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# The Effect of Guided Inquiry Learning Integrated with SETS on Students' Critical Thinking Ability and Self-Efficacy in Learning Buffer Solutions

**Widya Ikhma Yanti*, Suyanta**
*Departement of Chemistry Education Program, Yogyakarta University, Yogyakarta, 55281, Indonesia*

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* *Corresponding author:*

E-mail: widyaikhma.2023@student.uny.ac.id

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**A B S T R A C T**

The low critical thinking ability and self-efficacy of students in learning chemistry are caused by learning approaches that are still teacher-centered, less contextual, and limited opportunities for students to engage in problem-solving activities that require higher-level and reflective thinking. This study aims to analyze the differences in critical thinking ability and self-efficacy between students who participate in guided inquiry learning integrated with SETS and students who participate in scientific approach on buffer solution topic. This study used a quasi-experiment method with a pretest-posttest control group design involving four classes The results showed that the experimental class N-Gain score was higher than the control class, both in critical thinking ability and self-efficacy. The N-Gain score of critical thinking ability in the experimental class was 0.633 (medium category), while the control class was 0.488 (medium category). On the self-efficacy variable, the experimental class obtained an N-Gain score of 0.423 (medium category), while the control class was 0.210 (low category). The MANOVA test results showed that there were significant differences between the two groups in critical thinking ability and self-efficacy. So that the guided inquiry integrated with SETS is proven effective in improving students' critical thinking ability and self-efficacy in buffer solution topic.

## 1. Introduction

21st century education is faced with increasingly complex challenges as the Industrial Revolution 4.0 develops. This condition requires individuals to have skills and abilities that go far beyond mere academic knowledge. Therefore, the current educational paradigm focuses not only on mastering knowledge content, but also on developing crucial skills, especially 4C skills (Communication, Collaboration, Critical Thinking, and Creativity). But in reality, learning in schools has not facilitated the development of 21st century skills (Redhana, 2019).

One of the key characteristics that students need to acquire in 21st century learning is critical thinking. Before reaching to a well-considered conclusion, critical thinking enables students to comprehend material thoroughly, question presumptions, look for pertinent evidence, and consider into account other viewpoints (Elder & Paul, 2020; Mutakinati et al., 2018). Learners' critical thinking ability will improve if they engage in problem-solving activities that require high-level and rational thinking. However, in reality, based on the results of field studies and interviews conducted with several chemistry teachers in Riau, it shows that students' critical thinking ability haven't been able to develop optimally even though the learning models used are varied. This is due to the fact that learning is still teacher-centered in its implementation. Furthermore, the questions given have not been designed to facilitate the development of students' critical thinking ability.

Christian & Talanquer (2012) argues that students are typically not provided enough opportunity to build critical thinking ability during the learning process, especially in chemistry learning. This is because the teacher's primary focus is frequently on using algorithms to solve problems. Consequently, opportunities to develop critical thinking ability are limited. This indicates that chemistry learning, as applied in many schools, doesn't emphasize the broader aspects of critical thinking. Therefore, efforts are needed to train and enhance students' critical thinking ability in the learning process.

Dehghani et al (2011) found a strong positive correlation between critical thinking and self-efficacy. Critical thinking skills enable students to assess multiple potential answers, study issues more thoroughly, and make better conclusions. As a result, students will have greater faith in their capacity to handle academic assignments and difficulties. However, the field study found that most learners still do not have good self-efficacy, especially in asking and answering questions. Peranginangin et al (2019) revealed that students' self-efficacy in the learning process is still relatively low. This is typified by students who are not overly challenged to finish difficult assignments, give up easily, and are afraid to share their solutions in front of the class.

Students' critical thinking ability and self-efficacy can be trained by using an inquiry-based learning model, so one of the efforts that can be made is to implement a guided inquiry learning model. Guided inquiry learning is a series of learning activities that involve students actively in the process of investigation, exploration and concept discovery with guidance and direction from the teacher (Kuhlthau et al., 2015). This process requires critical thinking ability and strong self-confidence so that students can complete each stage of learning effectively.

The guided inquiry learning model will be more effective in improving students' critical thinking ability and self-efficacy if integrated with the right approach, one of which is the Science, Environment, Technology, and Society (SETS) approach. According to Diana et al (2023), the integration of SETS in the learning process can create meaningful learning because the topic learned is related to everyday life (contextual). The SETS approach integrates aspects of science, technology, social,

and environment by emphasizing the interrelationships and interactions between the four aspects.

One of the subjects with a strong connection to daily life and a high degree of urgency is chemistry. Buffer solution is one of the chemical concepts that is pertinent in this situation. According to Putri et al (2023), teachers hardly ever relate the topic of buffer solution to real-world occurrences throughout the learning process. Learning becomes less relevant to students as it concentrates more on explaining the theory and resolving mathematical problems. Therefore, in an attempt to address these issues and make learning more contextual and relevant, the guided inquiry integrated with SETS needs to be applied.

When chemistry is taught using a guided inquiry model that is combined with the SETS approach, students are encouraged to explore and acquire new ideas and principles. They are also encouraged to look at how chemical issues are applied in the four SETS elements, namely science, environment, technology, and society. While the SETS approach helps connect topics with aspects such as the environment, technology, and society to make learning more contextual and relevant, guided inquiry gives students the chance to be more active in their exploration, investigation, and experimentation of chemical concepts. In this case, an effort to improve students' critical thinking ability and self-efficacy is to apply a guided inquiry learning model integrated with the SETS approach.

Research conducted by Diana et al (2023) related to SETS-based guided inquiry to improve critical thinking skills in physics learning shows that the guided inquiry model based on the SETS approach can improve students' critical thinking skills. Astyana et al (2017) also discussed the effect of guided inquiry model with SETS vision on science process skills and learning outcomes on buffer solution topic. The results showed that the science process skills and learning outcomes of experimental class increased significantly compared to the control class. Another study conducted by Ardiany et al (2017) showed that learning with a guided inquiry model can improve the self-efficacy aspects of students on buffer solution topics. Therefore, efforts to improve students' critical thinking ability and self-efficacy in learning chemistry, especially in buffer solution topics can be done by applying a guided inquiry integrated with the SETS.

Based on the background, this study aims to analyze the differences in critical thinking ability and self-efficacy between students who participate in guided inquiry learning integrated with SETS and students who participate in scientific approach on buffer solution topics. The novelty of this research lies in the integration of SETS aspects in inquiry-based learning, which makes the learning process more meaningful. This learning is specifically designed to improve students' critical thinking ability and self-efficacy.

## 2. Methodology

This research was conducted at SMA Negeri 1 Pekanbaru. The selection of SMAN 1 Pekanbaru as the research sample was based on purposive sampling technique by considering factors such as school accreditation, curriculum implementation, availability of adequate facilities, and availability of facilities and infrastructure such as chemistry laboratory and school library to facilitate learning related to buffer solution topic. While the group sampling technique was carried out by random sampling of 7 MIPA XI classes at SMAN 1 Pekanbaru.

The type of research used is Quasi Experiment using Pretest-Posttest control group design. This study used 4 classes, namely 2 experimental classes and 2 control classes. The experimental class applied guided inquiry integrated with Science, Environment, Technology, and Society (SETS) and the control class applied a scientific approach. The purpose of this study was to see the difference in critical thinking ability and self-efficacy between experimental and control classes.
The design of this study can be seen in Table 1.

Table 1. Pretest-Posttest Control Group Design

| Class | Pretest | Treatment | Posttest |
|---|---|---|---|
| Experiment | $O_1O_2$ | $X_1$ | $O_1O_2$ |
| Control | $O_1O_2$ | - | $O_1O_2$ |

Notes: $O_1$: critical thinking questions about buffer solution; $O_2$: self efficacy questionnaire, $X_1$: guided inquiry integrated science, environment, technology, and society (SETS).

Data collection in this study used two instruments, namely critical thinking ability test instrument and self-efficacy questionnaire instrument. The critical thinking ability test instrument consists of 6 pretest questions and 6 posttest questions that have been tested for reliability and validity. The self-efficacy questionnaire consists of 27 statements that have been tested for reliability and validity. Critical thinking ability and self-efficacy measured during the pretest and posttest were then analyzed using N-Gain to see whether there was an increase in students' critical thinking ability and self-efficacy. To determine the N-Gain value, the following formula is used:

$$N - Gain = \frac{posttest\ score - pretest\ score}{\text{maximum score} - pretest\ score}$$

Source by (Hake, 1998)

With the criteria listed in Table 2.

Table 2. N-Gain Criteria

| Range | Criteria |
|---|---|
| N-Gain > 0,7 | High |
| 0,3 ≤ N-Gain ≤ 0,7 | Medium |
| N-Gain < 0,3 | Low |

To see whether there is a significant difference between the groups and the two variables tested, the MANOVA test is used. MANOVA analysis requires the

fulfillment of a number of basic assumptions so that the test results can be interpreted validly. Therefore, nine relevant assumptions were tested according to Stevens (2012) as follows:

a. Two or more dependent variables are measured in continuous interval or ratio form.
b. The independent variable consists of 2 or more categories.
c. The research is conducted independently
d. Have a minimum sample size of 25 students in each class
e. No multivariate and univariate outliers detected
f. Multivariate data is normally distributed.
g. Homogeneity of covariance matrix.
h. There is a linear relationship between a pair of dependent variables for each group of independent variables.
i. No multicollinearity detected

The MANOVA test is then carried out by looking at the Hotteling's $T^2$ Test value in the MANOVA test results table. Hypothesis testing is carried out with the help of SPSS version 24 software with the determination of decision making based on a significance rate of 0.05. If the significance level is <0.05 then $H_0$ is rejected, whereas if the significance level is >0.05 then $H_0$ is accepted (Hair et al., 2010). After carrying out Hotteling's Trace testing, the process continues by conducting univariate testing, namely Test of Between-subject Effect to determine differences in critical thinking ability and self-efficacy respectively after applying a guided inquiry integrated with SETS on buffer solution topic.

## 3. Results and Discussion

### A. Normalize Gain Test (N-Gain)

Critical thinking ability and self-efficacy of students show differences between students who apply Guided Inquiry Integrated Science, Environment, Technology, and Society (SETS) learning in the experimental class and students who apply a scientific approach in the control class on buffer solution topic. Learning with Guided Inquiry Integrated Science, Environment, Technology, and Society (SETS) provides better results on critical thinking ability and self-efficacy of students. This is evidenced by the average Normalized-gain (N-gain) value of the experimental class which is greater than the average N-gain value of the control class. The average N-gain results for critical thinking ability and self-efficacy of students are presented in Tables 3 and 4.

Table 3. Mean N-gain Results of Critical Thinking Ability

| Class | Number of students | Mean score | | |
|---|---|---|---|---|
| | | ***Pretest*** | ***Posttest*** | **N-gain** |
| Experiment | 79 | 46,445 | 81,182 | 0,633 |
| Control | 80 | 44,896 | 72,906 | 0,488 |

Table 4. Mean N-gain Results of Self Efficacy

| Class | Number of students | Mean score | | |
|---|---|---|---|---|
| | | *Pretest* | *Posttest* | N-gain |
| Experiment | 79 | 85,823 | 106,861 | 0,423 |
| Control | 80 | 83,600 | 94,488 | 0,210 |

## B. Test of Hypothesis

When the MANOVA prerequisite test has been fulfilled, starting from the absence of univariate and multivariate outliers, having a normal data distribution, a homogeneous variant matrix, linearity, and the absence of collinearity between variables. Then the next analysis can proceed to the MANOVA test for testing the research hypothesis.

### *a. Differences in Critical Thinking Ability and Self-Efficacy between Guided Inquiry integrated Science, Environment, Technology, and Society (SETS) with a Scientific Approach*

Hypothesis testing uses multivariate tests, and the results are shown in Table 5.

Table 5. Hypothesis Testing uses Multivariate Tests

| **Effect** | | **Value** | **F** | **Hypothesis df** | **Error df** | **Sig.** | **Partial Eta Squared** |
|---|---|---|---|---|---|---|---|
| Class | Hotelling's Trace | 1.139 | 88.830 | 2.000 | 156.000 | 0.000 | 0.532 |

The results of this test can be seen in Table 5, based on table 5, the Hotelling's Trace sig value obtained is 0.000. The significance value is less than the predetermined significance level value, namely (0.000 <0.05). So it can be concluded that there is a significant difference in critical thinking skills and self-efficacy between students who follow Guided Inquiry integrated Science, Environment, Technology, and Society (SETS) with students who follow a scientific approach to buffer solution topic.

Guided inquiry learning integrated Science, Environment, Technology, and Society (SETS) is a combination of guided inquiry learning model and SETS approach. Guided inquiry is a learning model that encourages students to be actively involved in the process of seeking and discovering information through the process of investigation or experimentation (Ayuningtyas & Yonata, 2019). The SETS approach aims to improve learners' ability to apply scientific knowledge to understand the relationship between what they learn in class and events in everyday life. As a result, students can participate in science classes that are more applicable to their everyday lives and have greater meaning (Xiang & Han, 2024). Learning with guided inquiry integrated with SETS is designed to increase students' critical thinking ability and self-efficacy by involving them in an active learning process that connects scientific concepts with real-world applications.

This research applies the guided inquiry model integrated with SETS assisted by learning media in the form of LKPD. LKPD is used as supporting media designed to guide students in learning activities (Yudha et al., 2019). The LKPD is prepared based on the syntax of the guided inquiry model integrated with SETS which includes orientation, identifying and formulating problems, formulating hypotheses, collecting data, data analysis, and formulating conclusions.

The results of descriptive analysis after treatment showed that the average score of students who participated in guided inquiry integrated with SETS was higher than that of students who participated in scientific learning. This finding is in line with research conducted by Diana et al (2023) with a higher average score in the experimental class that applied SETS-based guided inquiry compared to the control class. Another study conducted by Astyana et al (2017) showed that students who used the guided inquiry model with SETS vision had higher science process skills and cognitive learning outcomes compared to the control class.

### *b. Differences in Critical Thinking Ability between Guided Inquiry integrated Science, Environment, Technology, and Society (SETS) with a Scientific Approach*

To see the difference in critical thinking ability between the experimental class and the control class can be seen statistically through the significance results on the Test of Between Subject Effect which can be seen in Table 6.

Table 6. Test of Between Subject Effect Results on Critical Thinking Ability

| *Dependent Variable* | *Df* | *Mean Square* | *F* | *Sig.* | *Partial Eta Squared* |
|---|---|---|---|---|---|
| Critical thinking ability | 1 | 0.832 | 30.293 | 0.000 | 0.162 |

Based on table 6, the significance of 0.000 is obtained, which means that the value is smaller than the significance level (0.05). This proves that there is a significant difference in the critical thinking ability of students who follow Guided Inquiry integrated Science, Environment, Technology, and Society (SETS) with students who follow a scientific approach.

The difference in critical thinking ability is due to the activeness of students in the experimental class. Through exploration and investigation activities, guided inquiry helps students to actively participate in the process of discovering and developing their knowledge (Suwono et al., 2019). Based on problems or issues that the teacher presents on the LKPD, students are assisted with problem analysis, questioning, hypothesis formation, and observation. The problems presented are associated with aspects of Science, Environment, Technology, and Society (SETS). The integration of SETS into education enhances students' comprehension and practical application by enabling them to relate scientific ideas to the context of the environment, technology, and society. Furthermore, because the content is contextualized and relevant to students' daily lives, the usage of SETS in the classroom can result in meaningful learning (Diana et al., 2023). Learning with the SETS integrated guided

inquiry model helps students to develop their critical thinking ability by exposing them to real situations that require analysis and solutions (Syifahayu, 2017).

Makmur et al (2019) and Maknun (2020) also stated that guided inquiry learning can improve critical thinking skills. Dewi & Wardani (2020) also conducted a similar study with the assistance of the edmodo application. The results showed an Increase in critical thinking ability in the experimental class taught using guided inquiry assisted by edmodo application. Another study by Diana et al (2023), stated that the guided inquiry based on SETS can improve students' critical thinking skills as evidenced by the significant difference in posttest scores between the experimental class (guided inquiry based on SETS) and the control class (discovery learning). The mean posttest score of the experimental class is higher than the control class.

### *c. Differences in Self-Efficacy between Guided Inquiry integrated Science, Environment, Technology, and Society (SETS) with a Scientific Approach*

Based on statistical results, differences in self-efficacy between experimental and control class students can be seen through the significance results in the Test of Between Subject Effect which can be seen in Table 7.

Table 7 Test of Between Subject Effect Results on Self-Efficacy

| *Dependent Variable* | *Df* | *Mean Square* | *F* | *Sig.* | *Partial Eta Squared* |
|---|---|---|---|---|---|
| Self efficacy | 1 | 1.807 | 162.549 | 0.000 | 0.509 |

Based on table 7, the significance of 0.000 is obtained, which means that the value is smaller than the significance level (0.05). This proves that there is a significant difference in the self-efficacy of students who follow Guided Inquiry integrated Science, Environment, Technology, and Society (SETS) with students who follow the scientific approach.

Learning with guided inquiry integrated with SETS has a positive impact on students' self-efficacy. This finding is supported by research conducted by Ardiany et al (2017) which shows that students' self-efficacy in experimental classes employing guided inquiry models is significantly higher than that of control classes on buffer solution topic. Guided inquiry learning involves students in the process of finding problems, formulating hypotheses, collecting data, and drawing conclusions. This process trains critical, logical, creative, and analytical thinking skills, which support the development of self-efficacy because students feel successful in completing tasks independently.

The integration of the SETS approach in learning makes learning more contextual, because it connects science concepts with the environment, technology, and society. Contextual learning gives students a meaningful understanding that what they learn has real benefits in life, so they feel more confident and motivated to learn (Haryanto & Arty, 2019).

Research by Sopari et al (2022) shows that the self-efficacy of students taught with guided inquiry is better than conventional learning. This is characterized by students who are enthusiastic and brave in facing various problems because they feel challenged in working on complex problems. Amir & Vonitasari (2025) also revealed that guided inquiry learning can significantly increase students' self-efficacy.

Well-prepared tables and or figures must be of significant feature of this section, because they convey the major observations to readers. Any information provided in tables and figures should no longer be repeated in the text, but the text should focus on the importance of the principal findings of the study. In general, journal papers will contain three-seven figures and tables. The same data can not be presented in the form of tables and figures. The results of the study are discussed to address the problem formulated, objectives and research hypotheses. It is highly suggested that discussion be focused on the why and how of the research findings and to extend to which the research findings can be applied to other relevant problems.

## 4. Conclusion

This study concluded that learning using the guided inquiry model integrated with Science, Environment, Technology, and Society (SETS) significantly improved students' critical thinking ability and self-efficacy in buffer solution material. The experimental group showed higher improvement than the control group, as shown by the N-Gain score and MANOVA analysis. This success is due to the stages in guided inquiry that encourage students to think systematically, starting from problem identification, problem formulation, defining hypotheses, data collection, verification of results, to drawing conclusions, resulting in critical thinking skills, problem solving, and a deeper understanding of the material. SETS integration in learning allows students to connect scientific concepts with the context of the environment, technology, and society, which enhances their understanding and practical application. Futhermore, learning becomes more meaningful as it is connected to real-world situations, making it more contextual and relevant to learners.

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