The Use of E-Modules Based on Socio-Scientific Issues in Efforts to Improve Argumentation and Decision-Making Skills of High School Students

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Abstract: The use of e-modules based on socio-scientific issues can be used as a way to provide argumentation and decision-making skills. This study aims to determine the use of e-modules based on socio-scientific issues in improving the argumentation and decision-making skills of high school students. This study used a quasi-experimental method. The research design used was the non-equivalent control group design. The sample in this study was class X students consisting of 132 people who were determined by purposive sampling technique. The research was conducted on two classes, namely the experimental class (learning using e-modules based on socio-scientific issues) and the control class (learning using modules not based on socio-scientific issues). The results showed that there was a significant difference in the mean between the experimental class and the control class in argumentation skills. The Mann-Whitney test on the value of argumentation skills shows a number (2-tailed = 0.000) < α (0.05) which means that there is a difference in the effectiveness of using socio-scientific issue-based e-modules with ordinary modules to improve students' argumentation skills. Then the results of the study showed that there was a significant difference in the average between the experimental class and the control class in student decision-making, shows that the Mann-Whitney test score on the value of argumentation skills shows the number (2-tailed = 0.000) < α (0.05) which means that there is a difference in the effectiveness of using socio-scientific issue-based e-modules with regular modules to improve student decision making. As for the criteria for the N-Gain score, the use of e-modules based on socio-scientific issues to improve students' argumentation skills is included in the moderate category (N-gain = 0.42), and the use of e-modules based on socio-scientific issues to improve student decision making is included in the medium category (N-gain = 0.56).

Keyword: Argumentation skills; Decision making; E-module based on socio-scientific issues

Introduction

The 21st century is characterized by the development of digital information. This is what It is said by many to be a revolution industry, especially the information industry. Digital era this is what colors human life in this century 21 (Syahputra, 2018). Learning in the 21st century must be able to prepare generations of people welcoming advances in information technology and communication in social life. Therefore, the quality of education must be improved (Septikasari et al., 2018). Providing quality science education will impact achievement development of a country. Science education depending on the learning used in every country. Through science education, students can be involved in the impact of science in everyday life and the role of students in society. By applying deep science concepts science education, Indonesian students are expected able to solve real life problems in the 21st century era (Pratiwi et al., 2019).

Along with the development of science and technology in the 21st century, there are several skill demands that must be met. There are several 21st century skills, namely 4C (Communication, Collaboration,

Critical Thinking, and Creativity) or communication, collaboration, critical thinking, and creative skills. Among the 4C skills, critical thinking skills are one of the most important skills, because they have been selected as one of the most important skills for 21st-century citizens (Halpern, 2014). In critical thinking skills, there is one of the skills needed in learning, namely argumentation skills. Argumentation skills play an important role in helping students to support them in doing assignments and in making decisions (Noroozi et al., 2020).

According to Deane et al. (2014), argumentation plays an important role in the development of critical thinking patterns and in adding an in-depth understanding of an idea or idea. Arguments can also facilitate understanding different perspectives and resolving differences of opinion. It is very important to instill arguments in education, especially in the field of science, this is in line with the opinion of Roviati et al. (2019) that arguments in science teacher education are considered a central element of science education because they play a fundamental role in scientific practice in the scientific community. Although considered to have an important role in science education, it is still rarely used in the classroom.

According to Viyanti et al. (2016) argumentation must be supported by reasons, so it can be concluded that argumentation is presenting conclusions based on reasons. In this case, arguments can be used to provide reasons for problems which is challenging. Argumentation ability very important in everyday life because the argument plays a deep role make correct and logical decisions regarding controversial issues (Yang & Tsai, 2010). Socio-scientific issues are issues that are based on problems or concepts scientific, controversial, discussed in public space and usually has influence political and social (Vera et al., 2021).

According to Soenarko et al. (2018) decision making is a process of deciding what actions to take and choose, and involves choicesIn addition, the goal of learning science is that students can have an attitude of decision making which is important for students to have because in everyday life many things require making the right decisions. Decision making according to Luthfiyani et al. (2019) a person's choice in choosing the right thing among various alternatives or taking action as a solution to a problem. Based on the results of Badarudin (2017) observations, students tend to have difficulty deciding on alternative answers to science problem-solving questions, where students only give short answers and cannot explain the reasons for these choices. So the decision-making process is also important and needed in this case. The way of making decisions that are not following the problem can lead to a low level of accuracy

of the results. Thus, the method of decision-making becomes a matter that plays a role in determining the answers and results achieved. Wulandari et al. (2018) the ability to make decisions is still low, this can be seen from behavior in learning where students are still hesitant in determining solutions to given cases and are less able to see the facts or problems they face.

In modern society, many problems that arise are centered on the results of scientific and technological developments. A number of these problems became known as socio-scientific issue Amalia et al. (2018). In its application in the world of education, socio-scientific issues are important in science education, this is because socio-scientific issues occupy a central role in the process of scientific literacy. Learning with socio-scientific issues is a learning process that is associated with social issues in the environment and society that have the potential to support the development of intellectual abilities, social attitudes, communication skills, concern, and participation of students (Siska et al., 2020). According to Maloney (2019), by using contextual problems in the field and small class discussions, to reach a decision in decision making, exploration and clarification regarding available evidence is needed, where the use of this evidence or information is important.

Socio-scientific issues (SSI) is an appropriate and potential strategy to implement that can support the development of students' moral character (Rohmawati et al., 2018). The use of the context of socio-scientific issues in learning is expected to help students construct arguments related to scientific concepts, as well as problems in the surrounding environment and society related to science (Setyaningsih et al., 2019). Socio-scientific issues apart from that, socio-scientific issues can make science learning relevant to students' lives (Pitpiorntapin et al., 2019). When facing socioscientific issues, a student must create decision about what action to take taken or what to agree not approved, by disclosing evidence as well reasons that can support his decision. So that when students reason about socioscientific issues, students can show their arguments which include the construction of supporting arguments, counter-arguments, and rebuttals (Tekin et al., 2020).

Learning in today's schools requires interesting teaching materials or learning tools to increase student interest in learning, and increase the effectiveness of learning. By incorporating elements of student interest in the teaching and learning process, they will be interested in the lesson. Through learning that attracts students' interest in learning, they can use interesting teaching tools in the eyes of students, one of which is the module. The current learning that is held in schools is still adapting from the COVID-19 pandemic, namely

blended learning, where learning is held online and offline. This situation causes teachers to be required to be creative in preparing teaching materials that are easy for students to understand. Therefore, e-modules can be teaching materials that enable students to study anywhere and anytime Matsun et al. (2020). E-modules are defined as displaying information in a book format which is then presented electronically which is easy to read using a gadget or cellphone Elvarita et al. (2020). The e-modules created in this study will contain environmental issues that are currently being widely discussed such as climate change, global warming, and environmental pollution. In the e-module, there is also a student discussion room using Google Classroom and debating arguments about environmental issues.

Each module contains a context and applies certain concepts. According to Dewi and Lestari (2020), e-module is a type of module which contains digital material accompanied by simulations that are suitable for use in learning. There are images, text, animations, videos and graphics that can be accessed anytime and anywhere. E-modules can facilitate students' learning while honing students' argumentation skills with appropriate presentation tools (Efrialda et al., 2022).

Method

The research design in this study was a quasi-experimental design with a non-equivalent control group design type (Creswell, 2014). This research was conducted by giving treatment to the experimental class and control class as a comparison. In experimenting, the control and experimental classes were selected in such a way, that is, those that have almost the same characteristics in terms of their cognitive abilities. The experimental class received treatment using e-modules based on socio-scientific issues, while the control class was given treatment using modules published by Kemendikbud.

The sample in this study was taken using a purposive sampling technique, namely a sampling technique from the research population based on certain traits and characteristics in achieving the research objectives desired by the researcher. The sample in this study is two classes which will be the control class and the experimental class. Students in the experimental class who were given e-module treatment based on socio-scientific issues totaled 66 students and in the control class, there were 66 students.

In this research, a research procedure was carried out which consisted of three stages. The preparation stage, the implementation stage, and the reporting stage. In the preparatory stage, the development of e-modules based on socio-scientific issues, argumentation skill

instruments, and decision-making instruments was carried out. The e-module development stage in this study uses the ADDIE model. ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation Branch (2009). At the implementation stage, there were three meetings held for 3 weeks. After collecting data from the test results of argumentation skills and decision-making. Furthermore, it will be analyzed to compare the results of improving students' argumentation and decision-making skills from the results of the initial test (pretest) and posttest (posttest) of the control class and the experimental class. Data processing on the argumentation skills test and decision making on the pretest and posttest, namely the prerequisite test, N-gain analysis, and significance test.

Result and Discussion

Argumentation Skills Before and After Using e-module Based on Socio-Scientific Issues

After developing e-modules based on socio-scientific issues using ADDIE, a test of argumentation skills was then carried out. The results of this test are then tested statistically. Then the data were analyzed to see students' initial argumentation skills in the experimental class and control class. These results can be seen in table 1.

Table 1. Recapitulation of the Pretest Scores of the Argumentation Skills of the Experiment Class and Control Class Students

Data Type	Pretest	
Group	Control	Experiment
N	66	66
Average	35.45	38.79
Standard Deviation	9.80	14.63
Min	20	20
Max	60	80
Test of Normality (Kolmogorov-Smirnov)	Sig. 0. 000	0.000
	Inter	Abnormal
Test of Homogenity (Levene's Test)	Sig.	0.003
	Inter	Inhomogeneous
Mann Whitney U Test	Sig.	0.257
	Inter	Not Significant

Based on table 1, it can be seen that students' argumentation skills before learning between the control class and the experimental class did not show a significant difference in the pretest results. Based on the results of the pretest both the control class and the experimental class after being tested statistically it shows that control class and the experimental class are not normally distributed. After that, a homogeneity test was carried out and a result of 0.003 was obtained, which indicated that the data in the control class and the

experimental class were not homogeneous. Then the average comparison test was carried out using the Mann-Whitney U test to find out the difference between the control class and the experimental class in the pretest results. Then the results of the Mann-Whitney U test showed that the results of the pretest between the control class and the experimental class had argumentation skills that were not significantly different. Based on data processing, the average pretest conducted in the control class and the experimental class had no different values. Significantly, so that in general the argumentation skills of students in the experimental class and the control class before being given treatment were the same.

After the pretest was carried out, students were then given learning where the provision of e-modules based on socio-scientific issues for the experimental class and the provision of modules not based on socio-scientific issues at the observing stage for the control class. At the end of the lesson, both in the experimental class and the control class, a test was given with the same questions, namely in the form of a posttest. The results of this test are then tested statistically. Then the data were analyzed to see the increase in students' argumentation skills in the experimental class and the control class. The results of the final test analysis (post-test) can be seen in table 2.

Table 2. Posttest Score Recapitulation of Students' Argumentation Skills in Experiment Class and Control Class

Data Type	Posttest	
Group	Control	Experiment
N	66	66
Average	45.90	65.15
Standard Deviation	12.56	9.28
Min	30	40
Max	70	90
Test of Normality	Sig.	0.000 0.000
(Kolmogorov-Smirnov)	Inter	Abnormal
Test of Homogeneity	Sig.	0.009
(Levene's Test)	Inter	Inhomogeneous
Mann Whitney U Test	Sig.	0.000
	Inter	Significant

Based on table 2, it can be seen that the post-test data after being statistically tested using the Kolmogorov-Smirnov test for normality showed that the results were not normally distributed in the control class and the experimental class. Then the homogeneity test in the post-test using Levene's Test shows that the data in the control class and the experimental class are not homogeneous.

Then a non-parametric test was carried out using the Mann-Whitney U test because the data were not normally distributed and were not homogeneous. From the hypothesis test, the result is 0.000, this value is smaller than the significance level of 0.05. These results can be interpreted that the posttest scores of students' argumentation skills between the control class and the experimental class differ significantly.

Effectiveness of E-module in Improving Argumentation Skills

To determine how effective the use of e-modules based on socio-scientific issues is, an N-gain test is carried out. After calculating the N-gain, the results are presented in table 3.

Table 3. Results of N-gain Argumentation Skills

Class	Value	
	N-gain	Information
Control	0.15	Low
Experiment	0.42	Medium

Based on table 3 it can be seen that the N-gain result is 0.15 which is included in the low category for the control class and then the N-gain result is 0.42 which is included in the medium category for the experimental class.

Based on the data processing of the final test (posttest) which was carried out after the treatment, it was found that the average final test of students' argumentation skills in the experimental class and the control class as a whole had significantly different values after being treated using the e-module. The difference in the results of the argumentation skills test between the experimental class and the control class was caused by the different treatments in the two classes. The results of an increase in argumentation skills that are higher in the experimental class can be caused by the use of e-modules based on socio-scientific issues. By using e-modules based on socio-scientific issues students can improve their argumentation skills, possibly due to several things. First, there is the "Let's Argument" feature which contains articles based on socio-scientific issues and questions that allow students to try to express their arguments according to the socio-scientific issues presented. Second, the e-module also provides a discussion space that contains articles on socio-scientific issues that can direct students to debate among students in class. By doing this activity, students directly or indirectly carry out argumentation activities. Significant differences in argumentation skills in the experimental class and the control class can also be caused by the module in the control class which does not contain things that allow students to argue. In the module in the control class, it is presented directly in the form of teaching materials and followed by questions that must be answered by students. With a module character like this, students' opportunities to argue are less facilitated, besides that students are not challenged to find the data

sources needed for them to be able to make a complete argument. The results of this study are following the results of research conducted by Tekin et al. (2020) which show that modules based on socio-scientific issues can improve the quality of argumentation skills.

In argumentation skills, there are several aspects, namely Claim, Ground, Warrant, Backing, Qualifier, and Rebuttal. With the features that can hone argumentation skills in the e-module, students will be trained in these aspects of argumentation, while the control class is not familiar with these aspects so the average experimental score is higher than the control class. This is following the opinion of Sampson et al. Gebrino (2010) that to construct appropriate arguments according to established criteria or standards, students must be trained in the conformity of claims with all available evidence, the adequacy of the evidence included, and the quality of evidence.

From the results of the different N-gain analyses between the control class and the experimental class, it can be interpreted that the treatment in the form of using e-modules based on socio-scientific issues in the experimental class has moderate effectiveness to improve students' argumentation skills. Meanwhile, the control class that received e-module treatment that was not based on socio-scientific issues had low effectiveness in improving students' argumentation skills.

Decision Making Before and After Using E-Module Based on Socio-Scientific Issues

Before the treatment, written test questions were given in the form of descriptions in the experimental class and control class (pretest). The results of this test are then tested statistically. Then the data were analyzed to see students' initial decision-making in the experimental class and control class. Then the scores were tested for normality and homogeneity, the results are presented in Table 4.

Table 4. Recapitulation of Student Decision-Making Pretest Scores in the Experiment Class and Control Class

Data Type	Pretest	
Group	Control	Experiment
N	66	66
Average	54.04	51.11
Standar Deviation	9.26	8.78
Min	33	20
Max	80	73
Test of Normality	Sig. 0.001	0.000
(Kolmogorov-Smirnov)	Inter	Abnormal
Test of Homogenity	Sig.	0.587
(Levene's Test)	Inter	Homogeneous
Mann Whitney U Test	Sig.	0.086
	Inter	Not Significant

Based on table 4, it can be seen that students' decision-making before conducting learning between the control class and the experimental class did not have a significant difference in the pretest results. Based on the results of the pretest both the control class and the experimental class after being tested statistically it shows that control class and the experimental class are not normally distributed. After that, a homogeneity test was carried out and a result of 0.587 was obtained, this value was greater than the significance level of 0.05. This shows that the data in the control class and the experimental class are homogeneous. Then the average comparison test was carried out using the Mann-Whitney U test to find out the difference between the control class and the experimental class in the pretest results. The results of the Mann-Whitney U test showed that the pretest results between the control class and the experimental class had insignificant decision-making, meaning that the pretest averages of the control class and the experimental class had no difference. So that in general the decision-making of students in the experimental class and the control class before being given treatment is the same.

After the pretest, students were given e-modules based on socio-scientific issues for the experimental class and modules not based on socio-scientific issues for the control class. Then a test is given with the same questions as the pretest. The results of this test are then tested statistically. Then the data were analyzed to see the increase in student decision-making in the experimental class and the control class. The results of the final test analysis (post-test) can be seen in table 5.

Table 5. Recapitulation of Posttest Scores for Student Decision Making in the Experiment Class and Control Class

Data Type	Posttest	
Group	Control	Experiment
N	66	66
Average	65.85	79.37
Standard Deviation	9.26	8.78
Min	46	60
Max	80	100
Test of Normality	Sig. 0.000	0.000
(Kolmogorov-Smirnov)	Inter	Abnormal
Test of Homogeneity	Sig.	0.347
(Levene's Test)	Inter	Homogeny
Mann Whitney U Test	Sig.	0.000
	Inter	Significant

Based on table 5, it can be seen that the post-test data after being statistically tested using the Kolmogorov-Smirnov test for normality showed that the results were not normally distributed in the control class and the experimental class. Then the homogeneity test in the post-test using Levene's Test shows that the data in

the control class and the experimental class are homogeneous.

Then a non-parametric test was carried out using the Mann-Whitney U test because the data were not normally distributed and were not homogeneous. From the hypothesis test, the result is 0.000, this value is smaller than the significance level of 0.05. These results can be interpreted that the posttest scores of students' argumentation skills between the control class and the experimental class differ significantly.

Effectiveness of E-Modules in Improving Decision Making

The assessment of argumentation skills was carried out to obtain the N-gain test results. The results obtained were taken from the results of the initial and final tests in the experimental class with the treatment of e-modules based on socio-scientific issues and the control class with the treatment of modules issued by the Ministry of Education and Culture. After calculating the N-gain, a conclusion is obtained from the results of the calculation of the initial test (pretest) and the final test (posttest).

Table 6. Results of N-gain Decision Making

Class	Value	
	N-gain	Information
Control	0.23	Low
Experiment	0.56	Medium

Based on table 6 it can be seen that the N-gain result is 0.23 which is included in the low category for the control class. Then an N-gain result of 0.56 was obtained which was included in the medium category for the experimental class.

The result of an increase in higher decision-making in the experimental class can be caused by the use of e-modules based on socio-scientific issues. By using e-modules based on socio-scientific issues students can improve decision-making possibly due to several things. First, there is the "Mari Analisis Masalah" feature which contains articles based on socio-scientific issues and questions that allow students to try to identify problems according to the socio-scientific issues presented. Second, the e-module also features the "Ayo Mencari Informasi" feature which contains questions that allow students to collect information from various sources. The questions contained in the "Ayo Mencari Informasi" feature also allows students to be able to determine alternative solutions to the issues presented. Third, the e-module has a "Tentukan Keputusanmu" feature which contains questions and can enable students to make the right decision.

In the experimental class, students are given a socio-scientific problem or issue regarding the environment. These issues need to be clearly understood and described by students with the help of the teacher. The socio-scientific issues used must be a complicated topic that can lead to differences of opinion Johnson (2010). In this study, environmental pollution issues presented are controversial and close to students' environment, for example, issues of water pollution, air pollution, soil pollution, and global warming. This is following what was stated by Putra (2022) that learning about environmental pollution must be conveyed through controversial issues that are close to students, by evidence, and attract students to discuss these issues. According to Putra (2022), socio-scientific issues are explained as an effective learning strategy for improving student decision-making in science based on issues involving ethical aspects of science and the moral development of students.

Conclusion

Learning using e-modules based on socio-scientific issues can improve the argumentation and decision-making skills of high school students. Based on the results of the research and quantitative discussion in the previous chapter, the researcher can conclude several points based on the research questions. First, the argumentation skills between the experimental class using e-module-based learning on socio-scientific issues and the control class using learning using modules not based on socio-scientific issues there is a significant average difference in improving argumentation skills. The Mann-Whitney test on the value of argumentation skills shows the number (2-tailed = 0.000) < α (0.05) which means that there is a difference in the effectiveness of using e-modules based on socio-scientific issues and modules that are not based on socio-scientific issues to improve argumentation skills student. The N-gain criteria for using socio-scientific issue-based e-modules to improve students' argumentation skills are included in the medium category (N-gain = 0.42) for the experimental class and the use of non-socio-scientific issue-based modules to improve students' argumentation skills includes into the low category (N-gain = 0.15) for the control class. Second, the decision-making between the experimental class that uses learning with e-modules based on socio-scientific issues and the control class that uses learning using modules that are not based on socio-scientific issues there is a significant average difference. The Mann-Whitney test on the value of decision-making shows the number (2-tailed = 0.000) < α (0.05) which means that there is a difference in the effectiveness of using e-modules based on socio-scientific issues with modules that are not based on socio-scientific issues to improve decision making student. The N-gain criterion

for using e-modules based on socio-scientific issues to improve decision-making on environmental material is included in the medium category (N-gain = 0.56) for the experimental class and the use of modules not based on socio-scientific issues to improve decision-making students belong to the low category (N-gain = 0.23) for the control class.

Author Contributions
In this article, ghaida sekarlita fadha is duty in conceptualization, creating methodology, formal analysis, conducting research, writing and editing the original article, and research funding. Widi purwianingsih is responsible for reviewing, creating methodology, and as a supervisor. Rini Solihat is in charge of reviewing, creating methodology, and as a supervisor.

Conflicts of Interest
The authors declare no conflict of interest.

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