EST
Journal of Educational Science and Technology
Volume 7 Number 2 August 2021 page 226-235
p-ISSN:2460-1497 and e-ISSN: 2477-3840
DOI: https://doi.org/10.26858/est.v7i2.21858

The Effectiveness of Learning Tools: Improving Students' Scientific Literacy through Collaborative Learning

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(***Received***: 28-06-2021; ***Reviewed:*** 17-07-2021; ***Accepted:*** 19-08-2021;
Available online: 25-08-2021; ***Published:*** 29-08-2021)

Abstract. Scientific literacy is one of the skills that can meet all of the twenty-first century's educational demands. Educators are still struggling to find appropriate instructional tools for teaching these skills. Collaborative learning is considered a suitable model to train students' scientific literacy skills because collaborative activities can encourage students to be active in learning activities. The purpose of this research is to determine how effective learning tools based on collaborative learning is in improving high school students' scientific literacy skills in ecosystem materials. The type of research used is descriptive quantitative research with one group pretest-posttest research design. This study involved 30 students of X graders in Senior High School 1 Ngunut. The N gain score, paired sample t-test and a sensitivity test are used to determine the learning tools efficacy. Science skills exam questions are provided in 12 essay questions and are developed using scientific literacy indicators.The results showed an increase in the value of the science literacy skills test with an N gain value of 0.67, the sig value below 0.000 and a sensitivity of 0.48 The final result shows that collaborative learning are effectively used to improve students' scientific literacy skills.

Keywords: learning tools, collaborative learning, scientific literacy, ecosystem

INTRODUCTION:

One of the most important lessons to learn is science (Ahied, et al., 2020). The basis of learning science is providing a direct and meaningful learning experience for students, not merely memorizing or comprehending a topic. Students are taught to address issues in science classes, particularly through scientific literacy (Afriana, et. al., 2016). Scientific literacy refers to the knowledge and comprehension of scientific ideas and processes that are required for personal decision-making, community and cultural engagement, and economic production (Dani, 2009; Glaze, 2018).

Scientific literacy skills are one of the skills that are able to answer the demands of education in the 21st century, which include life and career skills, information technology and media skills, as well as learning and innovation skills which are divided into critical thinking, problem solving, communication, collaboration and creativity. The emphasis on the aforementioned skills should be on leading students so that they are trained and have the skills to think and learn in order to compete in the global era.This is a critical skill that students must learn more effectively (Deming et al., 2007; Udompong et al., 2013).

In fact, based on the results of interviews and surveys of researchers, some schools still find it difficult to teach scientific literacy skills effectively. One of them is at SMAN 1 Ngunut, Tulungagung. The biology teacher at SMAN 1 Ngunut stated that it was still difficult to find teaching materials that could train students' scientific literacy skills. So far, LKPD has been the only tool used to train students' scientific literacy skills through practical activities.

The identification of textbooks circulating in schools, as well as interviews with several biology teachers, revealed that the books met the guidelines but were not appealing to students to read.The textbook also does not link the concept to the phenomenon of the surrounding community, is less interactive and enrichment of practice of 21st century skills is still lacking.

According to a survey performed by the Program for International Student Assessment (PISA), Indonesian students have a poor level of scientific literacy, ranking 69th out of 76 nations (OECD, 2016). Other research (Fakriyah, et al., 2017; Rahmadani, et al., 2018; Utama, et al., 2019; Fuadi, et al., 2020) has found that students' scientific literacy abilities are lacking. These findings highlight the necessity of establishing scientific literacy in students as well as concentrating on the right learning techniques and resources.

The learning resources referred to above can be in the form of books. Textbooks are teaching materials that support and play an important role in learning by making it simpler, more interesting, practical, appear easier, more meaningful, and even capable of developing attitudes and values (Kemendikbud, 2016; Saad, 2017; Taber & Akpan, 2017).The preparation of good textbooks must pay attention to the clarity of principles, foundations, points of view, relevance of the curriculum, the ability of books to emphasize community values and practice life skills (Tarigan, 2009; Nurichah, 2012). This research is supported by the statement that to strengthen scientific literacy, it is important for teachers to understand the reality of education and the suitability of learning models with goals (Dragos & Mih, 2015).

One example of an effective learning model is collaborative learning. This learning model requires that learning is student-centered and does not emphasize competence, so that in the learning process, students who are more capable in academic terms can help less fortunate students. According to Wahyuni and Mustadi (2016), the model is for collaborative learning because it provides many learning experiences for students, expresses ideas and curiosity to solve a problem in groups, and increases responsibility and tolerance among students.

The stages of the learning process using collaborative learning include engagement, exploration, transformation, presentation, and reflection (Hosnan, 2014). The stage of the model is collaborative learning suitable be used to train students' scientific literacy. According to Anfa, Rachmadiarti, and Winarsih (2016), during the exploration and transformation stages, students are given the opportunity to discuss problem solving and seek knowledge by observing phenomena.The activities carried out by students in stage collaborative learning are in accordance with scientific literacy activities.

Previous research has also proven the effectiveness of-based collaborative learning learning (Mora, et al., 2019; Harvey & Uren, 2019; Deejring, 2014). The results of research from Anggraini, Rachmadiarti & Bashri (2019) show that through-based textbooks collaborative learning on environmental change materials, scientific literacy skills can be trained. Environmental change materials are thought to be appropriate for practicing scientific literacy skills because they are closely related to the students' lives.This also applies to ecosystem materials, materials that have a broad scope, close to the student environment (Anfa, Rachmadiarti & Winarsih, 2016).

Ecosystem materials can be taught through observing occurrences, evaluating and designing scientific studies, and scientifically interpreting facts and evidence in the environment around pupils. Several sub-chapters on ecosystem materials can be taught through hands-on activities that require students to examine and evaluate data in order to form conclusions. In the biogeochemical cycle subchapter, for example, students are required to demonstrate the role of plants in assisting the biogeochemical cycle through practical exercises. Project-based collaborative learning, in which students solve issues together, can be used to accomplish the practicum activities in question. Based on this foundation, more research is needed to develop students' scientific literacy skills through learning tools based on collaborative learning model of ecosystem material.

METHOD

The type of research used is development research. Learning tools are developed in the form of syllabuses, lesson plans and textbooks. The development of textbook-based collaborative learning to improve science literacy for class X high school students uses the Borg & Gall (2007) development model. According to Borg & Gall (2007), there are ten stages of research and development, namely (1) research and data collection, (2) planning, (3) development of initial product drafts, (4) initial field trials, (5) revision of test results trials, (6) field trials, (7) operational product revisions, (8) field implementation tests, (9) final product revisions, and (10) dissemination and implementation. However, in this research and development, not all of these stages are applied. The ten stages were adapted into seven stages according to the needs and conditions of the research. Thus, the researchers only carried out seven stages of the development model. The seven stages are (1) preliminary study, (2) development planning, (3) product draft development, (4) validation test, (5) initial product revision, (6) limited field test, (7) final product refinement. The eighth to the tenth stages were not carried out due to time and cost constraints.

The first trial of the application of the device was carried out on class X students of SMAN 1 Ngunut with a sample of 30 students in January of the 2020/2021 school year. Data was collected using test and documentation techniques. The assessment instrument uses a student's scientific literacy skills test, which is prepared by taking into account three indicators of scientific literacy and is presented with 12 essay questions. The instrument adapted from OECD (2016) is presented in Table 1.

Table 1. Scientific literacy indicator

Indicator of scientific literacy	Question number
Observing a phenomena	1,2,3,9
Evaluating and designing scientific investigation	7,8,10,11
Interpreting data and evidence scientifically	4,5,6,12

The results of students' pre-tests and post-tests on ecosystem materials are used to determine the effectiveness of learning and increasing students' scientific literacy before and after learning. This increase is known through N-Gain analysis. The N gain can be expressed by the formula (Hake, 2014), and interpretation of students'scientific literacy (by using N-Gain score) is describe in Table 2.

$$<\mathbf{g}>= \frac{\% < Sf > - \% < Si >}{\% < S\ maks > - \% < Si >} x\ 100\%$$

Description:

St = final score (posttest)
Si = initial score (pretest)
Smax = maximum possible score

Table 2. Interpretation of scientific literacy (gain score)

Score interval	Interpretation
>0.7	High
0.7≥X≥0.3	Medium
<0.3	Low

To determine the effect of tool-based collaborative learning on improving scientific literacy skills, student scores were collected and analyzed using the normality test, homogeneity test, and paired sample t-test.The sensitivity of the items is also analyzed, in order to determine the effectiveness of a lesson. The item sensitivity index is a measure of how well the items distinguish between students who have received learning and students who have not received learning. The sensitivity of the item (S) is calculated based on the formula suggested by Ngalim (2002):

$$S = \frac{RA - RB}{T}$$

Description:

S = Success sensitivity is sought.

RA = The number of students who correctly answered the item after the teaching process (posttest).

RB = The number of students who answered correctly the item before teaching process (pretest)

T = The number of students who take the test

The instrument item sensitivity index has an interval of 0.00 to 1. The greater the value of S for a test item, the more sensitive the test will be to learning (Gronlund, 1982). Items that have a sensitivity index of ≥ 0.3 have sufficient sensitivity to the effects of learning (Aiken, 1997).

RESULTS AND DISCUSSION

Result

Learning device is said to be effective if there is an increase science literacy skills of students with the acquisition of N-Gain score ≥ 0.3, paired sample t-test of <0.05 and sensitivity score items. ≥0.30. There were a total of 12 pretest and posttest questions with scientific literacy indicators used to evaluate the degree of students' scientific literacy skills in the form of questions. The following scientific literacy indicators were used in this study: (a) observing a phenomenon (recognizing, providing, and evaluating explanations for various phenomena), (b) evaluating and designing scientific investigations (description and assessing scientific investigations and proposing ways to answer questions scientifically), and (c) scientifically interpreting data and evidence (analysis).The level of students' scientific literacy skills was obtained by using the analysis method for obtaining test scores for each individual and for each scientific literacy indicator.

Science Literacy Skills Test Score

The average score of students' pretest and posttest scores can be used to see the increase in their scientific literacy skills, because the analysis of learning outcomes data uses the degree of improvement in N-Gain. The results of the analysis of student learning outcomes and scientific literacy skills are presented in Table 3.

Tabel 3. Achievement of students' scientific literacy skill

No	Student's name	Pre-test	Criteria	Post-test	Criteria	N Gain	Category
1	A	58.33	Fair	85.4	Very good	0.65	Medium
2	B	64.58	Fair	89.6	Very good	0.76	High
3	C	68.75	Fair	87.5	Very good	0.60	Medium
4	D	70.83	Good	83.3	Good	0.43	Medium
5	E	68.75	Fair	85.4	Very good	0.53	Medium
6	F	60.42	Fair	83.3	Good	0.58	Medium
7	G	68.75	Fair	91.7	Very good	0.73	High
8	H	66.67	Fair	89.5	Very good	0.69	Medium
9	I	60.42	Fair	85.4	Very good	0.63	Medium
10	J	72.92	Good	93.8	Very good	0.77	High
11	K	52.08	Fair	83.3	Good	0.65	Medium
12	L	60.42	Fair	87.5	Very good	0.68	Medium
13	M	64.58	Fair	93.8	Very good	0.82	High
14	N	77.08	Good	91.7	Very good	0.64	Medium
15	O	68.75	Fair	85.4	Very good	0.53	Medium
16	P	66.67	Fair	87.5	Very good	0.63	Medium
17	Q	64.58	Fair	79.2	Good	0.41	Medium
18	R	68.75	Fair	91.7	Very good	0.73	Medium
19	S	70.83	Good	87.5	Very good	0.57	Medium
20	T	72.92	Good	87.5	Very good	0.54	Medium

No	Student's name	Pre-test	Criteria	Post-test	Criteria	N Gain	Category
21	U	68.75	Fair	83.3	Good	0.47	Medium
22	V	64.58	Fair	89.6	Very good	0.71	High
23	W	66.67	Fair	89.6	Very good	0.69	Medium
24	X	75.00	Good	95.8	Very good	0.83	High
25	Y	66.67	Fair	87.5	Very good	0.63	Medium
26	Z	58.33	Fair	83.3	Good	0.60	Medium
27	AA	66.67	Fair	91.7	Very good	0.75	Medium
28	BB	60.42	Fair	85.4	Very good	0.63	Medium
29	CC	68.75	Fair	85.4	Very good	0.53	Medium
30	DD	68.75	Fair	77	Good	0.26	Low
Average		66.39	Fair	87.29	Very good	0.62	Medium

Based on the table above, obtained an N-gain value of 0.62 in the medium category. Students' literacy skills increase as a result of studying with learning tools based on collaborative learning model.

The effect of the collaborative learning tools on students' scientific literacy skill

The data normality test was conducted to determine whether the data from each group was normally distributed or not. The normality test of this data must be carried out before the statistical hypothesis is determined. The homogeneity of the data can also be analyzed after conducting the homogeneity test. Then, the decision making is adjusted to the results of the paired sample t-test. The results of the normality test, homogeneity test and paired sample t-test using SPSS can be seen in the following table.

Tabel 1 The effect of the collaborative learning tools on students' scientific literacy skill

Statistic Parameter	Score	
	Pre-test	**Post-test**
Mean	66.39	87.29
Normality test	0.259	0.526
Homogeneity test	0.320	
Paired sample t-test	0.000	

According to the table above, the value of the sig. normality test is greater than 0.05, indicating that the data is normally distributed. A sig.value of 0.320 > 0.05 was obtained in the homogeneity test, indicating that the data was homogeneous and could be used for statistical tests. The statistical paired sample t-test yielded a sign of 0.000 ≤0.05. As a result, there is an effect of using collaborative learning tools on improving students' scientific literacy skill.

Item sensitivity

Table 5. shows the results of the sensitivity (S) calculation for the student literacy skills exam that was administered.

Tabel 5. Results of item sensitivity

Qustion Number	R_B	R_A	Sensitivity	Criteria
1	11	21	0,33	Sensitive
2	6	23	0,57	Sensitive
3	3	12	0,3	Sensitive
4	7	19	0,4	Sensitive
5	2	14	0,4	Sensitive
6	9	26	0,57	Sensitive
7	4	19	0,5	Sensitive
8	3	17	0,47	Sensitive

Qustion Number	R_B	R_A	Sensitivity	Criteria
9	7	18	0,37	Sensitive
10	5	15	0,33	Sensitive
11	2	22	0,67	Sensitive
12	3	24	0,7	Sensitive
Average of item sensitivity			0.46	Sensitive

Based on this data, it is known that questions No. 1 to 12 have a sensitivity value of ≥ 0.3, so that the problem does not need to be repaired and is appropriate if used. Questions number 1,2,3 and 9 are questions with indicators of observing a phenomenon. Questions number 7,8,10,11 are questions with indicators for evaluating and designing scientific investigations. Questions number 4,5,6,12 are questions with indicators to interpret data and evidence scientifically. The questions were then tested on 30 high school students in class X so that the pretest and posttest scores were obtained.

Discussion

Based on the table above, obtained an N-gain value of 0.62 in the medium category. Students' literacy skills increase as a result of studying with learning tools based on collaborative learning model. Several factors contributed to the medium category for the value of N gain in scientific literacy skills, including the results of the pretest analysis and interviews with teachers and student representatives, which revealed that students were not used to working on the form of scientific literacy skills. Description-style questions necessitate a high-level thinking process, so that the average student's answers do not correspond to what was ordered in the question. So far, students are given questions based on the questions contained in the student handbook in the form of multiple choice and short entries. Students continue to struggle with answering questions in the form of descriptions because their responses are still in the form of short answers. Gunawan (2016), in his research, explains that if someone is used to solving story-form problems, they will automatically know what is known and what is asked in each question, according to their habits. The pretest carried out at home was also analyzed as the cause of the high pretest score, because of the lack of teacher supervision of the work. Thus, the difference between the students'- pretest and posttest was not too high (the increase in students' scientific literacy skills was not too high).

Scientific literacy skills are said to be the ability to understand nature, make observations and draw conclusions about them (nature), as well as identify scientific problems using scientific concepts. can use scientific process skills to solve problems that are relevant to real life. and able to engage with science-related ideas and professions (OECD, 2019; Roberts & Bybee, 2015). The variables that can increase scientific literacy abilities, according to Hestana & Rosana (2020), include fact-oriented issues and using problems as the beginning point of learning. Students are directed in text-based conversations through reflection exercises with biology professors. The students' grasp of the topic is still based on a sequential thinking process. Therefore, the teacher's responsibility in assisting students in thinking about the problem must be to first describe the problem and then connect it to a specific solution. Through precise verification, questioning facts and explaining scientific phenomena demonstrates scientific truth. Students must check the data in order for the analysis to be more exact.

The effectiveness of learning tools is also seen through their influence on improving scientific literacy skills. The findings of the *paired sample t-test* indicated that the sign of $0.000 < 0.05$. As a result, learning aids based on a collaborative learning model have a substantial impact on scientific literacy skills improvement.

To improve students' scientific literacy, the collaborative learning model is the best option. The learning tools that have been developed have aided this process. This is because collaborative activity stages can inspire students to participate actively in learning activities, resulting in positive participation in the same activities. Another benefit of collaborative learning is that it aids in the learning of difficult subjects (Sweller. Ayres & Kalyuga. 2011), for example ecosystem material. By using a learning model of collaborative learning that is rooted in the surrounding environment and focuses on students, this will certainly require them to work together, collaborate and be creative in analyzing the problems that occur, so that they can provide useful solutions.

The idea of borrowing and reorganization is used in collaborative learning. Information may be taken from other group members, reorganized, and combined with prior knowledge retained in pupils' long-term memory. (Paas & Sweller, 2012; Plass et al., 2013; De Corte, 2004; Paas & Sweller, 2012; Plass et al., 2013; Paas & Sweller, 2012). This type of learning has developed as a new type of future education in schools that is geared toward group learning. Improve problem-solving skills and encourage students to participate in class, such that learning outcomes are improved and learning processes are slowed (Chuen et al., 2008; Suh, 2011). The teacher becomes a facilitator in the conversation when students are involved in the process of fixing this challenge. When conflicts arise, experts are called in, as well as observers of group activities (Laal & Godsi. 2011; Astra, Wahyuni & Naseby. 2015). Students will be more engaged as a consequence, and the aim of exercising scientific skills will be achieved.

The exam questions presented during collaborative learning were also evaluated for sensitivity. The average item sensitivity score is 0.46 The highest sensitivity of the question is 0.7 in question number 12, analyze the pattern of interaction in the ecosystem based on data, while the lowest sensitivity is 0.3 in the 3rd question, which explains the relationship between differences in temperature and humidity in an environment and the differences in the vegetation biomes that exist on the earth.The average score obtained also shows that the tests that have been prepared are good. Items with a sensitivity index greater than 0.3 are sufficiently sensitive to the effects of learning.and the higher the value of S means the question has a better sensitivity (Gronlund, 1982; Aiken, 1997). The question with the highest sensitivity (0.67) is the question about the 11th indicator, which is analyzing the components of the water cycle against the concept of the biogeochemical cycle. There were ten students who correctly answered this question during the posttest, whereas no students correctly answered it during the pretest.The problem with the lowest sensitivity (0.33) is found in indicator 3, which explains the relationship between differences in temperature and humidity in an environment with differences in biome vegetation on earth. Despite the fact that the obtained score was only 0.33, The score is said to be quite sensitive. The question is effective and does not need to be discarded (Aiken, 1997). In addition to knowing the level of effectiveness, this item analysis is carried out as a reference for revising questions that are not relevant to the material being taught. So, refinements can be made to the items, so that in the future, the learning outcomes test prepared or designed by the teacher can measure what is being measured (Fitrianawati, 2018).

CONCLUSIONS AND SUGGESTIONS

Learning tools based on collaborative learning on ecosystem materials are effectively used to improve students' scientific literacy skills, with anscore N gain of 0.67, the score of the paired sample t-test is 0.000 and the sensitivity is 0.48. Learning tools in the form of a syllabus, the lesson plans and textbooks based on collaborative learning which are only developed on ecosystem materials are a limitation of research that needs to be followed up. Therefore, further research needs to be done in the form of extensive trials with more student subjects, or by developing learning tools based on collaborative learning on other materials.

ACKNOWLEDGMENTS

I would like to thank Indonesia Endowment Fund for Education (LPDP) from the Ministry of Finance Republic Indonesia for granting the scholarship and making this research and possible.

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