation uses a questionnaire. The data analysis technique used the *t* test and *teh* manova test. It was concluded that there were significant differences: (1) students' argumentation skills, (2) students' self-regulation, (3) argumentation skills and students' self-regulation using Problem Based Learning (PBL) combined with debates based on Socio-scientific issues (SSI) on environmental change material. The research results can be used as a reference related to PBL learning, debate method, argumentation skills and students' self-regulation abilities.

**Keywords:** Argumentation; debate; problem-based learning; self-regulation; socio-scientific issues.

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## INTRODUCTION

Learning is a process in an effort to influence feelings, intellectual and spiritual in a person (Indarta et al., 2022). In education, the learning process is built by teachers to maximally develop the potential and various abilities possessed by students, such as the ability to think, develop creativity, reconstruct knowledge and problem solving. These are the skills that students must have in the 21st Century (Angga et al., 2022). 21st century learning requires students to acquire the 4C skills of critical thinking, communication, collaboration, and creativity (Angga et al., 2022; Indarta et al., 2022). Biology learning is part of science that includes facts and legal principles resulting from scientific processes that require problem solving through critical thinking skills (Agnafia, 2019). Learning can be done by emphasizing the involvement of learners' performance through a series of scientific discourses such as discussion, argumentation, debate, negotiation or experimentation (Rahmawati et al., 2019).

Critical thinking is a fundamental problem-solving skill. A student with critical thinking skills will be able to solve problems effectively. The ability to solve problems is done by making the right decisions and is practised when students can think critically (Snyder & Snyder, 2008). The ability to think critically develops along with the development of argumentation skills (Sumarni et al., 2017). Argumentation skills can train students to develop their thinking skills (Rahayu et al., 2020).

Argumentation cannot be separated from science. Argumentation is an elemental structure of the language of science to resolve questions, problems and debates by using arguments according to their beliefs and reasons (Fatmawati et al., 2018). Argumentation skills are related to students' awareness in monitoring their own cognition, also known as self-regulation (Demirbağ, 2021). Self-Regulation involves one's awareness to monitor one's cognition, especially by applying skills in self-evaluation, drawing conclusions in the form of questioning, confirmation, validation and correlation (El-

Henawy et al., 2012). Self-regulation ability is also one of the indicators in critical thinking (Facione, 2011).

Based on the results of interviews with biology teachers and observations in learning in class X SMA N 2 Karanganyar. The learning process still emphasizes on understanding the material and has not emphasized students to have argumentation skills. The way to convey student arguments is also related to student self-regulation related to motivation, self-confidence, thought processes, and how to manage resources so that they can convey arguments appropriately, logically and can prove their truth. Basically, one's argumentation is not only theoretical but must be proven, so students are not only able to express the theory they know but students must be able to prove the truth as well (Suraya et al., 2019).

A lesson that trains argumentation skills is one that uses real problems in the environment for students to solve through a series of lessons. The Problem Based Learning (PBL) model is one of the investigation-based learning (Juriah & Zulfiani, 2019; Suwono et al., 2017). PBL is a learning model that introduces students to authentic and meaningful problem situations that can serve as a springboard for investigation and enquiry. PBL helps students develop critical thinking skills and problem-solving skills (Arends, 2012).

Debate method is a learning method that confronts students with a problem. Sanjaya (2009) states that the main purpose of the debate method is to solve problems, answer questions, add and understand students' knowledge, and to make a decision. In this way, students will be intensively and actively involved because students must dare to express their opinions (Arif, 2016). Therefore, it would be better if the PBL model is combined with a debate method where students' ability to argue can be honed properly.

Problem-based learning is best suited if it is based on socio-scientific issues (SSI) that are directly related to students' daily lives (Wilsa et al., 2017). SSI refers to dilemmatic social issues related to science conceptually, procedurally and technologically. Science is not just about finding

and presenting facts, but also about constructing arguments and analyzing them, as well as debating various explanations of phenomena, so providing alternative issues can expose students' abilities in debate and discussion (Septiningrum et al., 2021). By including debate into PBL and SSI-based, students are further challenged to be able to articulate their thoughts and arguments effectively, thus promoting a deeper understanding of the problem and its implications. Therefore, students' argumentation skills and self-regulation are expected to be trained and developed through PBL learning combined with SSI-based debate.

## METHOD

The research was conducted at SMA Negeri 2 Karanganyar in the 2022/2023 academic year which is located at Jalan Ronggowarsito, Bejen, Karanganyar. The research type used is quasi experimental with Potstest only control group design. The research sample used two classes, namely the control class and the experimental class. The sampling technique with cluster sampling. A cluster sampling technique is used as a random and clumped sampling. In the control class, the treatment was PBL learning, while in the experimental class, PBL learning was combined with SSI-based debates. The learning activities applied to each class were then given a posttest to determine students' argumentation skills and students' self-regulation.

The instruments used in this study were the Learning Implementation Plan (RPP) in the form of Teaching Modules, posttest questions, and self-regulation questionnaires. The posttest questions were based on the aspects of argumentation proposed by Osborne et al (2004) namely claim, evidence, and reasoning, while the student self-regulation questionnaire was prepared independently by the researcher based on 3 aspects of self-regulation by Zimmerman (2000) consisting of metacognition, motivation and behaviour which were arranged in accordance with a Likert scale. The assessment of the results of the argumentation posttest is based on the scoring of argumentation skills by Henderson & Osborne, (2019) as in Table 1.

Table 1. Argumentation Skills Quality Index

Score	Criteria
0	No response
1	Claims, data or reasons stated are false
2	Just giving a restatement of the previous issue
3	Provide scientifically relevant statements but do not fully describe the relation to the data or reasons
4	Quotations of data are scientifically valid, complete and relevant but do not provide reasons
5	Reasoning statements are scientifically valid, relevant and fully described without mentioning data
6	Provides scientifically valid, relevant and fully elaborated data and reasoning

The absolute requirement to get valid research results is that the instruments used are valid and reliable, with these instruments it is expected that the research results will be valid and reliable (Sugiyono, 2017). Testing the validity of the instrument is done by testing content validity and construct validity. The content validity test in this study was carried out by consulting an expert who has competence in accordance with his field. The construct validity test on the questions and questionnaires was carried out using the Pearson correlation technique, with the decision making that  $r_{\text{count}} > r_{\text{table}}$ . Five argumentation questions were declared valid, namely the results of  $r_{\text{count}} > r_{\text{table}}$  with a validity index  $> 0.799$ . The self-regulation questionnaire consisting of 25 statements was also declared valid with an average validity value of 0.4-0.799 where  $r_{\text{count}} > r_{\text{table}}$ . The instrument continued with the reliability test using Cronbach's Alpha. The reliability test coefficient of the argumentation question is 0.891, while the self-regulation questionnaire is 0.924. The coefficient of reliability of the two instruments is included in the very high category and reliable to use. The collected data were then processed and analysed. The analysis was carried out with the help of SPSS 25 software. The data from the research results were first carried out prerequisite tests, namely normality and homogeneity tests. The normality test used Shapiro-wilk while the homogeneity test used the Levene test with a confidence level of 95% ( $\alpha = 0.05$ ).

Hypothesis testing is carried out after the normality test and homogeneity test fulfil the requirements. Hypothesis testing aims to see the comparison of existing variables and samples and their effects. In this study, 2 types of tests were carried out, namely the t-test and the Manova test. The unpaired t-test is used to test whether there is an average difference between two groups that are independent of each other. This t-test in this study was used to determine differences in students' argumentation skills through test results, as well as differences in students' self-regulation through questionnaires.

The Manova test was used in this study because it has two dependent variables, namely argumentation skills and student self-regulation. The Manova test was used to determine whether there was a simultaneous difference between argumentation skills and student self-regulation with the application of the SSI-based PBL model compared to the control class. The data collection process and observation of learning implementation were assisted by observers by filling in the observation sheet instrument.

**RESULTS AND DISCUSSIONS**

The results of the first hypothesis test showed that there was a real difference in PBL combined with SSI-based debate on environmental change material on students' argumentation skills. The results of hypothesis testing using the t test of argumentation skills in the control class and

experimental class obtained a significance result of 0.014 which is <0.05 Normality and homogeneity tests were carried out before hypothesis testing, the results of normality and homogeneity tests in both the control and experimental classes obtained results, namely the Sig value. >0.05 and it can be concluded that the data is normal and homogeneous so that it can be continued for the t test as a hypothesis test. Based on the results of the hypothesis test, it can be concluded that there are differences in students' argumentation skills with the use of PBL combined with SSI-based debates and classes that only use PBL without combined debates. The results of this study are in accordance with Firdauzi et al., (2019) which states that the application of PBL learning model combined with debate method can improve students' argumentation skills. Furthermore, the debate material presented with SSI-based also supports students' argumentation skills, such as the research conducted by Siska et al., (2020) which states that SSI-based learning can improve students' scientific argumentation skills. Controversial issues in SSI can cause pros and cons, and to make a decision on the issue requires reasoning. It is therefore possible to practice the habit of argumentation and make correct and logical decisions about controversial issues (Istiana et al., 2019).

The percentage level of students' argumentation skills on the posttest results can be seen in Table 2 and Table 3.

Table 2. Percentage Level of Argumentation Skills of Control Class Students

Level	Question 1		Question 2		Question 3		Question 4		Question 5		Average %
	F	%	F	%	F	%	F	%	F	%	
	0	0	0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	8	22	2	5,6	7	19	12	33	4	11	18.3
4	16	44	17	47	12	33	15	42	17	47	42.8
5	12	33	17	47	13	36	9	25	14	39	36.1
6	0	0	0	0	4	11	0	0	1	2.8	2.8
<b>Total</b>	36	100	36	100	36	100	36	100	36	100	<b>100</b>

Description: F = Number of Students, % = Percentage of each level of argumentation (The percentage of scientific argumentation skills is calculated by the number of students who occupy the level (0, 1, 2, 3, 4, 5 or 6) divided by the total number of students then multiplied by 100% (Suraya et al., 2019).

Table 3. Percentage Level of Argumentation Skills of Experimental Class Students

Level	Question 1		Question 2		Question 3		Question 4		Question 5		Average %
	F	%	F	%	F	%	F	%	F	%	
	0	0	0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	4	11	4	11	0	0	3	8.3	2	5.6	7.2
4	15	42	13	36	10	28	12	33	14	39	35.6
5	16	44	19	53	18	50	19	53	15	42	48.3
6	1	2.8	0	0	8	22	2	5.6	5	14	8.9
<b>Total</b>	36	100	36	100	36	100	36	100	36	100	100

Description: F = Number of Students, % = Percentage of each level of argumentation (The percentage of scientific argumentation skills is calculated by the number of students who occupy the level (0, 1, 2, 3, 4, 5 or 6) divided by the total number of students then multiplied by 100% (Suraya et al., 2019)

Table 2 shows data on the percentage of students at each score level measuring argumentation skills in the control class. Based on the table, it can be seen that there are no students who occupy levels 0 to 2. The largest percentage is at level 4 which is 42.8% and shows that students have been able to provide scientific, complete and relevant data citations. The highest level, level 6, only obtained a percentage with a result of 2.8%.

Table 3 shows data on the percentage of students at each score level that measures argumentation skills in the experimental class. Based on the table, it can be seen that students have also been able to occupy levels 3 to 6. The largest percentage is at level 5 which is 48.3% and shows that students are able to provide data citations legitimately and scientifically, complete and relevant. Students have also been able to provide statements up to level 6 with a percentage result of 8.9% The percentage value of each level of argumentation based on the acquisition of control and experimental class scores is presented in Figure 1.

Based on the histogram in Figure 1, it can be seen that the average percentage of students' argumentation skills in the experimental class is higher when compared to the control class. Both in the control class and experimental class, it is known that students have been able to reach levels three to six. In the control class, the highest percentage score was at level 4 of 42.8%, while in the experimental class the highest percentage score was at level 5 of 48.3%. As a result, it can be concluded that the average student has been able to

provide statements, evidence or reasons as a form of argumentation in their answers.

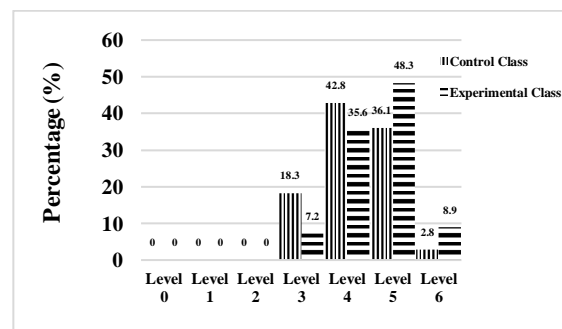


Figure 1. Histogram of Argumentation Level Percentage

The difference in scores that occurred in the control and experimental classes was due to the use of different learning models. The experimental class used the PBL model combined with SSI-based debate, while the control class was without debate activities. The PBL model combined with debate involves students directly in an investigation to find the truth of a problem to provide a solution, this is in line to support students to practice compiling arguments with statements, evidence or data and reasons submitted (Berland & Reiser, 2009). This is reinforced and supported by SSI-based debate activities. In these activities, students learn to solve a problem, answer questions to make a decision so that they can increase and understand knowledge (Arif, 2016).

Students in the experimental class were able to demonstrate better argumentation skills by showing a deep understanding of the topic, clear language, and logical and structured arguments.

They also provided arguments with clear and real evidence. In the opposite case, students in the control class tended not to provide sufficient evidence for their arguments, and only stuck to the books or other sources they read without exploring new evidence from their experiences or comparisons from the sources they had found.

An example of an argumentation question given is about student responses related to the bronch asthma trend among teenagers and the ticketing operation carried out by the authorities. Students in the experimental class can provide answers clearly, starting from their opinions agreeing or disagreeing, the reasons given, the impact that occurs both in social and health problems, and the solutions / actions taken by the community or related parties to overcome these problems. In addition, some students also explained their personal experiences related to the problems given. Whereas students in the control class on average answered with short answers and without any evidence to reinforce the reasons for the answers they gave. Students in the experimental class were generally more able to provide examples or evidence as reasons in greater breadth and detail, while students in the control class only provided general examples or reasons. Examples of student answers can be seen in Figures 2 and 3.

5. Menurut saya, saya tidak setuju dengan penggunaan knalpot bronch /tracing dikarenakan dapat menimbulkan suara yang bising dan mengganggu masyarakat. Selain mengganggu kenyamanan warga, knalpot bronch juga menimbulkan polusi udara. Banyaknya kasus tilang dan razia merupakan bukti bahwa knalpot bronch sangat mengganggu.

Figure 2. Example of answers given by students in the control class

5) Menurut saya, saya tidak setuju dengan adanya trend knalpot bronch/tracing dikarenakan dapat menimbulkan dampak negatif baik pada lingkungan dan juga mengganggu manusia (kenyamanan masyarakat). Adanya knalpot bronch menyebabkan kendaraan memiliki emisi gas buang yang lebih tinggi karena diubah dari knalpot standar menjadi bronch sehingga dapat menurunkan kualitas udara. Polusi udara dan suara yang ditimbulkan ~~dapat~~ dapat berdampak buruk pada kesehatan manusia seperti Penyakit paru-paru. Kegiatan razia yang dilakukan oleh pihak berwajib merupakan salah satu tindakan dalam upaya mengatasi trend yang tidak baik tersebut. Kegiatan razia tersebut juga sudah banyak diterapkan mulai dari tingkat bawah seperti tingkat RT/RW karena banyaknya laporan dari masyarakat yang merasa sangat terganggu.

Figure 3. Example of answers given by students in the experimental class

The results of the second hypothesis test show that there is a real difference in PBL combined with SSI-based debate on environmental change material on student self-regulation. The results of hypothesis testing using the t test of self-regulation in the control class and experimental class obtained a significant result of 0.037, which is  $<0.05$ . Normality and homogeneity tests were carried out before hypothesis testing, the results of normality and homogeneity tests in both control and experimental classes obtained results, namely the value of Sig.  $>0.05$  and can be concluded that the data is normal and homogeneous so that it can be continued for the t test as a hypothesis test. Based on the results of hypothesis testing, it can be concluded that there are differences in student self-regulation with the use of PBL combined with SSI-based debates and classes that only use PBL without combined debates. The results of this study are in accordance with the statement of Kusumawati et al., (2014) that PBL learning can stimulate and develop student self-regulation, and is strengthened by debate activities in the problem solving process presented in the PBL. Self-regulation in learning is related to the efforts made by students in achieving learning goals. (Mutmainnah, 2019). Therefore, through PBL learning combined with debate, students can learn to organize themselves to achieve goals through the problem-solving process.

Self-regulation is a process in producing thoughts, feelings, and actions. Students who have good self-regulation are able to actively participate metacognitively, motivationally and behaviorally in the learning process (Zimmerman, 2000). The histogram of the percentage value of each aspect of self-regulation is presented in Figure 4.

Based on the histogram in Figure 4, it can be seen that the percentage of aspects of argumentation skills in the experimental class is higher when compared to the control class. The percentage order from the highest in both control and experimental classes is the behavioral aspect, the metacognitive aspect and the lowest in the motivation aspect.

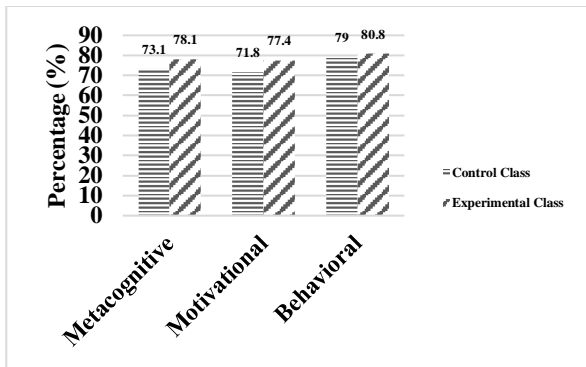


Figure 4. Histogram of Percentage of Self-Regulation Aspects

The metacognitive aspect of self-regulation refers to the decision-making process that governs the selection and use of different types of knowledge (Zimmerman, 2000). Indicators in metacognitive aspects consist of organizing and transforming, designing and planning goals and practicing and remembering. PBL activities combined with debates train students to explore and process various information, so that through these activities metacognitive aspects can also be developed, this is in accordance with the statement Januarti et al., (2022) that the metacognition aspect is the process of planning and processing information.

Motivation is the driving force that exists in everyone in organizing learning activities (Zimmerman, 2000). The motivation aspect in the experimental class has a higher percentage compared to the control class. The difference is due to the application of different learning methods, namely the application of debate. The activity of debate can motivate students to participate more actively in learning (Pangestika et al., 2015). The reason for students' participation is that they perceive the debate as a task that must be completed until they get a grade. The anxiety of fearing that the task given cannot be completed becomes a motivation in students (Sari & Yohana Wuri Satwika, 2022). Therefore, in addition to the tasks they get in PBL such as group discussions, debates are one of the factors that trigger student motivation in learning activities.

The last aspect is behavior. Behavior is an effort from students in self-regulation, selecting and utilizing the environment and creating an

environment that supports learning activities (Zimmerman, 2000). Through PBL learning combined with debate, students will be able to find and search for sources or facts, one of which is by conducting discussions. Group discussion in PBL is also a means of developing behavioral aspects. The student will complete the task by solving a problem, answering questions, increasing and understanding knowledge, and making decisions (Arif, 2016). This can be achieved by applying indicators of behavioral aspects such as seeking information from the problems they get, reading back related to the certainty of information, and seeking help by conducting group discussions.

The results of the third hypothesis test show that there is a simultaneous difference between argumentation skills and student self-regulation using PBL combined with SSI-based debate on environmental change material. The conclusion is obtained from the manova test results that the Sig value  $<0.05$ , which is 0.011. These results concluded that  $H_0$  was rejected and  $H_1$  was accepted. Students' argumentation and self-regulation skills can be developed through PBL learning combined with debate and supported by learning materials that are associated with issues in society, namely SSI. SSI is able to stimulate students to analyze and reason to determine the decision of a problem presented (Wilsa et al., 2017).

Argumentation is a person's skill to carry out the process of preparing a statement accompanied by evidence and logical reasons with the aim of justifying a belief, attitude or value, defending it and influencing others (Suraya et al., 2019). This can underline students how to think, act and communicate scientifically that is strengthened by data or evidence and based on science. Indirectly, PBL activities combined with debates can train students' argumentation skills as well as self-regulation because in the process of preparing the argument it must be based on regulating how to think, act and communicate. Debate activities encourage students to perform better self-regulation. Examples of self-regulation carried out by students in debate activities include how students understand and undergo the agreed debate rules. Students also pay more attention to the

surrounding environment including how to deal with debate opponents while gathering information in the form of facts that students can use to support the arguments they will convey. In the debate activity, students must be able to manage themselves to maintain good manners and try to convey arguments precisely and clearly so as to minimize errors in the delivery of arguments.

Aspects of students' argumentation skills consisting of claims, evidence and reasoning can be better conveyed and developed if students are also able to control their internal regulation in the aspects of metacognition, motivation and behavior. Students' courage in presenting a claim is certainly influenced by the existence of motivation in students. The process of thinking carried out by students to compile to be able to convey arguments is influenced by the existence of internal abilities related to metacognitive, motivational and behavioral aspects (Phan, 2010). The statements conveyed by students accompanied by evidence and reasons are the result of the students' thought process through planning, searching for sources of information and knowing the consequences related to what they convey in an argument. All the actions taken by students in learning activities can be accommodated properly and consciously through a control and organization within themselves (Zimmerman, 2000).

The activity of presenting arguments carried out by students is inseparable from various activities in the process of searching for information, preparing arguments to determine the arguments presented. In the experimental class, it is known that students explore more information from various sources. Some students are also known to make their own notes to support statements submitted either by group members or independently. These notes also serve as material for student evaluation and reflection in presenting arguments, especially in debate activities. As an evaluation and reflection material is to independently correct the papers they make and reflect on the mistakes in their writing. This statement is in accordance with Robillos (2021), that students' performance through a written

argumentation relates to the evaluation and reflection components as part of self-regulation.

## CONCLUSION

Based on the results of the study, it can be concluded that there are significant differences in: (1) students' argumentation skills, (2) students' self-regulation skills, (3) students' argumentation and self-regulation skills using Problem Based Learning (PBL) combined with socio-scientific issues (SSI) based debate on environmental change material. The research results can be used as a reference related to PBL learning, debate method, argumentation skills and students' self-regulation abilities. This study still needs to be studied further. Therefore, researchers can provide a recommendation for further research, including the dependent variable of argumentation can be developed by measuring argumentation orally and not only in writing. Instruments to measure self-regulation can be developed more specifically not only using questionnaires, so that they can show and improve changes in students significantly.

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