

IMPLEMENTATION OF GUIDED INQUIRY LEARNING WITH SOCIO-SCIENTIFIC ISSUES CONTEXT TO STUDENTS' CRITICAL THINKING SKILLS ON BUFFER SOLUTION MATERIAL

Sabrina Aulia Afifah¹, Oktavia Sulistina^{*1, 2}, and Istri Setyowati³

¹Teacher Professional Education Study Program, Postgraduate School, Universitas Negeri Malang

²Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang

³Universitas Negeri Malang Laboratory Senior High School

e-mail: oktavia.sulistina.fmipa@um.ac.id

Abstract

This study aims to determine the effect of the application of guided inquiry learning model with Socio-Scientific Issues (SSI) context on students' critical thinking skills on buffer solution material. This study used a pre-experiment design type one group Pre-Test Post-Test with the subject of 30 students of class XI MIPA 6 SMA Laboratorium UM Malang. The measurement instrument was a reasoned multiple choice test to measure students' critical thinking skills. Data were analyzed using normality test, homogeneity, N-Gain analysis, and Wilcoxon test. The results showed an increase in the average Post-Test score by 36.48 points from the Pre-Test. The N-Gain value showed an increase in the medium (56.67%), low (40.00%), and high (3.33%) categories. Guided Inquiry Learning syntax consisting of Problem Orientation, Problem Formulation, Hypothesis Formulation, Investigation, Data Analysis, and Conclusion Drawing proved effective in encouraging students' critical thinking skills. SSI contexts such as betel nut phenomenon provide contextual stimulus that helps students to be able to connect chemistry concept with their daily life and also strengthens students' analysis and reflection in chemistry learning. The Wilcoxon test results produced a significance value of 0.000 ($p < 0.05$) which means there is a significant difference between the Pre-Test and Post-Test. GIL syntax consisting of problem orientation, problem formulation, hypothesis formulation, investigation, data analysis, and conclusion drawing proved effective in encouraging students' critical thinking skills. SSI contexts such as the betel nut phenomenon provide contextual stimulus that strengthens students' analysis and reflection in chemistry learning.

Key words: Guided inquiry learning, Socio-Scientific Issues, Critical Thinking

INTRODUCTION

The 21st century is a time in which individuals are required to have skills in Critical Thinking, Creative Thinking, Problem Solving, Collaboration, and Communication (1). Education in Indonesia has been developed based on the Paradigma pembelajaran abad 21st century paradigm with Kurikulum 2013 and Kurikulum Merdeka implemented through student centered learning and scientific approach. This 21st learning paradigm emphasizes the development of students' skills and abilities to think critically, work together in problem solving, and the ability to learn from a variety of sources (2). According to Ennis, critical thinking is reasoned and reflective thinking that

focuses on the steps of making decisions about things to believe and things to do (3). Critical thinking is also defined as a cognitive and dispositional process that includes the ability to analyze arguments, conduct deductive and inductive inferences, evaluate, and solve problems reflectively and reasonably (4). Based on the two definitions, critical thinking is defined as the skill of analyzing, synthesizing, and evaluating various information to make decisions that can be explained using evidence, concepts, and methodology as the basis for decision making. Critical thinking skills are important for students as one basis for problem solving. In Chemistry learning, critical thinking skills are included in

scientific activities such as asking questions, choosing the right choice based on the results of the analysis, and drawing conclusions from the results of the analysis (5). In learning chemistry, critical thinking skills are important for students to be able to critically evaluate scientific statements, help students understand chemistry concepts, and the applications for solving problems in daily life. In other words, learning chemistry not only involves memorizing theories, formulas, and chemical reactions, but also understanding chemical concepts correctly (6).

Although critical thinking skills are very important to acquire, international studies such as the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) show that Indonesian students' critical thinking skills are still below the benchmark. The last TIMSS results that Indonesia participated in, which was in 2015, showed that Indonesia ranked 44th out of 49 countries with an average score below the benchmark (7). On the other hand, the 2022 PISA result showed that Indonesia ranked 69 out of 81 countries participated in PISA. More specifically, the PISA report shows that 34% of Indonesian students achieved level 2 or higher in science, which means students are able to recognize correct explanations for scientific phenomena and use this knowledge to identify valid conclusions based on data given in simple cases. In addition, PISA report also shows that almost no students in Indonesia have achieved high levels in Science (level 5 or 6) (8). The results obtained by Rahmi et. al showed that midterm exam results of 87,5% SMPN 11 Padang students were below the minimum competencies criteria that has been set, which is 75 (9). Fernanda et.al found that students across all ability groups struggled with making inductions while medium and low level students faced challenges in multiple areas of critical thinking, including evaluating observations and identifying assumptions. The most successful skill was asking and answering questions (10). Students' low critical thinking skills are caused by learning models that develop critical thinking are not adequately applied in every lesson in the classroom (11). Teachers who have a role as mediators and facilitators must

be able to design and implement certain learning models and strategies that are able to train and develop students' critical thinking skills (12). Some research results show that the learning model that is considered effective in improving critical thinking skills is an inquiry-based learning model (13).

The guided inquiry learning is one of the forms of inquiry learning model. The guided inquiry learning model is a student centered learning model that is capable of encouraging and directing students to participate optimally to think in a systematic way in the learning process (14). The main objective of this learning model is to improve students' ability to think logically, systematically, and think critically (14). Guided inquiry learning activities emphasize critical and analytical thinking processes for students so that students are possible to explore, decide, and use various sources of information and ideas to improve their understanding of a phenomenon. (15).

The usage of context in the inquiry learning process can improve students' understanding of concepts. Context is a bridge between abstract concepts and the reality of everyday life. One of the contexts that can be used in guided inquiry learning is Socio-Scientific Issues (SSI) (16). SSI is described as issues about science and society that are unstructured, complex, have indefinite solutions, and related to morals and ethics (17,18). SSI as a learning context can encourage students to build critical argumentation and reflective decision-making (19). That is, guided inquiry learning with the SSI context will engage students to think critically in analyzing problems, evaluating the sources used for analyzing problems, and generating solutions based on the analysis. (20).

Previous research has shown that the application of SSI-based guided inquiry learning can improve students' critical thinking skills as seen from the increase in the average Post-Test score of the research sample. (16). Learning with SSI as a context makes students active in learning through various activities such as conducting discussions, putting arguments with scientific background, and collecting various data sources for

further investigation (21,22). The same result also found in other studies which revealed that guided inquiry learning model combined with Socio-Scientific Issues can positively affect students' critical thinking skills on the material of environmental or climate change and waste recycling (23). However, previous studies have not specifically examined the improvement of students' critical thinking skills after the application of guided inquiry learning with SSI context in Chemistry learning on the topic of Buffer Solutions. Therefore, this study aims to investigate the effect of SSI-contextualized guided inquiry learning model on students' critical thinking skills on the topic of Buffer Solution with the expectation of being able to provide new insights related to innovative Chemistry learning design.

METHODS

This research is a quantitative research with one group pre and post test pre-experimental design. The Pre-Test was given to measure students' initial ability before receiving treatment while the Post-Test was given to measure students' final ability after receiving treatment. The research design schema is shown in Table 1 below.

Table 1. One Group Pre-Test-Post-Test Schema

Pre-Test	Treatment	Post-Test
Y_1	X	Y_2

The sample of this research was 30 students of class 11 MIPA 6 SMA Laboratorium UM Malang. The instruments used Critical Thinking Ability tests in the form of multiple choice reasoned developed by (24) consisting of 13 questions. The multiple choice reasoned used as

test instrument is suitable for students to write their critical analysis.

The validity test shows that the items in the research instrument have empirical validity in the sufficient, high, and very high category, indicating that all items met the required validity standards use in the study. The reliability test was carried out with the aim of knowing the extent to which the Critical Thinking Skills Test can accurately measure students' critical thinking skills. The calculation results show that the reliability for The Critical Thinking Skills Test is 0.830. Based on the reliability value criteria, the test has a reliability that is categorized as good. The data analysis technique used are the Saphiro-Wilk normality test and Levene's homogeneity test. Normality test and homogeneity test were conducted to determine whether the research data belonged to parametric or non-parametric data. The research hypothesis test used the Wilcoxon-Rank Test.

RESULTS AND DISCUSSIONS

1. Result

Learning activities used the guided inquiry learning model with Socio-Scientific Issues (SSI) context on Buffer Solution material. The learning activities of Buffer Solution with guided inquiry in the context of SSI lasted for three weeks with a total of five meetings and the duration of each meeting was 80 minutes. Learning activities consist of introduction activities, core activities, and closing activities. The introduction activity aims to increase student motivation and focus their attention on learning. Core activities consist of problem orientation activities, problem formulation, hypothesis formulation, investigation, data analysis, and conclusion (25).

Table 2. Guided Inquiry Learning Model with SSI Context

Guided Inquiry Learning Model with SSI Context	Learning Activities
Problem Orientation	At this stage, students are asked to read and understand the SSI phenomenon in the form of the Menginang Sirih Tradition written in the LKPD. The purpose of this process is to stimulate students' curiosity about the learning activities and the material they will learn. In addition, the SSI context used is relevant to the lives of Indonesian people and still raises many debates, especially in the fields of health and culture. This aims to increase students' interest and stimulate students to think critically about the solution to the problem..

Guided Inquiry Learning Model with SSI Context	Learning Activities
Problem Formulation	Students with guiding questions, group discussions, and teacher assistances identify and define problem statements based on the SSI phenomena presented. This activity aims to train critical and analytical thinking skills after studying a phenomenon.
Hypothesis Formulation	Students are asked to discuss with their respective groups to formulate hypotheses or temporary presumptions about the formulated problem. This hypothesis will be tested through the investigation process. This activity trains the ability to make logical predictions based on students' prior knowledge.
Investigation	Students conduct experiments, search for information, or search for secondary data to test hypothesis. The teacher acts as a facilitator who provides technical direction. The aim of this activity is to develop students' science process skills and scientific thinking.
Data Analysis	The data obtained from the investigation process was analyzed to determine whether the hypothesis is accepted or rejected. The purpose of this activity is to train students' logical thinking and interpretation skills related to data.
Conclusion	Students draw conclusions based on the results of data analysis and compare them with the initial hypothesis. The purpose of this activity is to train students to conclude learning scientifically and develop concepts as a whole.

Learning activities with guided inquiry learning model with SSI context aims to train students' critical thinking skills. Students' critical thinking skills are measured using Critical Thinking Skills Tests given before (Pre-Test) and after (Post-Test) learning. N-Gain analysis was used to determine the increase in students' critical thinking skills test scores after the application of guided inquiry learning with SSI context. The N-Gain criteria used are low ($0.3 < g$), medium ($0.3 < g < 0.7$), and high ($0.7 < g$) (25). The results of the N-Gain analysis of the Pre-Test and Post-Test scores of students' critical thinking skills can be seen in Table 3.

Table 3. N-Gain Analysis Results

N-Gain Category	Number	Percentage
High	1	3,33%
Medium	17	56,67%
Low	12	40,00%

Furthermore, the average N-Gain result of Pre-Test and Post-Test scores was 0.39 and indicated the Medium category. This shows that after the application of guided inquiry learning with SSI context, students' critical thinking skills increased. The Pre-Test and Post-Test data of students' critical thinking skills were then tested for normality and homogeneity as a prerequisite test

for hypothesis testing. The normality test was used to determine whether the Pre-Test and Post-Test data were normally distributed or not. The normality test used was the Saphiro-Wilk test with a significance level of 0.05 (95%). The results of the normality test of the Pre-Test and Post-Test scores of students' critical thinking skills can be seen in Table 4.

Table 4. Normality Test Results

Data	Significance Value	Description
Pre-Test	.128	Normal
Post-Test	.182	Normal

Based on table 4, both data have a significance value of more than 0.05 ($\text{sig.} > 0.05$) which means that the data for the Pre-Test and Post-Test scores of students' critical thinking skills are normally distributed. Furthermore, the Pre-Test and Post-Test scores of students' critical thinking skills were tested for homogeneity to determine if the two data had the same variance. Table 5 below shows the results of the homogeneity test of students' Pre-Test and Post-Test scores.

Table 5. Homogeneity Test Result

Based on	Significance Value	Description
----------	--------------------	-------------

Mean	.001	Not homogeneous
------	------	-----------------

Based on the results of Levene's homogeneity test, it is known that the significance value obtained is 0.001 which means less than 0.05 (sig. <0.05). This means that the data does not have the same variance or is not homogeneous. Based on the results of the normality and homogeneity tests, the data did not meet the prerequisite tests to be tested with the Paired Sample T-Test parametric test. Hypothesis testing then uses the Wilcoxon-Rank non-parametric test. The results of the Wilcoxon-Rank test are shown in Table 6.

Table 6. Non-Parametric Wilcoxon-Rank Test Result

	Significance Value
Pre-Test-Post-Test	.000

Based on the Wilcoxon-Rank test results, the significance value generated is .000. This value is smaller than the significance level used (α) 0.05 (sig. <0.05), so H_0 is rejected. Therefore, this result can prove that there is a significant difference in students' critical thinking skills before and after the application of guided inquiry learning with SSI context.

2. Discussions

The results showed that the application of guided inquiry learning with SSI context was able to have a significant impact on improving students' critical thinking skills on Buffer Solution material. The evidence of this improvement is the results of the Wilcoxon-Rank non-parametric statistical test which shows a significance value of 0.000 (sig. <0.05), which means there is a significant difference between students' critical thinking skills before and after guided inquiry learning with SSI context. In addition, the average Post-Test score showed an increase of 36.48 points from the Pre-Test. Meanwhile, the results of the N-Gain analysis showed that the increase in the Post-Test scores of students' critical thinking skills varied with most of them experiencing an increase in the medium category (56.57%), followed by an increase in the low category (40.00%), and finally an increase in the high category (3.33%).

The results of this study are strengthened with research conducted by Rahmi et al which

shows that students who participated in guided inquiry learning had better critical thinking skills than students who did not participate in the learning. The guided inquiry model is considered appropriate to be applied in real practical activities because it can help students build the knowledge and skills needed to master the subject in depth (9). Each syntax in guided inquiry learning is designed to train critical thinking skills through activities that emphasize critical and analytical thinking processes. Orientation and problem formulation activities emphasize students to make interpretations of the Menginang Sirih (Betel Quid) phenomenon, as the SSI context used, and relate it to oral pH stability. This interpretation is the foundation for formulating questions in the problem formulation stage and the hypothesis in the hypothesis formulation stage. Furthermore, students' analytical skills are trained in the activity of analyzing the experimental data obtained. Students with their groups analyze the difference in pH of the solution after adding strong acids and strong bases, which compounds can form buffer solutions, how buffer solutions can maintain pH when acids and bases are added, the equilibrium reaction of buffer solutions, and the calculation of the pH of buffer solutions with the help of guiding questions.

The next critical thinking skill is inference. Students learn to draw conclusions about the results of the experiment based on the analysis of the experimental data they have done. Then, students also learn to evaluate the literature sources they use in analyzing the experimental data. Students also learn to evaluate the calculation of pH with the formula that they successfully discussed with their group. These stages in guided inquiry learning allow students to find answers to the problems presented in learning, as well as develop high-level thinking skills systematically and reflectively (9).

The guided inquiry learning applied in this research can develop students' critical thinking skills because this model emphasize students in the process of seeking and finding answers to the problem used in the problem orientation, so that students are able to solve problem both in learning and everyday life (6). In addition, SSI as the

context used leads to problems that are often bedated, which stimulates students' interest in discussing from various points of view (26).

The integration of SSI as a context in learning enhances the significance of developing students' critical thinking skills because it provides an authentic and relevant context (27). This integration of SSI in learning provides opportunities for students to critically examine and evaluate the decision-making of the SSI phenomenon. (16). The results of several studies also show that learning with the context of SSI makes students more active in learning through deep thinking activities about various data sources to make the right decision about the SSI phenomenon context while considering moral values, ethics, and social aspects (7). In addition, discussion activities carried out by students during the process of analyzing SSI phenomena strengthen the practice of critical evaluation of scientific information and train students to make critical decisions (16).

The study was conducted using pre-experiment design with one experimental group without control group. This limitation was due to the researcher's role as a pre-service chemistry teacher who was only assigned to teach one class in grade 11. The other grade 11 classes were taught by fellow pre-service chemistry teachers or by non-supervising mentor, making it unfeasible to intervene in their teaching schedules. As a result, the absence of control group may limit the generalization of the findings and strength of causal inference. Therefore, further research with a more comprehensive research design is needed to strengthen the validity of the findings.

CONCLUSION

Based on the results of the study, it can be concluded that the application of guided inquiry learning model with Socio-Scientific Issues (SSI) context significantly improves students' critical thinking skills on buffer solution material. This is evidenced by the significant difference in students' Pre-Test and Post-Test scores based on the Wilcoxon-Rank hypothesis test ($p = 0.000$) and the average N-Gain score of 0.39 which is included in the medium category. The syntax in the guided inquiry learning model with the SSI context trains

students' critical thinking skills through a learning process that emphasizes reflective and analytical thinking. The use of SSI context in learning, such as the *mengingat sirih* phenomenon, plays an important role in stimulating students' cognitive engagement and building connections between chemical concepts and real life. Thus, guided inquiry learning with SSI context can be an effective strategy in improving students' critical thinking skills in learning Buffer Solution.

ACKNOWLEDMENT

The authors gratefully acknowledge the financial support provided by the Pre-service Teacher Professional Program (PPG Prajabatan), Malang State University, for this research.

REFERENCES

1. Partnership for 21st Century Skills Ohio Department of Education. 2007. *Partnership For 21st Century Skills-Core Content Integration*. www.P21.org. Accessed January 24, 2025.
2. Sudirman, Anggraeni, S., Marlinda, N. L. P. M., Silalahi, E. K., Fitriani, A., Siregar, H. T., Br Pa, R. H., Azizah, N. N., Hidayat, Saputri, M., Wirda, Nasrianty, and Karim, S. 2023. *Implementasi Pembelajaran Abad 21 Pada Berbagai Bidang Ilmu Pengetahuan*. Bandung: Media Sains Indonesia.
3. Ennis, R. H. 1962. *A Concept of Critical Thinking a Proposed Basis for Research in the Teaching and Evaluation of Critical Thinking Ability*. Cambridge.
4. Lai, E. R. 2011. *Critical Thinking: A Literature Review Research Report*. London: Pearson.
5. Sutiani A., Situmorang M., and Silalahi A. 2021. Implementation of an Inquiry Learning Model with Science Literacy to Improve Student Critical Thinking Skills. *International Journal of Instruction*. Vol. 14, No. 2, pp. 17–38.
6. Rushiana, R. A., Sumarna, O., and Anwar, S. 2023. Efforts to Develop Students' Critical Thinking Skills in Chemistry Learning: Systematic Literature Review. *Jurnal Penelitian Pendidikan IPA*, Vol. 9, No. 3, pp. 1425–1435.
7. Dusturia, N., Nurohman, S., and Wilujeng, I. 2024. Socio-Scientific Issues (SSI) Approach

- Implementation in Science Learning to Improve Students' Critical Thinking Skills: Systematic Literature Review. *Jurnal Penelitian Pendidikan IPA*, Vol. 10, No. 3, pp. 49–57.
8. OECD. 2023. *PISA 2022 Results Factsheets Indonesia*. OECD Publishing.
 9. Rahmi, Y. L., Alberida, H., and Astuti, M. Y. 2019. Enhancing Students' Critical Thinking Skills Through Inquiry-Based Learning Model. *International Journal of Physics: Conference Series*, Vol. 1317, pp. 1–6.
 10. Fernanda, A., Haryani, S., Tri, P. A, and Hilmi, M. 2019. Analisis Kemampuan Berpikir Kritis Siswa Kelas XI pada Materi Larutan Penyangga dengan Model Pembelajaran Predict Observe Explain. *Jurnal Inovasi Pendidikan Kimia*, Vol. 13, No. 1, pp. 2326–2336.
 11. Pasaribu, S. E., Atifah, Y., Helendra, and Ristiono. 2020. Perbandingan Kemampuan Berpikir Kritis Siswa SMP yang Diajar Dengan Model Problem Based Learning dan Discovery Learning. *Jurnal Mimbar Ilmu*, Vol. 25, No. 3, pp. 460–469.
 12. Ijirana, Aminah, S., Supriadi, and Magfirah. 2022. Critical Thinking Skills of Chemistry Education Students in Team Project-Based STEM-Metacognitive Skills Learning during The Covid-19 Pandemic. *Journal of Technology and Science Education*, Vol. 12, No. 2, pp. 397–409.
 13. Wulandari, D. S., Prayitno, B. A., and Maridi, M. 2022. Developing the Guided Inquiry-Based Module on the Circulatory System to Improve Student's Critical Thinking Skills. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, Vol. 8, No. 1, pp. 77–85.
 14. Oktavia, L. M., Syahri, W., and Asmiyunda. 2025. Pengembangan e-LKPD Larutan Penyangga Berbasis Guided Inquiry untuk Meningkatkan Kemampuan Berpikir Kritis Peserta Didik. *Journal on Education*, Vol. 7, No. 2, pp. 12771–12784.
 15. Kaltakci, D., and Oktay, O. 2011. Guided-Inquiry Laboratory Experiment to Reveal Students' Comprehension of Friction Concept: A Qualitative Study. *Balkan Physics Letters*, pp. 180–190.
 16. Mahanani, I., Rahayu, S., and Fajaroh, F. 2019. Pengaruh Pembelajaran Inkuiri Berkonteks Socioscientific-Issues Terhadap Keterampilan Berpikir Kritis dan Scientific Explanation. *Jurnal Kependidikan*, pp. 53–68.
 17. Eastwood, J. L., Sadler, T. D., Zeidler, D. L., Lewis, A., Amiri, L., and Applebaum, S. 2012. Contextualizing Nature of Science Instruction in Socioscientific Issues. *International Journal of Science Education*, Vol. 34, No. 15, pp. 2289–2315.
 18. Sadler, T. D. 2004. Informal Reasoning Regarding Socioscientific Issues: A Critical Review of Research. *Journal of Research in Science Teaching*, Vol. 41, No. 5, pp. 513–536.
 19. Högström, P., Gericke, N., Wallin, J., and Bergman, E. 2024. Teaching Socioscientific Issues: A Systematic Review. *Science & Education*.
 20. Qamariyah, S. N., Rahayu, S., Fajaroh, F, and Alsulami, N. M. 2021. The Effect of Implementation of Inquiry-based Learning with Socio-scientific Issues on Students' Higher-Order Thinking Skills. *Journal of Science Learning*, Vol. 4, No. 3, pp. 210–218.
 21. Sakamoto, M., Yamaguchi, E., Yamamoto, T., and Wakabayashi, K. 2021. An Intervention Study on Students' Decision-Making Towards Consensus Building on Socio-Scientific Issues. *International Journal of Science Education*, Vol. 43, No. 12, pp. 1965–1983.
 22. Schenk, L., Hamza, K., Arvanitis, L., Lundegård, I., Wojcik, A., and Haglund, K. 2021. Socioscientific Issues in Science Education: An opportunity to Incorporate Education about Risk and Risk Analysis? *Risk Analysis*, Vol. 41, No. 12, pp. 2209–2219.
 23. Dora, F., Afandi, A., Besse, T. A., Artika, W., and Titin, T. 2024. Pengaruh Model Guided Inquiry disertai Socioscientific Issues terhadap Keterampilan Berpikir Kritis Siswa. *JPSP (Jurnal Penelitian Sains dan Pendidikan)*, Vol. 4, No. 1, pp. 95–107.
 24. Rahmani, N. S. 2020. *Pengembangan Instrumen Tes Keterampilan Berpikir Kritis Siswa SMA pada Materi Larutan Penyangga dalam Konteks Problem Solving*. Bandung: Universitas Pendidikan Indonesia.

25. Sanjaya, W. 2006. *Strategi Pembelajaran Berorientasi Standar Proses Pendidikan*, Jakarta: Prenada Media.
26. Meltzer, D. E. 2002. The Relationship Between Mathematics Preparation and Conceptual Learning Gains in Physics: A Possible “Hidden Variable” in Diagnostic Pre-Test Scores. *Americam Journal of Physics*, Vol. 70, No. 12, pp. 1259–1268.
27. Putra, I. M. T. P. 2022. Kajian Literatur Sistematis: Integrasi Model Inkuiri Berbasis Socioscientific Issues pada Pembelajaran IPA. *Jurnal Pendidikan MIPA*, Vol. 12, No. 3, pp. 919–928.
28. Nareswari, Farera, K. P., Arianingrum, R. 2024. The Socioscientific Issues Approach in Chemistry Education: A Literature Study and Its Implication. *Jurnal Pendidikan MIPA*, Vol. 25, No. 4, pp. 1880–1892.