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The Effect of Multiple Representation-Based Scaffolding Strategy in Improving Chemical Literacy

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Abstract: The effect multiple representation-based scaffolding strategy in improving chemistry literacy. **Objective**: This study aims tyo understand the effectiveness of multiple representations-based scaffolding strateg in the topics of electrolyte and non-electrolyte solutions to improve the chemistry literacy skills. **Method:** The research used a quasi-experiment design. The subjects were 78 students of the tenth grade at SMAN 5 Bandar Lampung. The data were analyzed using Tukey test and effect size. **Findings**: The increase in chemistry literacy abilities of the students in the experimental class was 96.00% influenced by the application of multiple representations learning with scaffolding strategy; meanwhile, it was only 89.00% for control class with no scaffolding. **Conclusion:** The scaffolding strategy based on multiple-representation in chemistry learning had a high level of effectiveness in improving chemistry literacy skills..

Keywords: Effectiveness, scaffolding, multiple representations, chemistry literacy.

Abstrak: Efektivitas strategi scaffolding berbasis multipel representasi dalam meningkatkan literasi kimia. ***Tujuan:*** *Penelitian ini bertujuan untuk memahami efektivitas strategi perancah berbasis representasi ganda dalam topik solusi elektrolit dan non-elektrolit untuk meningkatkan keterampilan literasi kimia.* ***Metode:*** *Penelitian ini menggunakan desain kuasi eksperimen. Subjek penelitian adalah 78 siswa kelas X SMAN 5 Bandar Lampung. Data dianalisis menggunakan uji Tukey dan effect size.* ***Temuan:*** *Peningkatan kemampuan literasi kimia siswa di kelas eksperimen adalah 96,00% dipengaruhi oleh penerapan pembelajaran representasi ganda dengan strategi perancah; Sementara itu, hanya 89,00% untuk kelas kontrol tanpa perancah.* ***Kesimpulan:*** *Strategi scaffolding berdasarkan multi-representasi dalam pembelajaran kimia memiliki tingkat efektivitas yang tinggi dalam meningkatkan keterampilan literasi kimia.*

Kata kunci: *Efektivitas, scaffolding, multipel representasi, literasi kimia.*

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INTRODUCTION

The results of the research conducted both at domestically and abroad indicate that most chemistry subjects are considered by students to be difficult lessons to understand and be understood (BouJaoude & Barakat, 2003; Liliasari, 2007; Sunyono, et al., 2009). These studies focus more on the inability to understand scientific concepts from teachers, due to chemistry learning that has not been able to facilitate students' needs for scientific literacy, especially chemistry literacy. The problem of chemistry learning which has yet to be fully resolved is the assumption in students that this lesson is difficult to understand and be understood, even some students are antipathetic and consider it a scourge. This results in students' literacy abilities in Indonesia are still very low compared to neighboring countries.

Indonesian students' PISA results from year to year indicates that the trend of Indonesian students' science literacy has not shown any significant changes. From 2000 to 2012 the *correct proportion* score of Indonesian students was still low which was respectively 0.35; 0.35; 0.34; 0.34 (Balitbang Depdikbud, 2011). In addition, the quality of education of member countries of the Organization for Economic Development Cooperation (OECD) shows that Indonesia ranks eighth from the bottom (OECD, 2015). Indonesia ranks 40th with an index ranking and overall score of minus 1.84. Science literacy in the context of PISA is defined as the ability to use scientific knowledge, identify questions, and draw conclusions based on facts in order to understand the universe and changes made to nature through human activities (Firman, 2007). Given that one branch of Natural Sciences is chemistry, the ability in chemistry literacy will greatly contribute to students' scientific literacy abilities

Issues about scientific literacy (chemistry) have long been the center of attention for research experts in education, including *literacy* towards issues related to natural phenomena in a contextual manner. The ability of chemistry literacy is largely determined by the learning process carried out by teachers. The main key to success in learning is the ability of students to represent chemical phenomena at the submicroscopic level of learning. Thus, learning involves levels of chemical phenomena (macro, sub-micro, and symbolic) through multiple-representation based learning called the SiMaYang model which is a strategic step to improve the students' reasoning power ability, so that it will have an impact on increasing chemistry literacy skills. Moreover, with the help of the scaffolding strategy in such learning, it is expected that it will be easier for students to improve their chemistry literacy skills. In the long term this study aims to improve, shape, and instill learning values in teachers and resilience *of* students toward the negative environmental influences in order to foster strong reasoning power and reliable literacy skills.

The multiple representation based learning model still has several weaknesses related to the development of conceptual abilities in order to build students' chemistry literacy abilities. Thus, the scaffolding strategy needs to be integrated into the steps of multiple representation based learning to assist students in developing scientific literacy. The advantage of scaffolding is that the involvement of students in learning is not passive in listening to information from the teacher, so that it can motivate students to learn and reduce the level of frustration (Hsin-Yi Chang & Hsiang-Chi Chang, 2013), and can support in increasing *self-regulated learning* and student self-confidence in learning (Devolder *et al.,* 2012).

The utilization of learning with multiple representations is believed to be able to build procedural and conceptual knowledge, if interesting learning is carried out in learning for concepts that are at the submicroscopic level, and there are procedures in transforming from the macroscopic to symbolic levels and/or to submicroscopic or vice versa (Berthold et al., 2009; and Talanquer, 2011). Furthermore, Sunyono & Meristin (2018) states that the learning process using multiple representation models is suitable for students with a variety of initial abilities, especially students with moderate and low initial abilities.

Several studies have shown that chemistry learning by involving multiple representations can enhance learning understanding of chemistry concepts, among others: Guzel & Adadan (2013) utilized several representations in learning about the structure of matter to develop chemistry understanding of prospective teachers; Jaber & BouJaoude (2012) utilized multiple representations through the interaction of three levels of macro, sub-micro, and symbolic phenomena in the materials of chemical reactions discussions; and Abdurrahman (2010) utilized the role of multiple representations in the learning of quantum physics to improve mastery of concepts, generic science skills, and critical thinking skills of university physics students. Research related to the use of multiple representations by developing learning models has also been carried out in recent years. The development of the research produced a learning model called the SiMaYang model (Sunyono et al., 2015). The development of learning strategies by integrating scaffolding into multiple representation based learning models (SiMaYang model) is based on the efficacy of the scaffolding strategy in helping students to solve chemistry problems especially those related to submicroscopic phenomena (Hsin-Yi Chang & Hsiang-Chi Chang, 2013; Hsin-Yi Chang and Marcia, 2013). Scaffolding was chosen this because strategy has been proven effective in improving student understanding to the materials being studied (Kawalkar & Vijapurkar, 2013; Hsin-Yi Hsin Chang & Hsiang-Chi Chang, 2013). These studies show that scaffolding can help students develop a more sophisticated understanding of chemical reactions and scientific literacy after learning.

The learning process in order to build students' scientific literacy, has long been the center of attention for education experts in their research, including *literacy* toward issues related to natural phenomena contextually. Building student scientific literacy is indeed the teacher's duty. Therefore, efforts to improve the learning process in order to improve scientific literacy abilities needs to be continued. In this study, the concept of chemistry literacy refers to the concept of scientific literacy proposed by Gilbert & Treagust (2009) who argued that chemistry literacy is the ability to appreciate chemistry as the main aspect of scientific endeavor.

To measure students' chemistry literacy, researchers are guided by several experts, among others: Bybee & McCrae (2011) assessing students' chemistry literacy through assessing students' ability to use and connect facts with information on chemistry problems and the ability to use chemistry knowledge and skills to understand information about problems in everyday life. Shwartz et al. (2006) conducted an assessment of students' chemistry literacy by assessing students' abilities in terms of; (a) Understanding the importance of chemistry knowledge in explaining everyday phenomena; (b) Using an understanding of the chemistry that has been gained in their daily lives, as consumers of new products and technology, in decision making, and as participants in social debates on chemistry related issues. Soobard & Rannikmae (2011) suggested that in scientific literacy assessment, students can be categorized into 3 levels of ability, namely (a) Nominal ability; where students agree with what others say. (b) Conceptual and procedural abilities; where students make use of concepts between disciplines and show understanding and interrelationship, and (c) Multi dimensional abilities, where students utilize various concepts and demonstrate the ability to relate these concepts to everyday life. The instrument to measure student chemistry literacy capability in this research bases itself on the assessment done by previous researchers (Shwartz et al., 2006; Witte & Kees, 2003). The product in the form of a scaffolding strategy prototype needs to be tested for effectiveness in improving students' chemistry literacy capability compared with other strategy or learning models, namely like discovery learning without scaffolding (Slavin, 2006). To categorize student scientific literacy, Bybee & McCrae (2011) proposed a framework which consists of four levels, namely: nominal, functional, procedural, and multidimensional. The characteristics of questions to rate student literacy of science, among others, is about questions containing broader concepts, regarding the necessity to contain information or data in various forms of presentations, regarding the necessity that scientific literacy must make students capable of processing the information contained in it, regarding the ability to make several variations of the questions (multiple choice, essay, filling in), and that questions should cover the context of application (Astuti, 2016).

METHOD

a. Research design

The design used in the study was quasi-experimental. The design of this study was used to compare the increase in chemistry literacy of students between students who took part in learning using the scaffolding strategy with students learning without using scaffolding strategy.

b. Population and Samples

All high schools (SMA) in Bandar Lampung were used as the population in this study population. The selection of school samples was done through random sampling techniques, so that one school with two classes of tenth grade was obtained. The two classes consist of 1 (one) class as an experimental class sample (i.e. class with learning using scaffolding strategy); one class as controlled A class, that is a class with learning without using scaffolding). Through the random sampling technique, the 10th Grade MIA-3 and 10th Grade MIA-4 of SMAN 5 Bandar Lampung were obtained, respectively as experimental class and controlled class.

c. Procedure

Before the implementation of learning, all students involved in the study, both students from the experimental class and students from the controlled class were grouped based on their initial abilities. The students' initial abilities were determined through teacher assessment data on previous learning. Before learning took place, a pretest was administered in every class and at the end of the study, a posttest was carried out to see the achievement of students' chemistry literacy abilities based on their initial abilities. Learning in the experimental class was carried out using multiple representation based learning combined with the scaffolding strategy. The test of the scaffolding implementation in learning was carried out on observing the dimensions of scaffolding. There are 5 dimensions of scaffolding that are integrated into multiple representation based learning, namely intentionality, conformity, structure, collaboration and internalization.

d. Instrument and data analysis

The measurement of the implementation of the scaffolding strategy was carried out by observing 5 (five) dimensions of scaffolding using a 5-scale observation sheet (very high, high, medium, low, and very low). The instrument to measure the achievement of chemistry literacy abilities was a test instrument (questions) in the form of descriptions. Questions given to students in each sample class, both in *pretest* and *posttest*, are the same with a total number of 6 questions. The results of the *pretest* and *posttest were* assessed by means of scoring in accordance with the rubric that had been set. Before being used in the research, the test questions were initially tested for validity and reliability through a trial toward 20 students. The results of the validity and reliability tests show that the test questions to measure students' chemistry literacy abilities had high validity and reliability.

The achievement of chemistry literacy abilities was determined by the N-gain score achieved by students, namely the difference between the *posttest* and *pretest scores* (Hake, 2002). N-gain results were grouped based on students' initial abilities. Data analysis of students' mastery of concepts (both in *pretest* and *posttest*) was obtained from the results of the assessment of students' answers to test questions. The data was then analyzed by comparing the N-gain scores obtained by students of the learning class with the scaffolding strategy (experimental class) with the N-Gain scores from controlled class students (classes learning without scaffolding) using the average difference analysis (t-test). The calculation on the statistical test was carried out using SPSS v.17.0 software.

■ RESULT AND DISCUSSION

The results of the observation on the dimensions of scaffolding implementation in multiple representation based learning on electrolyte and non-electrolyte solution substances can be seen in Table 1 below.

Based on Table 1, The average scaffolding achievement of students obtained in the experimental class was 75.90 or with the "high" criteria at the third meeting, while in the controlled class the average scaffolding result *of* students was 14.87 or of "low" criteria. Table 1 also shows that the achievement of the scaffolding dimension in the experimental class from the 1st to the 3rd meeting increased sharply compared to the controlled class, so it can be said that the scaffolding implementation dimension of students during the implementation of learning with scaffolding based on multiple representations in the experimental class were better compared to the controlled class whose learning was without scaffolding strategy. Thus, it can also be said that the emergence of the scaffolding strategy in the experimental class was "high" or took place as planned, whereas in the controlled class, only a few experienced impact of learning with scaffolding, meaning that even though learning was done through scaffolding strategy without engineering, s*caffolding* (teacher assistance) dimensions can still be felt by students, even though it was very small. The appearance of the scaffolding dimension in the very small controlled class could be ignored, so that the analysis of the results of this study could be continued.

The effectiveness of learning through multiple representation based scaffolding strategy was measured based on an analysis of the influence of these learning effects on students'

Table 1. The results of observation for each dimensions of scaffolding.

No.	**Scaffolding Dimension**	**Meeting**					
		I		II		III	
		Exp	Controlled	Exp	Controlled	Exp	Controlled
1	Intentionality	46.15	12.82	64.10	15,38	79.48	12.82
2	Conformity	38.46	10.26	56.42	10.26	76.92	10.26
3	Structure	25,64	7.69	51.28	10.26	74.39	15,38
4	Collaboration	41.03	10.26	66.67	12.82	76.92	10.26
5	Internalization	30.77	0.00	46.15	5,13	71,79	7.69
	Average Percent	36.41	8.21	56.92	10.77	75.90	11.28

chemistry literacy abilities. The results of tests on students' chemistry literacy abilities after learning in both the experimental class and the controlled class can be seen in Figure 1. below.

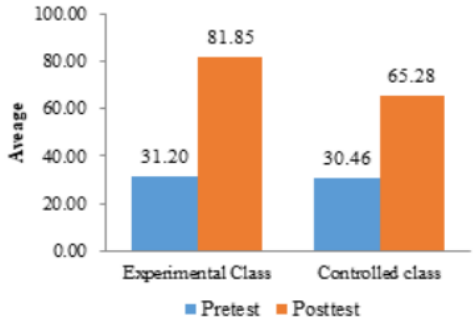

Figure 1. Average results of pretest and posttest of chemistry literacy abilities in the experimental class and controlled class.

Figure 1 indicates that students' chemistry literacy abilities after application of learning with the design of the scaffolding strategy in multiple representation based learning is better than before learning with the scaffolding strategy applied. Compared to the controlled class in which learning was without scaffolding strategy, it seems that learning in the experimental class with the application of the scaffolding strategy in learning electrolyte and non-electrolyte solutions was far better than learning in the controlled class. The increase in chemistry literacy abilities of students in the controlled class only reached an average of 65.28 and the score was smaller compared with the results of the value of chemistry literacy abilities in the experimental class with the achievement of an average value of 81.85. This shows that the chemistry literacy ability of the experimental class students was higher than the chemistry literacy abilities of the controlled class students.

Based on the results of the pretest and posttest scores, a calculation of the chemistry literacy abilities increase results was calculated through an *n-Gain scoring* (Hake, 2002). The pretest, posttest and n-*Gain* calculations for the two classes is presented in Figure 2.

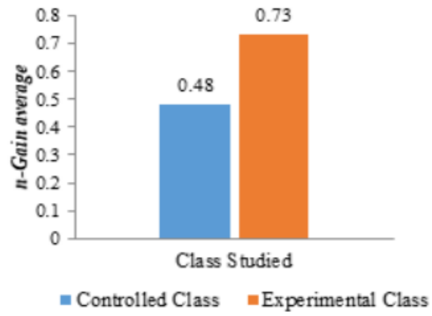

Figure 2. Average *n-Gain* score of chemistry literacy abilities in the experimental and controlled classes.

Figure 2 shows the average *n-Gain* score of chemistry literacy abilities results of the experimental class was categorized as "high" (0.73) and the average *n-Gain score of* the students in the controlled class was categorized as "moderate" (0.48). This shows that the average *n-Gain* score of the experimental class was higher than the *n-Gain* average in the controlled class. Thus it can be said that the implementation of the scaffolding strategy design on chemistry learning based on multiple representation was influential in improving students' chemistry literacy abilities in learning electrolyte and non-electrolyte solution materials.

A parametric statistics analysis is required to see the level of confidence in the learning results difference between the class in which learning was with scaffolding strategies, with the class in which learning was without scaffolding strategy. The requirement of parametric statistics results is that the samples originate from populations with normal and homogeneous distribution. Therefore, a normality and homogeneity test is needed before the test of the difference in the n-Gain average of both classes.

The normality test was done to find out

whether the distribution obtained was distributed normally or not. The normality test for the two classes was carried out using the *Kolmogorov-Smirnov Test* with a significance level of (á) of 0.05. The calculation results of the normality test for the experimental class in the *Kolmogorov-Smirnov* column was 0.169 and the controlled class was 0.200. Based on test criteria then H_0 was accepted. This shows that the pretest value obtained from the experimental class and the controlled class comes from populations with normal distribution. The significance of the *n-Gain* score in the experimental class was 0.075 and from the controlled class was 0,200. This is based on the test criteria where H_0 was accepted. This shows that the *n-Gain* score data obtained from the experimental class and controlled class comes from populations with normal distribution.

Furthermore, a homogeneity test was carried out using the *Levene Statistic* test with a significance level of (á) 0.05. The homogeneity test results toward the average n-gain of students' chemistry literacy abilities obtained a significance score of 0.74. Furthermore, the sig> 0.05 score means H_0 was accepted. Based on the test criteria, H_0 was accepted, namely the *n-Gain* in the controlled and experimental classes had variant scores that were homogeneous. Based on the results of the normality and homogeneity tests, a hypothesis testing was then carried out using the two-mean difference test (t-test) and e*ffect size.* T-test results data utilized the *independent sample t-test* which is presented in Table 2.

The test results of differences on the two averages indicates that the value *sig (2-tailed)* of 0.00 or sig <0.05 means H_0 was accepted, so it can be concluded that the average *n-Gain* of students' chemistry literacy abilities on the electrolyte and non-electrolyte solution materials by implementing a scaffolding strategy in chemistry learning differs from the average *n-gain* of students' chemistry literacy abilities with multiple representation learning without scaffolding strategies. This shows that the implementation of the scaffolding strategy in multiple representation based chemistry learning has an effect on improving students' chemistry literacy abilities on electrolyte and non-electrolyte solution materials.

Furthermore, the *effect size* test was carried out to measure the effect of the application of scaffolding strategy in multiple representation based chemistry learning. *Effect size was* calculated using the value of *t* from the t-test results (difference) of the pretest and posttest score. The results of the *t*-test (difference test) data of the pretest and posttest score are presented in Table 3. The test results of the difference in pretest and posttest scores in the experimental class obtained a *t* value of -19.80 with a degree of freedom (*df*) of 29, so that the *effect size* calculated using the AbuJahjuoh (2014) formula obtained the *effect size (μ)* result of 0, 96 with the criteria of "very large", while the controlled class obtained a *t* value of -10.70 with a degree of freedom *(df)* of 29 and *effect size (i)* result of 0.89 with a criteria of "large". Based on the *effect size* results calculation, it shows that the 96.00% high increase in the experimental class students' chemistry literacy abilities was influenced by the application of the

Table 2. T-test results of n-Gain score using *independent sample t-test*

Class	n	Average	*df*	$t_{calculation}$	*P* (*Sig. (2-tailed)*)	Decision
Experimental	30	0.73	58	6.83	0.00	Accept H_0
Controlled	30	0.48				

scaffolding strategy in chemistry learning based on multiple representations, while in the controlled class 89.00% increase in the students' low chemistry literacy abilities was influenced by multiple representation learning without scaffolding strategy.

The results of the implementation of the scaffolding strategy design in chemistry learning based on multiple representations provide information that the scaffolding strategy has primary characteristics that lie in the steps of student interaction with the teacher and between students which are in accordance with the characteristics of the multiple representation based learning model (Sunyono *et al.,* 2015). Based on the results of the analysis of the average *n-Gain* obtained both in the controlled and experimental class students showed an increase in students' chemistry literacy abilities. Chemistry literacy abilities of experimental class students are in the 'high' *n-Gain* criteria and the controlled class are in the 'average' criteria.

Table 3. Results of *t*-test scores for pretest, posttest, and *effect size* using *paired sample t-test*

Class	N		Average		*df*	$t_{calculation}$	*Effect Size* (μ)	Criteria
	Pretest	Posttest	Pretest	Posttest				
Experimental	30	30	31.20	81.86	29	-19.80	0.98	Very large
Controlled	30	30	30.46	65.30	29	-10.70	0.89	Large

In the difference test of the two averages for the *n-Gain* score average of students' chemistry literacy abilities in the controlled and experimental classes, it was found that the average *n-Gain* of the experimental class was higher than the controlled class *n-Gain* average. This shows that learning using the scaffolding strategy learning design can improve chemistry literacy abilities better than conventional learning which is commonly used by chemistry teachers in SMAN 5 Bandar Lampung. The test results also showed that the average *n-Gain* of chemistry literacy abilities of the experimental class and controlled class students differed significantly. This result is in line with the research conducted by Suwono *et al.* (2015) which states that problem-based learning with the help of teachers routinely can improve scientific literacy of high school students compared to presentation discussion learning. Likewise, research conducted by Gutierez (2015) found that the use of social issues with the help of relevant and authentic teachers (scaffolding) opened the possibility of students being encouraged to actively evaluate the advantages and disadvantages of science in life, so that student learning achievement increases.

Based on the analysis of the size of the effect of the scaffolding strategy it is known that the *effect size* on students' chemistry literacy abilities, both in the experimental class and the controlled class has a 'large' effect criteria. Based on the results of the analysis of the *effect size* shows that learning using a scaffolding strategy has a great influence in improving students' high chemical literacy skills. This is reinforced by the results of Maknun's research (2014) which states that the application of contextual learning that is associated with current issues and the existence of scaffolding assistance from teachers can improve scientific literacy and attract students' interest in learning. Similarly, Zeidler *et al.* (2005) argued that the issue of current science learning and teacher assistance in learning can foster scientific literacy in students. Furthermore, Casem and Alicia (2013) report that the application of the scaffolding strategy in learning can influence students' attitudes and knowledge of the learning process that takes place with a measure of influence of 0.93. This is because students have high motivation in learning chemical materials such as when working on the Student Worksheets and when giving opinions/discussions that continue to increase from the first meeting to the third meeting. The results of the Panji and Haninda (2015) study reported that the scaffolding strategy had a high influence on the increase in mastery of the concepts learning with the effect size of 0.93. Students' mastery of concepts is a picture of students' increasing chemistry literacy skills. The results of this study are also in line with the research of Wakhidah (2016) who found that the scaffolding strategy was effective toward students' mastery of scientific concepts and literacy with a measure of influence of 0.90. Thus, it can be said that the scaffolding strategy in chemistry learning based on multiple representations has a strong influence on increasing chemistry literacy, especially on electrolyte and non-electrolyte solution materials.

The improvement of students' chemistry literacy abilities in this study was due to learning using the scaffolding strategy carried out slowly or step by step, starting from assistance for the individual, group, and independent learning. In the actual practice of learning, scaffolding was carried out not only through assistance from the teacher, but also assistance from other students in the group who have achieved a higher level of scaffolding dimension. This type of group learning is what can actually cause students to understand chemistry concepts more directly, so that the student learning outcomes takes the form of chemistry literacy increase. This is in line with the research conducted by Kusuma & Rosidin (2013) which states that learning based on applying cooperative scaffolding learning can improve student learning outcomes. Providing assistance to students is also done through the use of visualization in learning electrolyte and non-electrolyte solution materials. Through the visualization of images from sub-microscopic phenomena, students will be easier in reasoning physical objects encountered, so that their thinking ability can be improved easily (Sunyono & Sudjarwo, 2018).

In this study, the application of scaffolding in chemistry learning based on multiple representations was carried out by providing assistance (*scaffold*) to students to solve given problems, either individually and in groups. With the help of the teacher, it is believed that students will be able to understand more things than if students learn independently. Assistance provided by teachers to students is gradually reduced, especially when students are practicing work on assignments, namely by providing motivation and enthusiasm to increase student self-confidence. If given assignments, students are definitely able to do the task because students' confidence in learning continues to increase. Gradually the students are given the trust to learn without the guidance of teachers, but teachers continue to monitor the students' progress. In addition, the teacher also always assigns students to exchange opinions with other students and compare their opinions, both within groups and between groups. Furthermore, students are given the opportunity to take charge and responsibilities in completing their tasks. This is relevant to the research conducted by Agustina (2013) which states that providing assistance (scaffolding) to learning activities using guided discovery models can improve student learning outcomes; thus, students' self-confidence and literacy abilities also increase.

The success in the implementation of the scaffolding strategy design is inseparable from the implementation of classroom learning. In the learning carried out, the scaffolding dimension could be achieved with a categorization of "high". Analysis results on the dimensions of scaffolding showed that the implementation of the scaffolding dimensions of students during learning in the experimental class was higher than the controlled class. The implementation of the scaffolding dimension has an effect on student learning outcomes, where based on the results of the research by Agustina (2013), it was found that the higher the dimensions of scaffolding or the assistance of student learning activities, the higher the student learning outcomes. The implementation of the five dimensions of scaffolding also contributed significantly to the improvement of students' literacy skills. Thus, an important finding of this study is that the design of the scaffolding strategy in chemistry learning based on multiple representations is able to provide a high increase in students' chemistry literacy.

CONCLUSION

Based on the results of research and discussion, it can be concluded that the design of the scaffolding strategy in chemistry learning based on multiple representations has a high level of effectiveness in improving students' chemistry literacy abilities. The findings of this study has implications for the implementation of chemistry learning to help students understand chemistry concepts that have macro, sub-micro, and symbolic characteristics, such as chemical bonds, chemical equilibrium, and others. Thus, it is expected that chemistry teachers can implement and develop these strategies in chemistry learning in the classroom.

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