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The Effect of Blended Problem-Based Learning on Problem Solving and Scientific Literacy in High School Students

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ABSTRACT: Problem-solving skills and literacy skills are two abilities that are important for students to master in this century. Appropriate strategies must be applied by the teacher for students to master both skills properly. This study aims to determine the effect of applying blended problem-based learning to improve students' problem-solving skills and scientific literacy skills. The research was conducted on 96 students of class XI at the secondary level. The study was conducted in two groups which were given different treatments. The group that is taught uses blended problem-based learning and the group without blended problem-based learning. There are two findings from this study indicating that 1) the group that was taught using blended problem-based learning obtained an average score of problem-solving skills that was higher than the average value of students without blended problem-based learning and, 2) literacy skills were obtained with a higher average high in the group that was studied using blended problem-based learning. Blended problem-based learning has a positive impact and strong influence on improving problem-solving skills and scientific literacy.

KEYWORDS: Blended learning, problem solving, scientific literacy, problem-based learning

I. INTRODUCTION

Integrating 21st-century skills in science learning is very important (Duran, E. et al., 2011), (Stehle and Peters-Burton, 2019), (Nwoye et al., 2020). As part of science learning, teaching chemistry to students should be a combination of educational principles and the concept of chemistry itself. The aim of learning in chemistry education is to understand chemical concepts and also the phenomena of various chemicals around us in everyday life, to create meaningful learning. In this context, chemistry learning faces challenges between basic chemistry concepts that need to be developed during chemistry learning, but on the other hand students' mastery of 21st-century skills is also very important to develop (Hadinugrahaningsih et al. al., 2017) (Aisyah et al., 2022).

Chemistry is considered a difficult subject for young students because chemistry consists of abstract concepts and is also highly related to everyday life (Ayas & Demirbas, 1997) (Sirhan, 2007) (Boachie et al., 2021). Chemistry subjects represent three aspects of the world that are represented, namely macroscopic, microscopic, and symbolic (Treagust et al., 2003 Tuysuz et al., 2011). During chemistry lessons, students must understand chemical concepts to solve many problems to build their knowledge based on their understanding (Rahmawati & Ridwan, 2017). Problem-solving skills are valuable skills that must be mastered by students when they enter the real world which has various kinds of problems from easy to complex problems (Zamakhsyari & Rahayu, 2020). Therefore, problem-solving skills are noble competencies that must be mastered by students in learning chemistry.

Another competency that is valuable in the 21st century, besides problem-solving skills in chemistry lessons, is digital-era literacy. Digital era literacy consists of scientific literacy, digital literacy, and also global awareness (Rahayu, 2017). Scientific literacy competence has become a demand for everyone in everyday life and the world of work. Everyone with good scientific literacy can use any scientific information to solve their problems in everyday life (Enawaty & Erlina, 2021). The importance of learning chemistry with the integration of scientific literacy is reinforced by the data from the 2018 PISA assessment (OECD, 2019). Based on the PISA assessment, Indonesian students have low scientific literacy scores. The average score of Indonesian students' scientific literacy skills is below 500 and ranks fifth from the bottom for the last seven years. Low scores indicate that Indonesian students tend to have basic-level abilities to recognize some scientific facts, but they cannot communicate and associate various scientific topics (Enawaty & Erlina, 2021). Therefore, an effort is needed to increase scientific literacy by choosing the right learning design model so that it can have implications for mastering good problem-solving skills.

A suitable learning model that is applied in the 21st century is learning that is carried out through the bold use of technology or a combination of bold and attractive which is often known as blended learning or hybrid learning (Clevelands-Innes & Wilton, 2018). The purpose of Blended learning is to increase and expand learning opportunities for students so that learning effectiveness can be achieved (Garrison and Kanuka, 2004) (Su, 2020), facilitating several 21st-century skills such as critical thinking, creativity, and mastery of complex thinking skills (Su, 2020). *Mixed learning* as one of the 21st-century learning models (Tarvyd, 2019), can be combined with other learning models to achieve the expected 21st-century content. Problem-solving is one of the contents of the 21st century (Trilling, B., & Fadel, C., 2009) which can be increased through *mixed learning* combined with *problem-based learning* (PBL) so that it becomes a *mixed learning model. problem-based learning* (B-PBL).

The application of blended problem-based learning in chemistry classes has been studied by several researchers. Research by Aisyah et al., (2022) proved the effect of differences in learning outcomes between students who studied the Blended Problem Based Learning (B-PBL) model and conventional problem-based learning models in chemistry learning. An investigation by Alias et al., (2020), showed that the application of reverse class problem-based learning (FC-PBL) to chemistry subjects in secondary schools could improve problem-solving skills better than a control class without FC-PBL. The application of FC-PBL in chemistry class has been proven by Paristiowati (Paristiowati et al., 2019) which can have a positive influence on the critical thinking skills and also scientific literacy of high school students.

An acid-base titration is an analytical chemistry topic for [class] XI students at the secondary level. According to Akani's research, (2017) 8 (eight) topics are considered difficult in Chemistry. They are analysis of acid-base titrations, reaction rates, the composition of non-metals and metals, astronomical chemistry, and finally nuclear chemistry. An acid-base titration is a challenging topic because acid-base reactions including the concepts of acidity and basicity and also their relationship to the concept of titration are an important part of any general chemistry course, and students have difficulty (Salame et al., 2022) to understand these concepts this concept. Students tend to focus on memorizing the facts and formulas used rather than trying to understand the concepts behind the topic of acids and bases and developing their problem-solving skills. In addition, based on observational interviews with several students, the researchers found that students did not know about the application of acid-base titrations in everyday life. Therefore, teachers need to choose the right learning model that can foster students' problem-solving abilities and at the same time students' scientific literacy. Blended problem-based learning can be an alternative learning model to improve students' problem-solving skills and scientific literacy.

Relating to the scientific background as well as data from previous investigations in the previous explanation, this study will investigate the effect of blended problem-based learning to develop problem-solving skills and scientific literacy as part of the 21st-century skills that must be mastered by .student.

II. METHOD

This research is a quasi-experimental study consisting of independent variables and dependent variables. According to Cook and Campbell (1979) and Thyer, AB (2012), a quasi-experimental is an experimental study that is followed by a certain treatment, calculates the effect, and also has an experimental unit but does not use random judgments to make comparisons and continues with an orientation to conclude certain changes as a result of the treatment given. Problem-solving and scientific literacy data collection methods use a questionnaire. Indicators of problem-solving skills include (1) developing creative and innovative solutions; (2) developing practical solutions; (3) showing independence and initiative in identifying problems and solving them; (4) implementing various problem-solving strategies; (5) implementing problem-solving strategies in various fields (Centre for Good Governance, 2019). Science literacy has five aspects of assessment including (1) the knowledge of science; (2) The investigative nature of science; (3) Science as a way of knowing; (4) Interaction of science, technology, and society (Dani, 2009). Data analysis of both data using one-way ANOVA.

III. RESULTS AND DISCUSSION

The results of data analysis by comparing the two treatments given, namely the group that was taught using problem-based learning with the group that was taught in class and saw changes in both problem-solving skills and literacy science. The prerequisite test was carried out using the normality test (table 1) and homogeneity test (table 2) to determine data distribution and data similarity.

Table 1. Normality Test Results

Tests of Normality							
	class	Kolmogorov- Smirnov [a]			Shapiro- Wilk		
		Statistics	df	Sig.	Statistics	df	Sig.
Literacy Skills	Problem-Based Learning	083	50	.200 *	.959	50	.078
	Control Class	071	50	.200 *	.962	50	.110
Problem-Solving	Problem-Based Learning	082	50	.200 *	.958	50	.073

	Control Class	083	50	.200 *	.957	50	.070
*. This is a lower bound of the true significance.							
a. Lilliefors Significance Correction							

Table 2. Homogeneity Test Results

Test of Homogeneity of Variances		
	Literacy Skills	Problem-Solving
Levene Statistics	008	002
df1	1	1
df2	98	98
Sig.	.927	.969

Based on the results of the normality test in (table 1) shows that the two groups on literacy skills have data normally distributed with the Kolmogorov-Smirnov test acquisition of 200 > 0.050 and the Shapiro-Wilk 0.078 and 0.110 both are greater than the value of 0.050. Likewise, the problem-solving abilities of the two groups had data normally distributed with the Kolmogorov-Smirnov test of 200 > 0.050 and the Shapiro-Wilk test in both groups of 0.073 and 0.070. So that all data is normally distributed. Based on the acquisition of homogeneity test data (table 2) it shows that literacy skills data obtained 0.927 > 0.050 and problem-solving skills of 0.969 > 0.050. So it can be interpreted that all data is homogeneous.

Table 3. ANOVA test results

		Sum of Squares	df	MeanSquare	F	Sig.
Literacy Skills	Between Groups	1017610	1	1017610	5,096	.026
	Within Groups	19569.140	98	199,685		
	Total	20586750	99			
Problem-Solving	Between Groups	1246090	1	1246090	6,258	014
	Within Groups	19514.020	98	199,123		
	Total	20760.110	99			

Table 4. Differences in Problem-Solving Ability and Science Literacy Values

		Literacy Skills			Problem-Solving		
		Problem-Based Learning	Control Class	Total	Problem-Based Learning	Control Class	Total
N		50	50	100	50	50	100
Means		76.74	70.36	73.55	78.86	71.80	75.33
std. Deviation		14.208	14,053	14,420	14,080	14.142	14,481
std. Error		2009	1987	1,442	1991	2,000	1,448
95% Confidence Interval for Mean	LowerBound	72.70	66.37	70.69	74.86	67.78	72.46
	Upper bound	80.78	74.35	76.41	82.86	75.82	78.20
Minimum		48	42	42	50	43	43
Maximum		98	92	98	100	93	100

Based on the results obtained in (table 4) shows that the problem-solving ability in the group that was taught with problem-based learning obtained a higher average score of 78.86 compared to the average problem skill score in the control group of 71.80. Literacy skills in the group that was taught using problem-based learning obtained an average score of 76.74 higher than the average score in the group that was not taught using problem-based learning of 70.36. Based on these data it proves that students who are taught using problem-based learning have better problem-solving skills and circuitry skills. Based on (Table 3), the results of the significance of problem-solving are 0.014 <0.050, and the acquisition of significance in literacy skills is 0.026 <0.050 so there is a difference in value between the group taught using problem-based learning and the group taught without problem-based learning.

In line with the research that has been done, some studies are related and support the findings in this study. Research conducted by Valdez & Bungihan, (2019) proved that problem-based learning can effectively improve students' ability to solve problems. The results of this study were also supported by other research conducted by Kök & Duman, (2023) in their research showing that students experienced a significant increase in problem-solving skills after learning was carried out using problem-based learning. Problem-based learning can also improve literacy skills as evidenced by research conducted by Nainggolan et al., (2021) that problem-based learning facilitates student activities to increase their scientific literacy and strongly supports the development of students' scientific literacy skills. Another study conducted by Karmila et al., (2021) proved that in his research there was an increase in students' scientific literacy skills after being taught using problem-based learning.

Problem-based learning is the main strategy for improving students' problem-solving skills. In addition, improving problem-solving skills is an important promise of problem-based learning strategies (Hung, 2012). Problem-based learning was created as a learning tool by focusing students' attention on problems and their knowledge can previously be used rationally to think of problem-solving solutions (Karimi, 2011). A strong attribute of the application of prior knowledge is that problem-based learning promotes scientific literacy and communication skills, inquiry, the use of real-life situations, and the application of cultural capital (Magaji, 2021). Information literacy and argumentation skills are the most important factors in problem-based learning for science education (Kim & Vicentini, 2022). Both have a relationship that scientific literacy integrates other competency values using scientific methods to solve problems (Kaya et al., 2012; Oliver & Adkins, 2020). Strong information literacy, collaboration, and argumentation skills are essential for success in problem-based learning (Belland & Kim, 2021)

IV. CONCLUSIONS

Blended problem-based learning (P-PBL) improves students' skills in solving problems. In addition, it is proven that problem-based learning can improve students' literacy skills in science learning. Problem-based learning provides the right container needed to improve these two skills. Scientific literacy is also one of the most important factors in problem-solving activities. So problem-based learning is very supportive in learning that aims to improve students' literacy skills and problem-solving.

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