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RICOSRE FOR THE EMPOWERMENT OF STUDENTS' SCIENTIFIC LITERACY IN AN ISLAMIC BOARDING SCHOOL

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ABSTRACT
Scientific literacy skills are very important in the learning process and daily life. Scientific literacy does not arise suddenly but requires a facilitator who enables it. One of these is the application of learning models that have the potential to improve scientific literacy. A learning model that has the potential to improve science literacy skills is Problem-Based Learning one of which is RICOSRE. This study aims to investigate the effect of RICOSRE on the science literacy skills of grade X students compared to PBL and conventional models. This study involved 94 students from SMA Progresif Bumi Shalawat Sidoarjo, East Java, Indonesia, and employed a pretest-posttest design with a non-equivalent controls group. The pretest and posttest consisted of 8 essay questions each. ANCOVA and LSD tests to analyze student scores. The results indicated a significant effect of RICOSRE on the students' scientific literacy skills. The student's average score on scientific literacy skills increased considerably (45,23%) on RICOSRE and PBL (15.73%) and decreased in conventional learning by 4.57%. RICOSRE can be implemented to empower students' scientific literacy skills. These results indicate that RICOSRE is proven to be more effective in improving students' scientific literacy skills compared to PBL and conventional learning models.

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1. INTRODUCTION

In the 21st century, the progress of science and technology in different countries is increasing rapidly. Each individual must make decisions based on scientific information to solve problems of daily life and produce useful scientific products based on scientific education. Given the importance of science literacy, educating science literacy to the public is the main goal of any reform of science education (Deboer, 2000). Science literacy is one of science education's targets (Holbrook & Rannikmae, 2009).

Indicators of scientific literacy by the Programme for International Student Assessment (PISA) include: (a) the ability to explain phenomena scientifically, (b) design and evaluate scientific inquiry, and (c) interpreting data and evidence scientifically (OECD, 2017a). The latter could be more specified by dividing it into two, procedural knowledge (i.e., the procedures and strategies used in all forms of scientific inquiry) and epistemic knowledge (i.e., how ideas are justified and warranted in science) (OECD, 2017b). So, there are three kinds of knowledge required to achieve these competencies.

In this case, science education that includes 21st-century skills is very important to develop students' scientific literacy, which in turn will become scientifically literate citizens in the future. It is well accepted that education in schools must be changed to create the new forms of learning needed to meet the complex challenges of a global future. Trends in International Mathematics and Science Studies (TIMSS) 2011 in the field of scientific literacy, Indonesia is ranked 40 out of 42 countries (Mullis, Ina V S Martin, Michael O Foy, Pierre Arora, 2011). The results of the Program for International Student Assessment (PISA) 2012 published by the Organization for Economic Cooperation and Development (OECD) also show Indonesia's position which is ranked 64th out of 65 countries (OECD, 2017b).

The majority of students in Indonesia perform poorly in scientific literacy (Dian Dwi, Lisdiana, & Sri, 2016). Based on the results of preliminary research, it is known that students at SMA Progresif Bumi Shalawat Sidoarjo get an average score of 1.9 on a 4-point scale. Furthermore, the results of interviews conducted with a group of biology teachers showed that students always have difficulties in solving problems and applying knowledge in real contexts due to a lack of interest in reading/literacy. These limitations indicate the students' lack of creative thinking ability (Deboer, 2000).

Approaches/strategies/models/learning methods are indispensable in supporting the realization of all competencies and skills contained in the 2013 Curriculum (K13), one of which is scientific literacy skills. The teacher does not pay special attention to basic scientific literacy. In Indonesian classrooms, forms of pedagogical "delivery" that direct learning toward indifference and boredom still dominate. (Zubaidah, 2017). According to Jannah (2020) and Suwono (2020) factor that affects students' scientific literacy is the learning process (Jannah, Suwono, & Tenzer, 2020); (Suwono, Salmah, & Tenzer, 2020). Teachers acting as agents of change play an important role in providing science education to students to achieve science learning goals (Yasemin, Pınar, Bülent, Jale, & Hamide, 2010). Therefore, it is expected that teachers also have good scientific literacy (Cavas, Ozdem, & Cavas, 2013).

Scientific literacy is not an innate skill; it can be developed with the teaching strategies, pedagogies, and methodologies used in education (Siarova, Sternadel, & Szőnyi, 2019). The purpose of teaching is to solve problems, so a teacher must be able to identify and solve problems in the classroom, including making decisions. (Suwono, 2016). Thus, Problem-Based Learning known as PBL can also be applied to empower scientific literacy (Turiman, Omar, Daud, & Osman, 2012). PBL includes the following activities: aligning students with problems, organizing students for learning, supporting independent and group inquiry, developing and presenting artifacts and exhibits, analysing and evaluating problem-solving processes. (Richard, 2012). Another learning model that has the potential to improve science literacy among students is Reading, Identifying the problem, Constructing the solution, Solving the problem, Reviewing the problem solving, and extending the problem solving (RICOSRE), because RICOSRE is a development and adapted from PBL. RICOSRE is a learning model developed by Mahanal & Zubaidah. The RICOSRE syntax consists of Reading, identifying problems, constructing solutions, Solving the problems, Reviewing the problem-solving process, and extending the problem-solving process. The basic difference syntaxes between PBL and RICOSRE are to read, check the problem-solving process and extend the problem-solving process.

This study aims to investigate the effect of RICOSRE on students compared to PBL and conventional models. RICOSRE is believed to affect students' scientific literacy.

2. RESEARCH METHOD

This quasi-experiment uses a pre-test-post-test design with non-equivalent controls and scientific literacy as the dependent variable and RICOSRE, PBL, and conventional as the independent variables. The quasi-experimental design is presented in table 1.

Table 1. Pretest-Posttest Non-Equivalent Control Group Design

Pretest	Treatment Group	Posttest
O_1	X_1	O_2
O_3	X_2	O_4
O_5	X_3	O_6

The pre-test includes O1, O3, and O5 (scientific literacy skills and early learning outcomes); The post-test includes O2, O4, and O6 (scientific literacy skills and final learning outcomes); while in the X1 treatment group for RICOSRE, X2 for PBL and X3 for conventional learning models).

Participants in this study were selected by lottery using the random sampling method. They consist of 94 students from three different classes (X MIPA 4, X MIPA 5, and X MIPA 6) of SMA Progresif Bumi Shalawat Sidoarjo, East Java, Indonesia. This quasi-experiment was conducted in the odd semester of the 2020/2021 academic year (from September to October 2020).

The indicators used in measuring scientific literacy adapted to scientific literacy competence in the Program for International Student Assessment (PISA) include (1) explaining phenomena scientifically, (2) designing and evaluating scientific inquiry, and (3) interpreting data and evidence scientifically (OECD, 2017a). The students' scientific literacy skills were assessed using an essay test that is presented in Table 2, which has been tested for validity and reliability. Item validity and reliability were tested using Cronbach's alpha. The normality and homogeneity of the analysed data were respectively tested using the one-sample Kolmogorov-Smirnov and Levene's test for equality of error variances, while the ANCOVA analysis was performed using the SPSS application. The final test, the LSD test, was performed after the significance of the hypothesis test results had been confirmed.

3. RESULT AND DISCUSSION

ANCOVA analysis and the increase in students' scientific literacy scores are presented in Table 2 and Table 3.

Tabel 2. ANCOVA Analysis

Source	Type III Sum of Square	Df	Mean Square	F	Sig.
Corrected Model	5931.854[a]	3	1977.285	344.332	.000
Intercept	927.893	1	927.893	161.587	.000
XKBK	1888.431	1	1888.431	328.859	.000
Class	5546.032	2	2773.016	482.904	.000
Error	511.071	89	5.742		
Total	181944.000	93	1977.285		
Corrected Total	6442.925	92	927.893		

Table 2 shows that the learning model applied in this quasi-experimental research has a significant effect on students' scientific literacy thinking skills (F-calculated = 482.904, with a significance level of 0.00<0.05).

Tabel 3. Increase in Student's Scientific Literacy Skills

Treatment Group	Pretest	Posttest	Difference	Increase	Average Score	LSD Notation
RICOSRE	30.688	52.406	21.719	70.77%	54.64	a
PBL	35.161	40.129	4.968	14.13%	39.008	b
Conventional	35.300	37.300	2.000	5.67%	36.075	c

Table 3 showed that the students' scientific literacy scores improved by 70.77% in RICOSRE, 14.13% on PBL, and 5.67% in a conventional classroom. It was concluded that the increase in students' scientific literacy scores in the RICOSRE class was more significant in both the PBL and conventional classes. For more details, a comparison of students' literacy scores is shown in Figure 1.

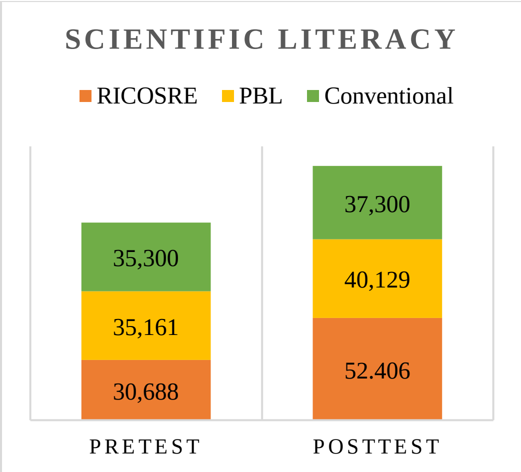

Figure 1. Students' scientific literacy score

A significant difference in students 'scientific literacy in the RICOSRE compared to conventional learning and PBL is inseparable from the application of RICOSRE stage that has the potential to empower students' scientific literacy. The stage of the RICOSRE learning model is similar to learning the development of science literacy (Basam, Rusilowati, & Ridlo, 2017). The first stage of the RICOSRE begins with Reading (R) which is the beginning for students to practice scientific literacy. Students are instructed to read and make resumes obtained from valid and credible sources. Fang (2005) states that reading can help students understand complex problems in science (Fang, 2005). Reading activities help students to understand topics and active learning also become important in the development of scientific literacy (Norris & Phillips, 2003).

In the second stage or identifying the problem (I) in this stage students are trained in identifying the problems that have been presented. According to OECD (2012) identifying a problem might make a different learning experience for each student (OECD, 2012). The problems presented in this stage are in accordance with PISA standards, namely problems involving important issues in society (Uus, Sri, & Andrian, 2011). Students will realize the problem in the discourse, then make a list of solutions needed to solve the problem (Mahanal & Siti, 2017). In the third stage constructing the solution (C), students are trained in designing solutions to problems that have been discussed in the previous stage. Students can design solutions to problems by understanding concepts and carrying out appropriate discussion and brainstorming procedures (Selçuk, Çal, & Erol, 2008). In scientific discussion activities can improve students' scientific literacy skills by broadening their horizons regarding related problems.

In the fourth stage Solving the problem (S) is an important stage to improve the basis of scientific literacy skills because scientific literacy is related to good problem-solving skills. The problem-solving activities provided in the worksheet or UKBM must go through the process of interpreting and analysing one or more relationships between data, problems, and technology. When students already have the skills to interpret data and scientifically proven, students can improve their scientific literacy skills. The next step is Reviewing the problem solution (R), students are trained to review, explore, and consider which solutions are more relevant than other solutions. The review of contextual problem solutions aims to increase student contributions in real life in the future (Holbrook & Rannikmae, 2009). According to Deanna (2005) based on his book, the selection of the right solution based on correct thinking and review can improve communication skills, critical thinking skills, and scientific literacy skills (Deanna & Richard, 2005).

In the last stage, Extending the solution to the problem (E) Students are asked to evaluate the solutions found. The results of the evaluation process can be viewed by the students as a reward for future work on similar issues, this is related to the ability to evaluate scientific investigations. (OECD, 2017a). At this stage, students are very empowered with scientific study excitement activities that also affect students' scientific literacy skills. All stages of the RICOSRE are similar to Andersen, et al research in 2007 which states that the problem identification activities, the selection of solutions, the assessment of solutions to problems, and the expansion of solutions to problems are meaningful learning that can facilitate cognitive and metacognitive processes, develop communication skills, develop problem-solving skills, support students' understanding of life culture and practices, and improve scientific literacy skills (Andersen, Clark, & Duschl, 2007).

4. CONCLUSION

RICOSRE is proven to be more effective in improving students' scientific literacy compared to PBL and conventional learning models. Therefore, the implementation of this learning model is highly recommended. The consistency of the effect of RICOSRE in encouraging students' scientific literacy needs to be studied further on more diverse variables.

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