THE EFFECT OF SCIENTIFIC LITERACY INTEGRATION WITH CASE-BASED LEARNING MODEL ON STUDENTS′ CRITICAL-THINKING SKILLS

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Abstract

This study aims to describe the effect of the integration of scientific literacy in the Case-Based Learning (CBL) model of students' critical thinking skills. This type of research is a quasi-experimental design with quantitative descriptive analysis techniques, and the research design used is non-equivalent control group design. The subjects of this study were students of class XI Even Semester Academic Year 2019/2020 at SMAN 1 Gondang Nganjuk. The data used is a written test obtained from the results of pre-test and post-test, then analyzed using inferential statistics One-way ANOVA. The analysis shows that learning with the integration of scientific literacy in the CBL model influences students' critical thinking skills. Learning with the integration of scientific literacy in the CBL model increases the critical-thinking skills of students with high categories, wherein the ”experimental class 1”, ”experimental class 2”, and the ”control class” get an N-gain score of 0.73, 0.72, and 0.35 respectively. Based on the N-gain score shows that the increase in critical thinking skills in the experimental class is higher than the control class. It can conclude that the integration of scientific literacy in the CBL model influences students' critical thinking skills. Therefore, the integration of science literacy in the CBL model can further applied to other physics materials to improve critical-thinking skills.

Keywords: Case-Based Learning (CBL), scientific literacy, critical-thinking skills.

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan pengaruh integrasi literasi sains dalam model *Case-Based Learning* (CBL) terhadap keterampilan berpikir kritis peserta didik. Jenis penelitian ini adalah *quasi-experimental design* dengan teknik analisis deskriptif kuantitatif dan rancangan penelitian yang digunakan adalah non-*equivalent control group design*. Subjek penelitian ini adalah siswa kelas XI Semester Genap Tahun Ajaran 2019/2020 di SMAN 1 Gondang Nganjuk. Data yang digunakan adalah *written test* yang diperoleh dari hasil *pre-test* dan *post-test*, kemudian dianalisis menggunakan statistik inferensial *One-way ANOVA*. Hasil analisis menunjukkan bahwa pembelajaran dengan integrasi literasi sains pada model CBL memengaruhi keterampilan berpikir kritis peserta didik. Pembelajaran dengan integrasi literasi sains pada model CBL meningkatkan keterampilan berpikir kritis peserta didik dengan kategori tinggi di mana pada kelas eksperimen 1, kelas ekperimen 2, dan kelas kontrol memperoleh skor *N-gain* 0,73, 0,72, dan 0,35 secara berurutan. Berdasarkan skor *N-gain* menunjukkan bahwa peningkatan keterampilan berpikir kritis pada kelas eksperimen lebih tinggi daripada kelas kontrol. Dapat disimpulkan bahwa integrasi literasi sains pada model CBL memengaruhi keterampilan berpikir kritis peserta didik. Oleh karena itu, integrasi literasi sains dalam model CBL dapat diterapkan lebih lanjut dalam pembelajaran materi fisika yang lain untuk meningkatkan keterampilan berpikir kritis.

Keywords: *Case-Based Learning* (CBL), literasi sains, keterampilan berpikir kritis

INTRODUCTION

It cannot deny that science and technology have developed rapidly in the 21st century. Information and technology massively influence educational activities in this case. In this era, the world makes progress in the global paradigm. There is a massive change in the framing of references about society, work, and ways of life. These force students to be more intellectual and competitive in facing every problem in their real life, so students required to obtained complex solutions. Viinika & Ubani (2019) stated the importance of learning and innovation skills that must be possessed by students in the 21st century include critical-thinking, creativity and innovation, collaboration, communication, and learning to learn. These skills are essential for students to face in the post-school world.

Various educational institutions strive to improve the quality of education based on the importance of education in improving the quality of human resources. One of the efforts to improve the quality of education in Indonesia is to make curriculum improvements periodically, along with the changing times. The current curriculum in Indonesia is the 2013 (K-13) revised 2017 curriculum, which oriented towards learning which requires the active role of students. Ministry of Education and Culture Regulation No. 36 of 2018 stated that K-13 changed 2017 competency-based designed to provide the most comprehensive learning experience for students in developing the ability to behave, be knowledgeable, be skilled, and act by giving students direct learning experience (Depdikbud, 2018).

Based on the results of the PISA survey, Indonesia's ranking in 2012 ranked 64th out of 65 participating countries with a score of 382. In 2015, Indonesia ranked 64th out of 72 participating countries with a score of 403. Furthermore, in 2018 Indonesia was ranked 70th out of 78 participating countries with a score of 396 (OECD, 2019). From the results of the last three surveys, Indonesian students' score is still far from the international average score set by PISA, which is 500. PISA questions not only measure students' ability to apply concepts but how they can apply in various situations. In this case, these skills are critical-thinking skills. Critical thinking is the strategy of thinking about thinking that improves students to be of acceptable quality by applying assessment forms, making judgments, and dealing with knowledge constructions (Saleh, 2019). According to Facione (2013), indicators of critical-thinking skills, among others, interpretation, analysis, evaluation, inference, explanation, and self-regulation.

Physics is one of the subjects at the secondary level (SMA/MA/SMK) in the specialization in Mathematics and Natural Science. The Ministry of Education and Culture stated on Regulation No. 59 of 2014, "The objectives of learning physics include developing the ability to reason, which is applying physical concepts and principles in explaining various natural phenomena, and also solving problems". Based on the description above, learning physics intends to develop the skills of students to be able to be literate in science or what is known as scientific literacy. Scientific literacy defined as the ability to use scientific, knowledge, identify questions, and draw conclusions based on evidence, to understand and make a decision relating to nature and the changes made by humans or nature (OECD, 2017). Sunarti (2018) states that learning scientific literacy is emphasized on using physical knowledge to explain phenomena scientifically, evaluate and design scientific investigations, interpret data, and provide scientific evidence. In this case, critical-thinking skills as a fundamental skill to develop themselves in providing analysis, assessment, and decision-making ability to solve problems are needed.

Based on pre-research conducted in November 2019 at SMAN 1 Gondang Nganjuk, it found that some of the competencies of students' critical-thinking skills were still in the low category. The percentage of indicators of critical-thinking skills interpretation by 36%, analysis by 34%, inference by 31%, evaluation by 39%, and explanation by 36%. Observation results show that the students' critical-thinking skills are low because students have difficulty interpreting data, identifying false assumptions, analyzing and explaining the relationship of scientific phenomena to the concept in physics learning. It reinforced by the results of the interview with physics teachers who stated that in learning, they still use conventional models. Although in learning the teacher associates the concept of physics with everyday life, but indicators of critical-thinking skills have not been trained in learning. Whereas, in the 21st-century education paradigm, critical-thinking skills as one of several learning skills and innovations that expected to be achieved by students to prepare for post-secondary education and the workforce (Changwong et al., 2018).

Based on the facts that have described, a solutive step is needed to create a significant physics learning activity in the hope of improving students' critical-thinking skills. Alternative learning models thought to be effective in enhancing critical-thinking skills in the context of 21st-century education. One such learning models is Case-Based Learning (CBL). CBL is a long-established pedagogical method that focuses on inquiry-

based learning and case study teaching that uses cases as a trigger of the though process. The trigger case or scenario used is well structured with a specific set of solutions (McLean, 2016). Thus, this learning model with structured issues is suitable for application to students who not accustomed to learning that train critical-thinking skills. When students deviate from the focus of the case, the teacher as a facilitator will guide so students can focus on the case question. Corresponds to Srinivasan et al. (2007) that stated CBL helps students' focus on the critical points of cases and encourages a structural approach to problem-solving while allowing facilitators to correct any incorrect students' assumptions, which does not always happen in Problem Based-Learning (PBL).

In improving critical-thinking skills, integrated science literacy on the learning model used in its implementation. It is because the students' literacy ability affects the overall learning outcomes. It is in line with Murti & Winoto (2018), in their research, state that there is a positive influence between students' literacy abilities on learning outcomes. Students with high literacy abilities tend to get better learning outcomes compared to students with lower literacy abilities. The implementation of integrated science learning can improve students' scientific literacy skills and affects the students' critical-thinking skills (Ardianto, 2016). Scientific literacy competencies, among others explaining scientific phenomena, evaluating and designing investigations, interpreting data, and scientific evidence (OECD, 2015).

This research conducted to improve students' critical-thinking skills through the integration of scientific literacy on the CBL model. Its integration by integrating each science literacy competence into the CBL learning activities. In explain scientific phenomena competence, students describe and evaluate issues and natural phenomena in daily life. Then in the competence of "evaluating and designing investigations", students conduct explorations and investigations through a virtual *PhET* laboratory. The competence of interpreting scientific data and evidence, students analyze scientific data and make appropriate conclusions. Therefore, through the scientific literacy approach, students can be actively involved in investigations to train critical-thinking skills at each stage of learning.

Critical-thinking skills improvement, efforts are needed through learning that encourages students closer to current issues and familiar to students' lives. In physics learning, several materials are closely related to the real-life of students, including global warming. The study of this complex global warming material is appropriate when CBL with scientific literacy approach is applied to analyze environmental issues that are currently of grave concern. Students, as academics, are required to be able to take an active role in exploring ideas to reduce global warming. Therefore, in this research, the material chosen is global warming.

The application of CBL has proven its effectiveness in several studies, among others, Sudibyo et al. (2016), in their research, found that CBL can significantly improve students' analytical thinking skills. Other than that, Giacalone (2016) states that case based-teaching allows students to apply students' analytical knowledge and skills on the relevance of real-life to the subject matter. Besides, Gunawardena (2017) states that the implementation of literacy learning can provide opportunities for students to be more able to explore and become critical learners. Based on the background, researchers are interested in conducting research "The Effect of Scientific Literacy Integration With Case-Based Learning Model on Students' Critical Thinking Skills".

METHOD

This type of research is a Quasi-Experimental design with quantitative descriptive analysis. The research model used in this study is a non-equivalent control group design based on the selection of samples not taken randomly (Sugiyono, 2017). The following is a pre-test post-test non-equivalent control group research design.

Table 1. Research Design

Class	Pre-test	Treatment	Post-test
Experiment 1	O_1	X_1	O_2
Experiment 2	O_1	X_1	O_2
Control	O_1	X_0	O_2

(Sugiyono, 2017)

Information:
O_1 = pre-test score (before treatment)
O_2 = post-test score (after treatment)
X_1= Treatment CBL with scientific literacy approach
X_0= Implementation of conventional learning model commonly taught at school

This research includes three classes of XI SCIENCE by observing at the pre-test stage, then given treatment and post-test. Pre-test (O_1) aims to determine the students' fundamental critical-thinking skills. Furthermore, students are provided by the treatment that is integrated science literacy on the CBL model in the "experimental classes" and the implementation of conventional models in the control class. Furthermore, students are provided by a post-test (O_2) to test students'

critical-thinking skills after being given treatment. Then, the pre-test and post-test results are analyzed to find out is whether any influence of integrated scientific literacy in CBL models on students' critical-thinking skills. The technique used in the research sample is purposive sampling. Through the introduction test in the previous material, it is showing that students have the same initial ability.

The manipulation variable in this research is integrated scientific literacy on the CBL model. The control variable is researchers who act as teachers, time allocation, and content of the material, and response variables are the improvement of students' critical-thinking skills. The research instrument used to measure students' critical-thinking skills was in the form of written test items with a total of 7 questions which adjusted for the indicator of critical-thinking skills include interpretation, analysis, evaluation, inference, and explanation. The data analysis technique used is the One-way ANOVA test with the help of SPSS 23.0 for Windows. Before testing the hypothesis, there is a prerequisite test that is the normality test and homogeneity test with the Kolmogorov-Smirnov test with the help of SPSS 23.0 for Windows. One Way ANOVA test used to determine whether there are differences in student learning outcomes in the three classes of research samples. Furthermore, the calculation of n-gain to identify the category of improvement in students' critical-thinking skills.

RESULTS AND DISCUSSION

Students' critical-thinking skills measurement used pre-test and post-test scores. The learning material was global warming, as shown in Table 2.

Table 2. Description of Experimental classes and Control Class Score

Class	Pre-test	Post-test
Experiment 1	33.68	82.76
Experiment 2	34.68	81.82
Control	34.85	58.03

Table 2 shows that there are differences in students' critical-thinking skills in the experimental and control classes. The students' critical thinking in the group of experiment 1 is higher than the control group. Students' critical-thinking skills improve after being treated. It means that the learning model applied to the learning process influences students' critical-thinking skills.

The data tested to test the hypothesis using the one-way ANOVA test is the post-test data. The N-Gain Test used to find out the improvement in students' critical-thinking skills after being treated. Based on pre-test results were tested for normality, the significance value for the control group is 0.200 or sig > 0.05, and for the group of experiment 1 and experiment 2 also is 0.200 or sig > 0.05. Based on the hypothesis that has formulated, if sig > 0.05, then H_0 is rejected (Yamin & Kurniawan, 2014). So, it can conclude that the pre-test scores in all three classes have a normal distribution. The homogeneity of the three groups of research samples comes from homogeneous variance. It based on the homogeneity test results using SPSS, which obtained a significance value of 0.95 or sig > 0.05. Based on the hypothesis that has formulated, if sig> 0.05, then H_0 is rejected (Yamin & Kurniawan, 2014). It can conclude that the pre-test scores in the three classes are homogeneous.

The same thing found in the post-test scores in all groups distributed reasonable and comparable. It indicated by the results of the normality test in the control class obtained post-test significance value 0.097 or sig > 0.05. The significance value of the post-test in the group of experiment 1 and experiment 2 was 0.152 and 0.179, respectively, or sig > 0.05. Based on the hypothesis that has formulated, if sig > 0.05, then H_0 is rejected (Yamin & Kurniawan, 2014). The homogeneity of the three classes comes from homogeneous variance. It based on the homogeneity test results using SPSS, which obtained a significance value of 0.291 or sig > 0.05. Based on the hypothesis that has formulated, if sig> 0.05, then H_0 is rejected (Yamin & Kurniawan, 2014). So, it can conclude that the pre-test scores in the three classes are homogeneous. Based on normality and homogeneity test results, it found that the samples reasonable and comparable, so the next is to conduct the One-way ANOVA test, and the result shown in Table 3.

Table 3. One Way ANOVA Result

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13360.647	2	6680.324	164.924	.000
Within Groups	4010.029	99	40.505		
Total	17370.676	101			

Based on Table 3, the One-way ANOVA test results obtained significance value 0.000 or sig <0.05, so H_0 is rejected. Therefore, it can conclude that there were

differences in critical-thinking skills between the three classes of research samples. One-way ANOVA test was done only to find out that there are differences in critical-thinking skills in the three groups, then further tests are conducted, the Post Hoc advanced analysis, and the result showing in Table 4.

Table 4. Post Hoc Advanced Result

(I) Class	(J) Class	Mean Diff (I-J)	Std. Error	Sig.
Exp 1	Exp 2	.941	1.544	.815
	Control	24.735*	1.544	.000
Exp 2	Exp 1	-.941	1.544	.815
	Control	23.794*	1.544	.000
Control	Exp 1	-24.735*	1.544	.000
	Exp 2	-23.794*	1.544	.000

Based on the Post Hoc advanced test, the significance coefficient between experiment 1 and experiment 2 got 0.815 or sig > 0.05. The significance coefficient between experiment 1 and control class got 0.000 or sig < 0.05. The significance coefficient between experimental class 2 and control class got 0.000 or sig < 0.05. It means there is no significant difference in learning outcomes between the group of experiment 1 and experiment 2. While between the group of experiment 1 and the control class, there are differences significantly, the same thing between the experiment 2 group and the control group, there are significant differences. It can conclude that there are differences significantly in critical-thinking skills between students who learned by the integration of science literacy on the CBL model and students who got by implemented conventional models.

The students' critical-thinking skills improvement, the n-gain calculation is performed. Through n-gain analysis, we know whether the students' critical-thinking skills improvement of the experimental class is better than the control class or vice versa. The results of the n-gain calculation, as shown in Table 5.

Table 5. N-Gain Results

Class	N <g>	Category
Experiment 1	0.73	High
Experiment 2	0.72	High
Control	0.35	Medium

Based on Table 5, showing that two groups of the experiment have great category improvement, while in the control class has medium category improvement. According to Hake (1998) shows <g> > 0.7 is included in high category and 0.7 > <g> > 0.3 is included in the medium category. Their results indicate that in Experimental 1 class, Experimental 2 class, and control class have an average N Gain of 0.73, 0.72, and 0.35 respectively. Based on the n-gain results, it can seem that the improvement in students' critical-thinking skills is included in the high category and is consistent in both "experimental classes" that are integrated scientific literacy on the CBL model. The difference in the value of N-gain in experimental class 1 and experimental class 2 due to cognitive abilities between students is different, so that even though the same material taught with the same teacher and the same time, but learning outcomes between students differ (Arends, 2012). Whereas, the improvement in critical-thinking skills in the control class after applying the conventional learning model included in the medium category.

It can use to conclude that the integrated scientific literacy on the CBL model can improve students' critical-thinking skills better than the conventional learning model. Astikawati & Sunarti (2019), in their research, found that the application of CBL can significantly enhance scientific reasoning skills. Scientific reasoning is a way to be able to think critically that involves cognitive skills in understanding and evaluating scientific information. In the other study, Arifin and Sunarti (2017) found that the application of guided inquiry increases the students' scientific literacy. It study accustoms students to carry out the stages of investigation so that students have scientific literacy competencies. While in this research, integrate aspects of scientific literacy competencies in the application of CBL to improve students' critical-thinking skills. Aspects of scientific literacy integrated into the CBL model include explaining scientific phenomena, evaluating and designing investigations, interpreting data, and scientific evidence which requires the existence of real-life phenomena that are supported by the data or graphics in the presentation of cases. If only applying the CBL model without data or

graphics, students' efforts to think critically are less provoked. Through the integration of scientific literacy in CBL can help students hone critical-thinking skills.

Other than that, Gunawardena (2017), in his research, found that literacy is the most effective approach to developing long-life learner skills, including effective communication, reading, and critical thinking. Whereas in this study, scientific literacy competencies integrated with the CBL model. If only applying a literacy approach without the CBL model, it's challenging for students' who are accustomed to learning with conventional methods. Through studying with integrated scientific literacy on the CBL model, students can actively involve in investigations which in the process can train critical-thinking skills. The CBL learning model requires teacher guidance so that students' knowledge is more systematic and directed in achieving learning objectives. The result of the n-gain analysis of each critical thinking skill indicator in three classes shown in Figure 1.

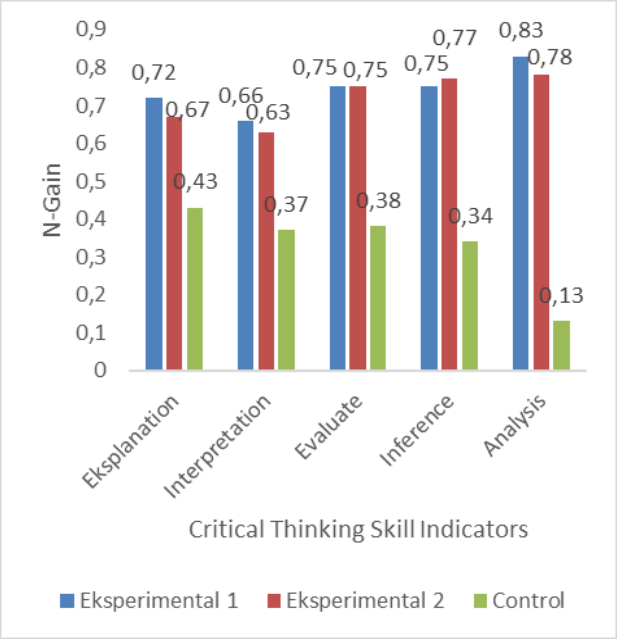

Figure 1. N-Gain Result

Based on Figure 1, it can know that all the indicators of critical-thinking skills have improved after the implementation learning model. The students' critical-thinking skills improvement in the experimental class in the high category shows that they are more capable of analyzing the relationship of concepts used in solving problems. They are also more proficient in interpreting issues based on data or graphs, in making conclusions correctly, in explanation or state opinions by providing rational reasons, and in evaluating or assess the credibility of a statement based on one's experience, perception, situation, judgment, and advice.

The indicator of explanation referred to the students' ability to express an idea by giving rational reasons based on the results that have obtained. The interpretation indicator related to how students identify the problem presented and write the meaning of the issue clearly and precisely based on data tables or graphs. The interpretation indicator has the lowest N-Gain value because students found it challenging to understand the contents of data tables or figures. However, this ability can still hone because the integrated science literacy on the CBL model allowed students to explore, investigate, and write the results of the investigation in a table or graph. This activity can make students familiar with the table or graph data.

The evaluation indicator required students to assess the credibility of a statement based on experience, perception, situation, judgment, and opinion. The inference indicator referred to how students draw the right conclusions by guessing alternative solutions. The analysis indicator referred to how students write the relationship between the concepts used in solving problems correctly. Based on N-Gain value, the analysis indicator had the highest one. That was because learning with integrated science literacy on the CBL model. Students presented with cases in daily life. And they could be resolved in more than one way by exchanging ideas or opinions with group discussions.

The success of CBL in improving critical-thinking skills was supported by steps of CBL learning that integrated science literacy competencies so that students can be actively involved in discovering the right formula. There is teacher guidance so that knowledge is more systematic and directed in achieving learning objectives. Learning activities that require formulating the problem, collecting information, processing information, doing a discussion, and presenting the results of the problem make students can master critical-thinking skills (Sujanem et al., 2018).

Integrated science literacy on CBL learning involves the activity of analyzing cases in daily life, so that train students' analytical skills. This result is in line with Sannathimmapha (2019) that everyday life case motivated and promoted students learning, and it enhances students' logical thinking. CBL learning with integrated scientific literacy can encourage students to be more active in the learning process and provide opportunities for them to explore and conduct an investigation. Learning through independent research by students on the integration of scientific literacy in learning makes there are interaction and discussion in

groups to exchange opinions to resolve cases. Investigate groups to find problems in their surrounding environment, analyze, and solve the problem stimulates the students' critical-thinking skills (Asyari, 2015).

CONCLUSION

Based on the research results, we conclude that the effect of integrated scientific literacy on student performance is to increase students' critical-thinking skill, which is part of the academic skills required. This skill improvement achieved during the class implementation of the CBL model adopted in this study. We find that the integration of scientific literacy into the model in class classified as 'high' for improved skill in critical-thinking performance

Based on this research, there are some suggestions given. Integrated science literacy on the CBL model requires recent cases or issues prepared by educators to trigger students' thought processes. Integrated science literacy on the CBL model requires investigation activities so that further research expected to develop experimental tools or virtual laboratories. Integrated science literacy on the CBL model requires proper time management when learning takes.

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