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LAVOISIER: CHEMISTRY EDUCATION JOURNAL
Vol. 4 (1), 2025

The Effect of Self-Organised Learning Environment (SOLE) Model Towards Students' Critical Thinking Skills in Buffer Solution Topic

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Article History

Received 02 26th 2025
Revised 06 13th 2025
Accepted 06 28th 2025
Available Online 06 30th 2025

Keywords:
SOLE
Critical Thingking
Buffer Solution

Abstract
Conventional learning models in learning activities is one of the factors that has been caused students' critical thinking skills at SMA N 15 Semarang become low. Therefore, an interactive learning model is needed to develop the skills. The study has a purpose to determine the effect of Self Organized Learning Environment (SOLE) model towards students' critical thinking skills. the pretest-posttest control group design was used in the research and random sampling was used as the technique to determine the sample. The data collection techniques that was used were observation, interviews and tests. The test instrument was made using indicators of critical thinking skills according to Ennis. The data analysis technique used the N-Gain Score Test and the Independent Sample t-test. The t-test score results 0.000 < 0.05 meaning that H_a is accepted and the SOLE model has effect towards students' critical thinking skills. The critical thinking skills of students based on n-gain value is also shown improved. The experimental class got 0.71 with high criteria, while the control class got a value of 0.48 with medium criteria.

1. Introduction

Education equips students with the mechanisms to tackle problems and dilemmas that arise, enabling them to navigate challenges in the community environment. The integration of digital technology, given the world's current industrial revolution 4.0, is crucial and integral to global environmental dynamics. The rapid development of technology requires the continuity of thinking skills improvement while posing a challenge to win the increasingly tight competition. Problems can be overcome by providing quality education in the changing era. The changes are seen from 21st-century learning, namely, interactive learning that is centred on students. Interactive learning is a learning process that needs interaction between teachers and students in various forms of communication. Active learning

investigates the learning process so that students are more active by providing various questions that they want to know the answers to(Suciono et al., 2021). One of the educational tools that can provide students with critical thinking is by providing them with the skills needed to solve problems and issues that exist in the community.

Integration of critical thinking in learning can be done and manifested in various aspects, including teaching models, learning materials and assessment strategies (Saleh, 2019). The method that students must master to face the 21st century is being able to make decisions, solve problems, and think creatively and critically (Setianingsih & Roshayanti, 2022). Critical thinking is an active intellectual process and full of skills for conceptualize, implementing, analysing, and evaluating (Siti Zubaidah, 2010). Critical thinking is a component that is difficult to separate from every change made to knowledge in scientifically oriented science. Chemistry is included in the category of Natural Sciences (IPA), which is one of the sciences that is taught in Indonesian high schools. One of the subjects that requires critical thinking skills is Chemistry (Norrizqa, 2021) .

The relevance of critical thinking in the learning process is the importance of preparing students to be able to make the right decisions. Having independent thinking is very important for students, along with the increasing number of types of jobs in the future, because the job requires workers who are trustworthy and have critical thinking (Muhfahroyin, 2009). Before starting learning activities, a learning process that includes learning strategies and models is needed. Various learning models can be applied by teachers so that the students can follow interactive and effective learning activities. To improve thinking skills, teachers as facilitators need to choose an effective learning model, because with an effective learning model, they can create a complete, active, interactive, and creative learning atmosphere so that it can make it easier for students to master the material, during the learning process students become more critical in responding to problems, social skills and learning outcomes become optimal (Saepuloh et al., 2021) .

Lack of critical thinking skills becomes one of the problems for students. To improve students' critical thinking skills, a learning model or tactic is needed by involves students directly in the process of finding facts or information taught by the teacher (Saepuloh et al., 2021). One of the models that is believed to be able to encourage students to think critically is the SOLE model. SOLE is a learning model that was initially introduced by a scientist from India named Sugata Mitra in 1999. The use of the SOLE model focuses on the independent learning process, where students are required to be able to learn independently using devices connected to the internet (Suciati, 2021). The implementation of the SOLE model has advantages for students in learning that is focused on quality education that endorses equity and equal opportunity for all, according to the goals of UNESCO for Sustainable Development Goal-4 (SDG4) 2030 (Shalini Roy & Gandhimathi, 2024).

An observation and interview were conducted with one of the Chemistry teachers at SMA N 15 Semarang, revealing that conventional learning models, such as direct instruction and discussion methods, are typically employed in the chemistry learning process. The model that was implemented allowed students to directly receive what the teacher had taught without seeking another knowledge. The process of learning made students lack in developing critical thinking skills and learned independently. In addition, students are less able to understand the application of chemical concepts, and that is evidenced by the average daily evaluation score is still lower than the Minimum Completion Criterion (KKM). Based on the problem, the objective of the study was to determine the effect of the SOLE (Self-Organised Learning Environment) model towards students' critical thinking skills in a buffer solution.

2. Materials and Methods

A quasi-experimental design was used as a research approach with a pretest-posttest control group design. While the samples used two classes, in this study, the population were all students of class XI MIPA at SMA N 15 Semarang in the buffer solutions topic. The topic was chosen considered it requires a deep understanding and has practical applications in everyday life, especially in various industrial fields. However, based on the results of interviews conducted with teachers, students had difficulty understanding this material, as evidenced by the average daily evaluation score is still below the Minimum Completion Criteria (KKM). Sampling was done using a random sampling technique. A class

was used as an experimental class that taught using the SOLE model, while another class was a control class that taught using the conventional learning model, and each class contained 35 students.

Data collection used observation techniques, interviews and tests. Observations were carried out directly when the teacher was conducting learning activities in the classroom to determine the learning model used. Interviews were also conducted directly with one of the Chemistry teachers at SMA N 15 Semarang to find out the problems that occurred in the school and students at the school. The tests used 10 essays using critical thinking indicators according to Ennis (1984) such as providing logical explanations, establishing the basis for decision making, concluding, estimating and combining actions, and providing further explanations.

Quantitative analysis is used as a data analysis technique that analyses it in the form of numbers. The data analysis technique is used to conduct normality and homogeneity tests as prerequisite tests. Furthermore, the N-gain test is continued to see the average pretest and posttest values. The results of the study were then interpreted, and the N-Gain value *was* categorised according to Hake (1998) what is shown in Table 1.

Table 1. N-Gain Test Criterion

Range	Criterion
$g > 0.7$	Very High
$0.3 < g > 0.7$	High
$g < 0.3$	Low
$g \leq 0$	Very low

(Hake, 1998)

The next data analysis technique is the critical thinking skills test technique, which is used to correct the answer results according to the scoring rubric using the formula.

$$\% \text{ Skill} = \frac{\text{amount of students score}}{\text{amount of maximum score}} \text{x } 100\%$$

(Riduwan, 2019)

The percentage criteria can be seen in Table 2.

Table 2. Criteria for Percentage of Students' Critical Thinking Skills

No	Score Interval	Classification
1	$80\% < T \leq 100\%$	Very high
2	$60\% < T \leq 80\%$	High
3	$40\% < T \leq 60\%$	Moderate
4	$20\% < T \leq 40\%$	Low
5	$0\% < T \leq 20\%$	Very Low

(Riduwan, 2019)

3. Results and Discussions

This study was conducted to determine the effect of the SOLE model towards students' critical thinking skills at SMA N 15 Semarang. The results normality and homogeneity test of the pretest data using SPSS are shown in Tables 3 and 4.

Table 3. Normality Test

Class	Number of Students	Sig.	Significance Level
Experiment	35	0.161	0.05
Control	36	0.088	0.05

Table 4. Homogeneity Test

Class	Level Statistics	Sig.	Sig. Level
Experiment and Control	2,827	0.097	0.05

Based on the analysis of the prerequisite test using the pretest data, it shows that both classes are normally distributed, this is evidenced by the sig value of both classes > 0.05. Both classes have the same level of knowledge about chemical materials. Likewise, the homogeneity test sig value > 0.05, which means that both classes have the same variance. Therefore, testing in this study uses parametric tests. Both classes were given pretest and posttest questions. The pretest questions were given to determine the initial ability of the buffer solution material. Meanwhile, the posttest questions aim to determine the difference in the average critical thinking skills of students between the experimental class and the control class after being given different treatments.

An essay test was arranged based on the critical thinking skills indicators Ennis, (1984). The indicators used include providing a logical explanation, establishing the basis for decision making, concluding, estimating and combining actions, and providing further explanations.

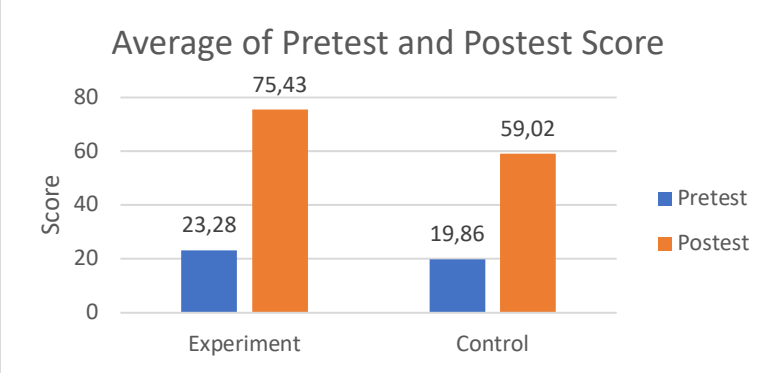

Figure 1. Average of Pretest and Posttest Scores in Experiment and Control Class.

The average of pretest scores based on Figure 1 showed that those in the experimental or the control class are very low. Those mean the initial knowledge of students and the readiness to learn buffer solutions topics are also very low. The reason is that the number of students who did not complete the question and were less prepared when they are going to take part in learning. In line with the research that Ningsih & Suniasi (2020) has been done, those is revealed that internal factors, including learning motivation, student readiness in participating in learning, and self-actualisation, affect student learning outcomes. If the three factors are high, learning outcomes will also be high. Therefore, initial planning before carrying out learning activities can affect student learning outcomes.

In Figure 1, we can see the difference in the average pretest and posttest scores of the experimental class, that is 49,36 and the control class, which is 39.44. This indicates that learning activities with the application of the SOLE model have a higher effect compared to the learning process with the application

of conventional learning models. One of the reasons posttest scores in the control class are lower is that the learning process is still implemented conventional model. In addition, factors from students' habits also influence the final learning outcomes. If students are accustomed to participating in learning by honing critical thinking skills, it will affect the level of critical thinking skills and understanding of the concepts given well (Dores et al., 2020).

Sirait (2019) explains that each student has a different ability to understand the material presented, so teachers must be able to understand this situation. Students who have critical thinking skills in learning can be assured that the learning outcomes of the students will be good results. Likewise, students who have low critical thinking skills will result in less than optimal learning outcomes.

1. Effectiveness of Using the SOLE Model on Students' Critical Thinking Skills.

The level of students' thinking skills can be seen through the *pretest* and posttest scores. The results of the *N-Gain* test analysis are shown in Figure 2.

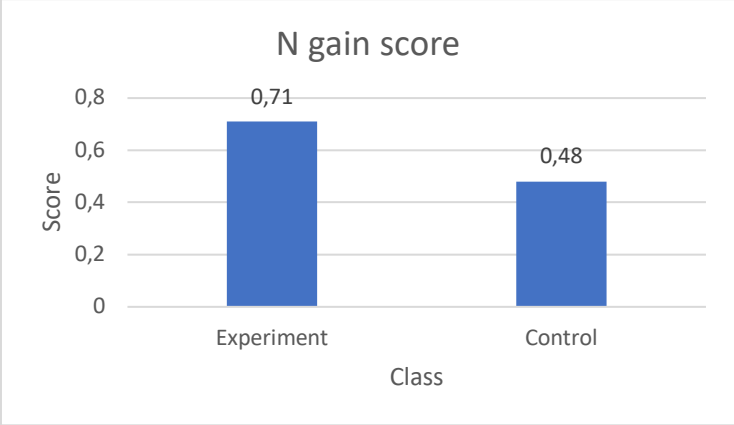

Figure 2: Average Results of *N-Gain Values*

The graph showed that the class that was used as the experiment got 0.71 as average N-gain score, while categorised as "high", and the class that was used as control got 0.48 as average N-gain score, while categorised as "moderate". The learning process indicated that the implementation of the SOLE model has an effect towards students' critical thinking skills compared to the learning process with the implementation of conventional learning models.

The average N-Gain value data was then analysed to test the hypothesis. Testing using an independent sample t-test *concerning* significance. The 2-tailed value on Equal variances assumed was conducted to test the hypothesis in this study. The results obtained were that the significance value was $0.000 < 0.05$. This means that $H_{0\ is}$ rejected and Ha is accepted. It can be concluded that the SOLE model is effective for students' critical thinking skills. There is a significant increase in learning outcomes from students who are taught using the SOLE model compared to conventional learning models. These results are in line with the study conducted by Kartika & Sapriya, (2021) who stated that the sole model can train students' critical thinking skills. SOLE model can also form problem-solving skills, communication skills and develop independent, active and effective attitudes in the learning process. These skills and attitudes will emerge because the stages in the SOLE model force students to ask questions, investigate and review independently through various online sources (Fariha & Amalia, 2021).

2. SOLE Model and Students' Critical Thinking Skills

To see the percentage of students' critical thinking skills, it is necessary to analyse the achievement of critical thinking indicators in both classes. The following is an analysis of test items that are under critical thinking indicators Ennis, (1984).

Table 5. Analysis of Critical Thinking Skills Indicators of Students After Being Given Treatment

NO	Critical Thinking Skills Aspects	Average Grade Improvement of Experimental Class	Category	Average Increase in Control Class Values	Category
1	Provide a logical explanation	64%	High	42%	Moderate
2	Establish the basis for decision making	42 %	Moderate	40%	Moderate
3	Estimate and combine actions	53%	Moderate	40%	Moderate
4	Provide further explanation	65%	High	40%	Moderate
5	Draw a conclusion	60%	High	41%	Moderate

Based on the results of the analysis of the questions in Table 5. The experimental class got a better percentage increase than the control class. The critical thinking skills of students taught using the SOLE model are higher than the skills of students taught using conventional learning models.

The indicator that has a very big influence on critical thinking skills in this study is the indicator that provides further explanation (advanced clarification). This indicator is related to skills in the aspects of identifying terms, defining considerations and identifying assumptions. The next indicator is concluding (Inference), which is related to the skills to consider the results of deduction and determine the value of consideration. Providing a simple explanation, this indicator is related to the skills to analyse opinions, ask and answer questions that require explanation.

The factor causing the experimental class to have superior critical thinking skills compared to the control class is the habit factor. Learning activities in the experimental class are taught using the SOLE model, which contains *syntax* for conducting investigations. Students ' critical thinking skills are honed by training students to find information related to the material being studied by seeking knowledge independently. So that students are accustomed to honing their critical thinking skills so that learning objectives are achieved properly.

According to Sirait's research (2019), which revealed that there are various types of student learning habits, one of them is by using the right learning model. So that it will have a positive impact on the success achieved by students. Marzano et al., (1993) on is book states that every human being has a habit of controlling behaviour and human thought processes using effective thought habits. From this explanation, the habit factor can influence students' critical thinking skills.

Psychological and interaction factors also affect students' critical thinking skills. Psychological factors include intellectual development; if students have high intellectual development, they will quickly understand the content of the material. However, conversely, if students' intellectual development is low, they will also be slow to understand the content of the material being taught. This is related to research Dores et al. (2020) which explains that each person's intellectual development is different, so it will also be different in solving problems and responding to stimuli well.

Based on the research results, it is known that teachers give students the freedom to express their opinions and ask questions if there is lesson material that has not been understood during the lesson. Teachers guide students to understand the material presented so that students can solve problems in the lesson material being studied. Therefore, will the creation of interaction between teachers and students that can develop students' critical thinking skills . According to Nuraida's research (2019) , one of the ways teachers can improve and develop critical thinking skills is through interaction between teachers and students, therefore the teaching and learning atmosphere must provide freedom and a sense of security for students to express their opinions during teaching and learning activities. This follows *the syntax of* the SOLE model, which gives students the freedom to ask questions and seek information about problems in the learning material. So that the experimental class taught using the SOLE model has better critical thinking skills than the control class.

5. Conclusions

The use of the SOLE model is effective for students' critical thinking skills. This is proven by the results of the independent sample t-test hypothesis test, which obtained a value (sig) of 0.000 < 0.05. The results of the N-Gain test. The score showed that the experimental class was 0.71. While the N-Gain score in the control class was 0.48. This indicates that the use of the SOLE (Self-Organised Learning Environment) learning model is more effective for students' critical thinking skills when compared to conventional learning models.

Students who are taught using the SOLE model have better critical thinking skills compared to students who are taught using conventional learning models. This is evidenced by the percentage of experimental class skill values, which are always superior to the control class. Factors that influence the critical thinking skills of the experimental class to be superior to those of the control class are motivation, habits, interaction between teachers and students, and intellectual factors.

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