



The Effectiveness of Socio-scientific Issues-Based Learning and Digital Literacy to Build Critical Thinking Skills for Students of Senior High School

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Article Info	Abstract
<p>Article History :</p> <p>Received May 2022</p> <p>Accepted August 2022</p> <p>Published December 2022</p> <p>Keywords: socio-scientific issues-based learning, digital literacy, critical thinking skills</p>	<p>The graduate's profile of the middle education unit is expected to be able to achieve national educational goals which consider 21st-century skills such as critical thinking. One of the learning strategies which can build students' critical thinking skills is socio-scientific issues-based learning and digital literacy. This research aims to analyze the effectiveness of socio-scientific issues-based learning and digital literacy to build the critical thinking skills of the students of senior high school. This research is quasi-experimental research with a posttest-only control-group design. The subjects in this study are the students of class X MIPA 1, X MIPA 2, X MIPA 7, and X MIPA 8, which are taken by random sampling technique. The data taken in this research is the data on critical thinking skills which are collected by test and non-test methods. The results of the research show that (1) based on the t-test, the results of the scores of Sig (2-tailed) < 0.05 mean that the scores of the student's critical thinking skills in the experimental classes are significantly different from the control class. The average scores of the student's critical thinking skills of the experimental classes are higher than the control class scores, so it can be interpreted that the student's critical thinking skills of the experimental classes are better than the control class, (2) the classical completeness in the experimental classes is higher than in the control classes. However, classical completeness in the experimental classes only reaches 65%, (3) the scores of the student response questionnaires in the good-very good category reach 97.2%, with details in the good category (75-84) reaching 59.7%, the very good category (85-100) reaching 37.5%. Thus, it can be concluded that socio-scientific issues-based learning and digital literacy on viruses and bacteria material is effective in building the critical thinking skills of high school students, however, it has not been effective in fulfilling classical completeness.</p>

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INTRODUCTION

Based on Permendikbud No. 36 of 2018, the 2013 Curriculum used today, was developed to improve critical learning patterns. Minister of Education and Culture (Mendikbud) Nadiem Makarim in his speech stated that the challenges that will be faced in the future are so complex that they require a myriad of competencies. One of these competencies is the ability to think critically. According to Halpern (2014), Critical thinking is the ability to use cognitive skills or strategies to achieve the intended results. Cognitive skills in question include solving problems, formulating conclusions, calculating possibilities, analyzing, and making decisions. BSNP (2020) states that in Biology learning, teachers must cultivate higher-order thinking skills.

The learning process in the classroom can be done by applying various methods, models, approaches, and strategies. One of the existing learning strategies is socio-scientific issues-based learning which place a more specific emphasis on cognitive and moral development, emotive reasoning, character education, socio-moral discourse, and the nature of science (Chen & So, 2017). Research and practice on socioscientific issues in science education have been shown to significantly influence the functional development of student literacy and students' moral dimensions because they are directly influenced by the moral elements contained in socioscientific issues (Zeidler et al., 2019). In addition, according to Bosser and Lindahl (2017) learning based on socioscientific issues can provide opportunities for students to practice higher-order thinking skills, reasoning, make decisions, and take actions related to socioscientific issues.

In addition to socio-scientific issues-based learning, digital literacy-based learning is also able to develop critical thinking skills. According to the Ministry of Education and Culture (2017), digital literacy is the knowledge and skills to use digital media, communication tools, or networks in finding, evaluating, using, creating information, and using it in a healthy, wise, intelligent, careful, precise, and effective manner that obey the law to foster communication and interaction in everyday life. Giovanni and Komariah (2019) stated that

there was a significant relationship between digital literacy and student achievement. Masitoh (2018) mentions two advantages of using digital literacy, namely, it can improve the quality of learning and can develop students' critical thinking skills.

Based on the results of observations and questionnaires to six biology teachers from two different schools, it was found that in learning about viruses and bacteria, learning outcomes were only at the level of remembering (C1), understanding (C2), and applying (C3). It can be seen from the evaluation questions used and the learning process that asks students to make PPT which is then presented. This is not per the learning achievement of viruses and bacteria which have basic competence at the level of analyzing (C4). In addition, 50% of respondents stated that they had applied learning based on socio-scientific issues, but when asked to provide examples of the themes raised in the lesson, the examples mentioned did not match the themes of socio-scientific issues. Likewise, with digital literacy, 50% of respondents stated that they had implemented it. However, when asked to mention the source of the information, it turned out that they were still using an invalid blog.

On the material of viruses and bacteria can be applied socio-scientific issues-based learning. This is because there are many issues about viruses and bacteria that develop in a society that is good to be raised in learning. In addition, currently, the procurement and use of the internet in schools have become a basic need in supporting education. Based on this, learning material on viruses and bacteria can be taught by applying socio-scientific issues-based learning and digital literacy that can develop critical thinking skills.

METHODS

This research is quasi-experimental research with a posttest-only control-group design. In the design of this research, there is treatment of experimental groups based on socio-scientific issues and digital literacy, while the control groups apply scientific learning and digital literacy. The design of the study gave a posttest to the experimental and control groups (Gall et al., 2003). This research is carried out at SMA N 2 Pati

in the Odd Semester of the Academic Year 2019/2020. The populations in this study are all of the students in class X MIPA. While the samples are the students of class X MIPA 1, X MIPA 2, X MIPA 7, and X MIPA 8, which are taken by random sampling technique. The effectiveness in this study has three indicators, namely (1) the critical thinking ability of the experimental class students is better than the control class, (2) the classical completeness of the experimental class students is 75%, (3) the experimental class students' responses are 75% in the Good-Very Good category. The data taken in this research is the data on critical thinking skills which are collected by test and non-test methods. The data analysis technique uses quantitative and qualitative descriptive methods. Measuring critical thinking ability can be performed with tests and nontests (performance duties). The research's critical thinking ability test is essay. Performance duties are a concrete exercise form which students

need to apply critical thinking ability and to be communicated in problem solving (Benjamin et al., 2016). According to De bie & Wilhelm (2015) The questions of the test which have the open questions describe more the patterns, motivations and deliberations of critical thinking of respondent.

RESULTS AND DISCUSSION

This study aims to analyze the effectiveness of using learning strategies by applying socioscientific issues combined with digital literacy to build students' critical thinking skills. In this section, presented some data obtained from the results of research that has been done. The data includes the score of critical thinking skills and the score of student response questionnaires. The score of critical thinking ability includes critical thinking ability test scores, poster work scores, and report scores.

Table 1. Score of Critical Thinking Ability Per Indicator

Indicator	Average Score of Control Class	Average Score of Experimental Class
Reasoning	29.2	45.37
Thinking as hypothesis testing	21.4	33
Argument analysis	54.6	66.9
Likelihood and uncertainty analysis	17.6	47.9
Problem-solving and decision-making	28	56.9
Average Score of Critical Thinking Ability	30.2	50

Table 2. Results of Critical Thinking Ability

Description	Control Class				Experimental Class			
	Test	Poster Work	Report	Final Score	Test	Poster Work	Report	Final Score
Number of Students	72	72	72	72	72	72	72	72
Highest Score	57	82	85	70	74	92.5	95	78
Lowest Score	9	52.5	32.5	33	29	60.5	60	52
Average	29	71	64	49	49	80	83	65

Based on the data in Table 1, it is known that the score of students' critical thinking skills per indicator in the experimental class is higher than the control class. Furthermore, based on the data in Table 2, it is known that the average score of students' critical thinking skills in the experimental class is higher than in the control class. To

strengthen the results, the proof is carried out by performing a right-hand t-test using the SPSS application. The results of the t-test show the score of Sig. (2-tailed) < which is 0.00, then Ho is rejected. Based on these results, it can be concluded that the average critical thinking ability of the experimental class students is significantly

different from the control class. Thus, the critical thinking ability of the experimental class students is better than the control class, so the criteria for critical thinking abilities are met.

Table 3. Results of Classical Completeness Analysis

Description	Control Class	Experimental Class
Total Number of Students	72	72
Completed number of students	1	47
Incompleted number of students	71	25
Classical Completion %	1.38%	65%

Based on the data in Table 3, it is known that the classical completeness in the experimental class is higher than in the control class. However, classical completeness in the experimental class only reached 65%. The criteria for testing the effectiveness of socio-scientific issues-based learning and digital literacy are 75% of students meet classical completeness. Thus, the classical completeness criteria are not met.

Table 4. Results of Student Response Analysis

Description	Experimental Class
Total Number of Students	72
Number of responses on very good category	27
Number of responses on good category	43
Number of responses on fair category	2
Number of responses on poor category	0
Responses percentage on good-very good category %	97,2%

Based on the data in Table 4, it is known that the number of student responses in the good-very good category in the experimental class is 97.2%. The criteria for testing the effectiveness of learning based on socioscientific issues and digital literacy are 75% of student responses in the good-very good category. Thus, the student response criteria are met.

Table 5. Examples of Student Answers

Reasoning Indicator	
Student answer of Control Class	Student answer of Experimental Class
Because HIV is a virus that attacks the immune system and can cause AIDS which causes death because there is no cure yet.	Because the HIV is a retrovirus that infects CD4 cells that play a role in the immune system. Sufferers will have a decreased immune system and cause AIDS which can cause death because there is no cure. In addition, people think that the HIV is malignant because it is easily infected, even though the HIV can only be transmitted through blood transfusions, injections, and free sex.
Thinking As Hypothesis Testing Indicator	
HIV is easily transmitted because it is transmitted through free sex, needles and blood transfusions and because the HIV reproduces very quickly, so transmission is also fast.	Lack of public knowledge about HIV and AIDS causes the emergence of misunderstandings in society. they may assume that all body fluids produced by PLWHA can spread the virus, such as sweat and saliva. But the HIV is not that easy to enter a person's body. Because

	the HIV can only live and reproduce in a suitable host (CD4 cells)
Argument Analysis Indicator	
Disagree, because HIV will be transmitted through blood transfusions, free sex, and injections. If you just fall and bleed, HIV will not be contagious.	Disagree, because HIV is not transmitted that easily. if a child with PLWHA falls and bleeds, other children will not be infected unless there is an open wound on the other child's body and the blood of the child with PLWHA touches the open wound. This is because HIV in its transmission requires contact through body fluids as access to enter the body so that it can be infected, besides that the HIV can only live in a suitable host, namely CD4 cells in certain body fluids.
Likelihood And Uncertainty Analysis Indicator	
There will continue to be rejection by the community and more and more people will suffer from measles and rubella because there is no substitute for pork.	There will still be pros and cons in society. Seeing that the majority of Indonesians are Muslims, people will urge the government to create a new vaccine without pork. If a replacement is still not found, the government will intensively socialize the fatwa that is permissible in the use of the vaccine, considering the health interests and because of compulsion.
Problem-Solving And Decision-Making Indicator	
The solution to this problem is to find another way or do other experiments to replace the pork content. As a Muslim, I still refuse the vaccine. Because according to the teachings of our religion we are not allowed to eat haram food.	The solution to this problem is to find or make halal vaccines. As a Muslim, I still receive the vaccine. because until now there is no halal vaccine and also for the sake of health. besides that, because MUI has issued a fatwa that is permissible for the MR vaccine

In this study, the results obtained that through socio-scientific issues-based learning and digital literacy students' critical thinking skills were better. The reasoning ability of the experimental class students can be seen in the answers to the description tests which can show the ability to analyze or evaluate ideas or problems from different perspectives. Experimental class students were able to give detailed and detailed answers, while control class students were only able to give general answers. According to research conducted by Herman et al. (2018), the results show that the application of contextual and authentic socio-scientific issues in learning can encourage emotional reasoning (emotive reasoning) which is needed by students to solve socio-scientific issues. In addition, digital literacy can increase students' experience in analyzing. Students become trained to analyze a problem.

The thinking as hypothesis testing ability of experimental class students is seen in the ability to provide answers that show a causal relationship, can examine more complete information to make valid conclusions. While the control class students were only able to mention a few answers without being able to explain the relevance of these answers. Based on research conducted by Zeidler et al. (2009), socio-scientific issues-based learning can encourage students' reflective assessment abilities including the ability to consider multiple points of view and integrate variously related and related data. Thus, students are trained to show the causal relationship of a problem.

Experimental class students have better argument analysis skills. This is because, in answering questions, experimental class students can identify key parts in an argument, identify arguments or reasons that support conclusions. Students are also able to guess the correct

statement from the data provided and can provide generalized validation criticism. Research conducted by Lin & Mintzes (2010) shows the results that the selection of appropriate socio-scientific issues in learning can improve students' argumentation skills positively. The better argumentation ability of experimental class students is also supported by digital literacy skills. Hadjerrouit (2010) states that by using good digital learning resources, digital literacy can grow so that it affects student learning positively.

Based on the analysis of student answers, the experimental class has better likelihood and uncertainty analysis abilities. In this problem, experimental class students can understand the possibility of events that will occur and understand the needs or things needed related to the problems presented. However, the control class students answered simply and tended to only one point of view. According to Solli et al. (2019), socioscientific issues which are controversial themes can encourage students to create many perspectives related to these problems. In addition, through discussion and presentation activities, students can gain various perspectives from other students, thereby enriching students' knowledge. With the various perspectives that are understood, it can encourage students' ability to make good predictions.

Experimental class students have better problem-solving and decision-making skills. In these problems, experimental class students can identify the best choices from choices in problem-solving, can decide based on scientific validity when applied to new situations, and can develop arguments and creative solutions to solve problems. Problem-solving skills are obtained after students understand well the cases that have occurred either through the process of finding information with digital literacy independently or exchanging opinions among group members. After students can solve problems, students can make decisions in addressing the controversial cases discussed. According to Florian and Anke (2013: 500) learning socioscientific issues with indirect instruction makes students able to create better decision-making strategies. In this case, students are allowed to develop their appropriate decision-making strategies based on the data

provided. Based on research conducted by Gutierrez (2015) shows that integrating socioscientific issues in biology lessons is useful for improving students' decision-making skills.

The achievement of classical completeness after obtaining socio-scientific issues-based learning and digital literacy was not fulfilled properly. This is because only 65% of students have completed, while the criteria set regarding the effectiveness of the research are 75% of students who have completed. In this study, the school KKM is used as a reference, namely 65. Based on this it can be said that socio-scientific issues-based learning and digital literacy has not been effective in fulfilling classical completeness. However, when we compare the achievement of classical completeness between the control class and the experimental class, the results are very different. This is because in the control class only 1 student has completed, while in the experimental class 47 students have completed. Based on the researcher's analysis, 2 factors can cause this, namely the track record and the determination of KKM. Based on the data, in the previous study of viruses and bacteria, only 15% of students were able to reach the KKM. When compared with the results of the achievement of KKM with the application of socio-scientific issues-based learning and digital literacy, it can be said that the achievement of students' KKM classically increases.

Based on the researcher's analysis, the school KKM of 65 which is used as a reference, is not appropriate if applied in this study. This is because this study applies to learning with high complexity. After all, it is oriented to students' critical thinking skills, so that materials, learning activities, questions, and assessments carried out during learning are problems that require high-level thinking skills to solving them. However, from an intake point of view, it is in a low category. This is because the characteristics of class X students for the 2019/2020 school year are zoning students who are accepted at school based on distance, not achievement. Based on the results of interviews with the vice principal in the field of curriculum, it is known that the school where the research takes place has 75% student zoning, which is dominated by students from junior high schools who are not favorites. Meanwhile, for

students who enter through the zoning achievement path, only 25%. Based on the researcher's analysis, these two factors influence the non-fulfillment of classical completeness.

Regarding the students' classical mastery that has not been achieved, further analysis was carried out to determine the characteristics of students (learning styles). According to Kurniawan et al. (2017), learning outcomes are influenced by internal factors and external factors. Internal factors such as learning styles, interests, and motivation, while external factors such as teaching methods, learning media, and learning environment. Based on research conducted by Rijal & Bachtiar (2015) it was found that there was a positive relationship between student learning styles and cognitive learning outcomes in Biology. This further analysis was conducted to analyze the suitability of the learning strategies applied to students' learning styles. Based on the results of the student learning style questionnaire, the results showed that 71% of students had a visual learning style, 25% of students had an auditory learning style, and 4% of students had a kinesthetic learning style. The applied learning based on socioscientific issues and digital literacy has accommodated the three student learning styles, but learning activities are more dominant in activities that accommodate auditory learning styles (discussion and presentation). This is one of the factors that influence the classical completeness criteria not yet achieved.

In this study, in addition to data on critical thinking skills and classical completeness, there are data on student responses. Student responses after receiving learning based on socioscientific issues and digital literacy are very good. In this study, student responses were obtained from the results of a questionnaire filled out by 72 students after the learning activities were completed. Based on the results of the analysis of student responses, the results obtained were 97.2% of students gave responses in the good-very good category. With details 37.5% very good category (85-100) and 59.7% good category (75-84). This proves that socio-scientific issues-based learning and digital literacy is effective for building students' critical thinking skills.

Based on the results and findings in the research conducted, socio-scientific issues-based learning and digital literacy is highly recommended to be applied in learning. With the characteristics of learning that present controversial themes in society, it provides added score in learning, namely, there is compatibility with real life, has many criteria, and provides compatibility with other disciplines, so that learning is well integrated (Altan et al., 2018). According to Chung et al. (2016), socioscientific issues can encourage students' communication skills. This is because, in socio-scientific issues-based learning, students are given the freedom to express ideas and views, as well as share personal experiences and scores related to the problem. Based on research conducted by Pratiwi et al. (2016) shows that the use of socioscientific issues (SSI) as a learning context has a significant effect on the critical thinking skills of high school students. Other supporting research, based on research conducted by Cahyarini et al. (2016) reported that there was a significant difference between students' critical thinking, students were taught using conventional methods, and students were taught using the 5E LC + SSI (socio-science issues) model and the 5E LC model. Wilsa et al (2017) state that the application of the SSI-based PBL model affects the development of critical thinking skills, written and verbal communication, and cognitive learning outcomes. Digital literacy also has a role in building students' critical thinking skills. Based on the results of Sriyanto's research (2021) it can be concluded that the application of digital literacy can improve 4C skills. In addition, according to Handayani (2020) learning of STEM-based digital literacy culture can improve students' critical thinking skills.

CONCLUSION

Based on the results of the analysis and discussion that has been carried out, it can be concluded that (1) By socio-scientific issues-based learning and digital literacy on virus and bacteria material, the critical thinking skills of the students are better than students who don't use socio-scientific issues-based learning and digital literacy. (2) By socio-scientific issues-based learning and

digital literacy on virus and bacteria material, the classical completeness hasn't been achieved. (3) The students' response of socio-scientific issues-based learning and digital literacy on virus and bacteria material reaches 97,2 % in Good category - Very good category.

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