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# Implementation of the Socio-scientific Issues Approach with the Investigative Group Learning Model to Improve Students' Critical Thinking Skills on Environmental Change Materials

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**Abstract:** This study aims to determine the effect of the socio-scientific issue approach with the investigative group learning model on the critical thinking skills on environmental change. This study uses a quasi-experimental method with a pretest-posttest control group design. The research population is the students of class X IPA SMAN 1 Batu Sopang, Paser Regency, East Kalimantan, in the academic year 2020/2021. The samples were class X IPA 1 (experimental group) and X IPA 2 (control group). The test instrument used is a written test. The average pre-test and post-test of the experimental class increased by 15.86, while the average value of the pre-test and post-test of the control class increased by 8.62. the two classes have a difference of 7.24. The N-Gain test result for the experimental class is 0.33, including the medium category and the control class is 0.20, including the low category. The results of the independent samples t-test are sig. 0.08 < 0.05 and t count 2.740 > 1.99, meaning that H0 is rejected. Based on the study results, the socio-scientific approach to issues with the investigative group learning model proved to be more effective in improving students' critical thinking skills than conventional learning models.

**Keywords:** Socio-scientific issues; Group investigation, Critical thinking skills

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## Introduction

In the current 21st century, indicators of educational success are not only measured by the achievement index and the value obtained by students in exams but also by the readiness and success of students facing real-life (Selman & Jaedun, 2020). Education must prepare students with the skills to face the future because the demands for changing the mindset of the 21st-century society are to create education that can produce quality human resources in the face of global competition (Santika, 2018). Some of the student skills needed in the 21st century include the 4Cs. 4C consists of critical thinking, collaboration, communication, and creativity skills. These 4C skills are considered valuable to complement the core subjects of educational programs to prepare young people to become part of global, informative, and broad-minded citizens (Santika, 2018; Selman & Jaedun, 2020).

Critical thinking is one of the abilities that must be possessed. It needs to be developed for every student at all levels of education during the learning process at school, and it is necessary to find ways to build this potential (Selman & Jaedun, 2020; Arisa et al., 2021). In today's digital literacy era, students are expected to independently identify a problem, analyze the situation, collect data or information, interpret information, assess something, evaluate, and summarize the information

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they have generated. Students need to observe, experience, reflect, think, or communicate to build or strengthen their beliefs and actions before making relevant decisions (Selman & Jaedun, 2020; van Laar et al., 2020; Arisa et al., 2021).

Critical thinking is crucial in learning science because biology is complex learning. For example, in biology, there is knowledge of facts, concepts, principles, and ways to find out about nature systematically or related to the discovery process (Daniati, 2018). Therefore, the best way to develop critical thinking skills is to link learning materials with students' experiences in their daily environment in the 2013 curriculum learning (Wasyilah, 2021).

Based on observations and interviews with teachers at SMAN 1 Batu Sopang, the learning process still applies teacher-centered learning and uses the lecture method. However, this learning process has not improved students' critical thinking skills because students are less active during the learning process. The circle contained in teacher-centered learning starts with the teacher who gives lessons, the teacher who proves theories or facts, the teacher who offers examples of questions, and the teacher who also answers the questions. While students only act as listeners and imitate the teacher's way of answering questions, students will feel confused when faced with other questions because they are not used to answering according to their thoughts. This results in less meaningful learning in the classroom, and students assume that all the material provided by the teacher is rote (Indawati, 2018).

One of the potential learning strategies to be applied in honing and improving students' critical thinking skills is the socio-scientific issue approach (SSI). The SSI approach in education makes science learning more relevant in students' lives (Gutierez, 2015). The SSI approach can support the development of intellectual abilities, communication skills, social attitudes, caring, and student participation through social science topics (Aisya et al., 2017; Rosana, 2020). SSI is important for knowing how students understand, negotiate, and solve problems. According to Rostikawati (2016), the SSI approach can be used to bridge real issues in society and the foundation for students to explore science content.

According to Rahayu (2019), before using the SSI approach, first look at the topics in the curriculum because the subjects must have socio-scientific issues. Then, the teacher selects and develops these issues by adding guiding questions to engage students in the critical thinking process. Quality criteria in selecting and reflecting social contexts that have potential as SSI problems for science learning include: (1) the topic must be authentic, engaging, and currently being discussed in various mass media; (2) the topic must be relevant, and students can make scenarios see which decisions are taken in solving the problem and what kind of impact it will have; (3) SSI problems allow problem-solving from various points of view, so they must be evaluated; (4) SSI topics should allow for discussion in an open forum, and; (5) topics related to techno-scientific questions.

The socio-scientific issues approach in the learning process to improve students' critical thinking skills can be combined with the investigative group (GI) learning model. The GI learning model provides broad opportunities for students to be directly and actively involved in building their knowledge through group collaboration and can motivate students to think critically (Supriyanto, 2020). The GI learning model can train students to give opinions on a given problem and hone their ability to conclude from various ideas and decide on the right decision or action in solving the problem. The stages of the GI learning model are: (1) identifying the given topic; (2) planning the tasks of each group member; (3) starting an investigation on a predetermined topic; (4) preparing the results of the analysis; (5) presenting or presenting analysis; and (6) evaluate (Widyaningsing, 2020). The results obtained from the GI learning model are the involvement of students in providing their ideas. It aims to hone the critical thinking skills of each student.

Combining the SSI approach with the GI learning model is centered on problems based on social issues related to science that exist in society. In the first stage, each student and their group members identify the problem topic to be investigated. At this stage, students examine several sources related to the issue of the problem and categorize them. In the second stage, students work together and exchange opinions about how they learn, what tasks they have to do, and their goals in investigating the problem. In the third stage, each student will collect information, analyze data, and make conclusions about the investigated social-science issues. Students will also exchange ideas in group discussions to unite their views and opinions. In the fourth stage, each student and their group determine the essential points from the results of their small talk and plan how they present it. In the fifth stage, each group representative will deliver the results of their group investigation. Groups that do not act as presenters act as participants or listeners. Students may ask questions, provide feedback, evaluate, clarify, and add information on the topics presented. Finally, in the sixth stage, students and teachers assess together or assess the process and results of student projects. Combining the SSI approach with the GI learning model will provide students with more authentic and meaningful learning and improve critical thinking skills.

One of the currently developing issues related to socio-scientific issues is environmental change. This subject aims to educate students about the surrounding environment, especially waste and pollution.

Unfortunately, teacher-centered learning makes this subject dull because students do not get the opportunity to explore or find information independently, so their critical thinking skills are lacking. Therefore, this study was conducted to prove the effectiveness of the SSI approaches with the GI learning model in improving students' critical thinking skills in environmental change

## Method

The method used in this study is quasi-experimental with the form of a pretest-posttest control group design. Therefore, this study used two classes: the experimental and control classes. Details of this method can be seen in table 1 by Creswell (2012).

**Table 1.** Research Design

| Subject | Pretest | Treatment | Posttest |
|---|---|---|---|
| Experiment | O1 | X | O2 |
| Control | O3 | - | O4 |

Description:
O1 = pre-test in the experimental class
O2 = posttest in the experimental class
O3 = pre-test in the control class
O4 = posttest in the control class
X = implementation of the SSI approach with GI learning model

The procedure of this research is shown in Figure 1.

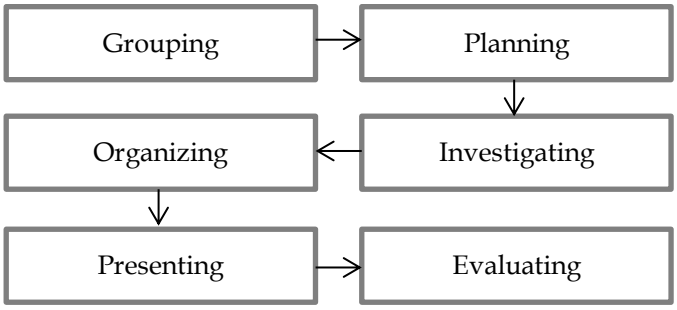



**Figure 1.** Research Procedures

The population in this study were students of class X SMAN 1 Batu Sopang, Paser Regency, East Kalimantan, in the academic year 2020/2021. While the sample used was determined by a simple random sampling technique. The results obtained from this technique are class X IPA 1 with 33 students as the experimental class and class X IPA 2 with 35 students as the control class. The indicator sought in this study is students' critical thinking skills on environmental change material using the SSI approach with the GI learning model.

The instrument used is a written test in the form of a description of 10 questions. The test instrument contains critical thinking indicators, namely analyzing (C4), evaluating (C5), and creating (C6). This test consists of an initial test (pre-test) and a final test (post-test). This test is intended to determine students' critical thinking skills and to determine students' understanding of the concept of environmental change. The results from the pre-test will be compared with the post-test results after treatment in the experimental class. This instrument has been tested and proven its validity by experts and can be used in research.

The data analysis aims to see the differences in students' critical thinking skills before and after learning using the SSI approach with the GI model. The data analysis is in the form of an N-Gain test and hypothesis. The N-Gain analysis data is intended to see the increase between the pre-test and post-test scores. The hypothesis test aims to determine whether there is a significant difference between the two samples or variables using the t-test. The data obtained were analyzed using SPSS software version 25. N-gain formulas and criteria (Thurrodliah et al., 2020) can be seen in formula 1 and Table 2.

$$G1 = \frac{Posttest\ Score - Pretest\ Score}{100 - Pretest\ Score} \quad (1)$$

**Table 2.** N-Gain criteria

| Normalized gain score | Normalized gain criteria |
|---|---|
| Normalized gain ≥ 0.70 | High |
| 0.30 ≤ normalized gain < 0.70 | Average |
| Normalized gain < 0.30 | Low |

(Hake, 1998)

## Result and Discussion

This study applies the SSI approach with the GI learning model in the experimental class and conventional methods in lectures in the control class to measure whether the SSI approach can improve students' critical thinking skills. First, both types were given a pre-test to identify students' initial essential thinking skills before treatment. Then, the two classes were offered a post-test after the treatment to determine whether the treatment affected students' critical thinking skills. The pre-test and post-test questions consist of 10 items in the form of descriptions that have been tested for validity and reliability. Before conducting the N-Gain and hypothesis tests, normality and homogeneity tests were first carried out. Both tests are prerequisite tests to determine the statistics used in hypothesis testing. The normality test used the Kolmogorov-Smirnov test, and the homogeneity test used the Levene test. The results are shown in Tables 3 and 4.

**Table 3.** Normality test results

| Data | Class | Sig. |
|---|---|---|
| Pre-test | Experiment | 0.637 |
| | Control | 0.413 |
| Posttest | Experiment | 0.077 |
| | Control | 0.648 |

**Table 4.** Homogeneity test results

| Data | Levene statistic | Sig |
|---|---|---|
| Pretest | 0.000 | 0.982 |
| Posttest | 1.577 | 0.214 |

Based on Table 3, the significance value of each data obtained is greater than the actual determining level of 0.05, so all data are typically distributed. The homogeneity test in table 4 shows a value of 0.982 for the pre-test and 0.214 for the post-test. Both values are more significant than 0.05, so it can be concluded that the variance of the critical thinking ability test data for experimental and control class students is homogeneous. After conducting the prerequisite test, it is known that the data is normally distributed and homogeneous, so parametric analysis and the N-Gain test can be performed.

**Table 5.** The average value of the pre-test, post-test, and N-Gain of the experimental and the control class

| Data Analysis | Experimental class | Control class |
|---|---|---|
| The average value of the pre-test | 54.24 | 52.38 |
| The average value of the post-test | 70.10 | 62.86 |
| N-Gain | 0.33 | 0.20 |

The results of N-Gain showed an increase in learning outcomes after using the SSI approach with the GI learning model, which was 0.33 compared to the control class with conventional treatment of 0.20. the experimental class is in the medium category, so the SSI approach with the GI learning model improves students' critical thinking skills. On the other hand, while the control class is in a low category, conventional methods with lectures are ineffective in enhancing students' critical thinking skills. Then a hypothesis test is carried out using an independent samples t-Test as below:

**Table 6.** Independent Samples t-Test

| | t | df | Sig. (2-tailed) | Mean Differenc | Std. Error Difference |
|---|---|---|---|---|---|
| Equal variances assumed | 2.740 | 66.000 | 0.008 | 7.243 | 2.644 |
| Equal variances not assumed | 2.740 | 64.439 | 0.008 | 7.243 | 2.627 |

Hypothesis testing was conducted to determine whether the hypothesis was accepted or rejected using an independent sample t-test. The analysis was conducted at a 95% confidence level ($\alpha = 0.05$) using SPSS version 25 software. This hypothesis test was conducted to test whether there are differences in critical thinking skills between students who use the SSI approach and the GI learning model and students who use conventional learning on the subject discussion of environmental change at SMAN 1 Batu Sopang. The hypotheses proposed in this study are as follows:

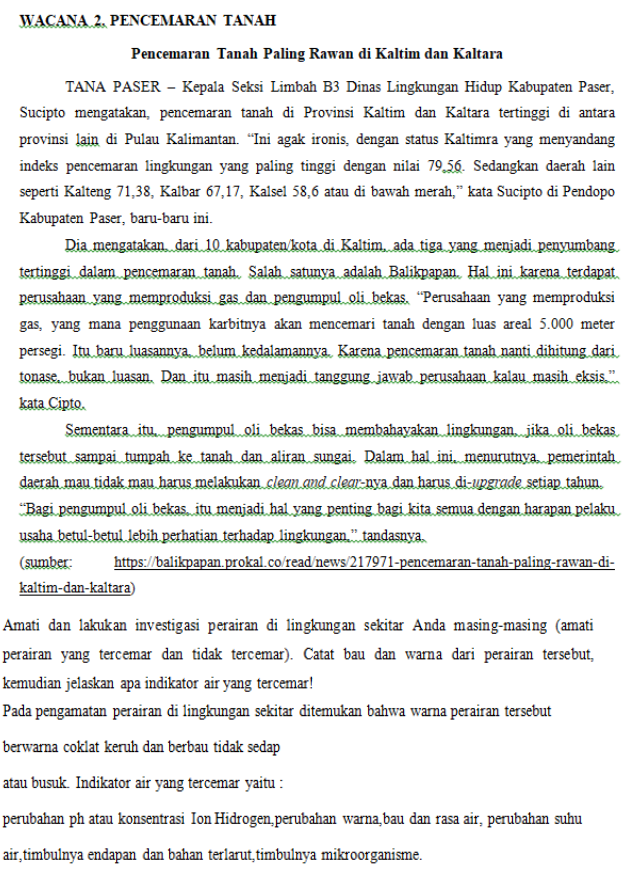
Ho: there is no effect on critical thinking skills between students who use the SSI approach with the GI learning model and students who use conventional learning

Based on table 6, a significance value of 0.008 (sig. < 0.05) was obtained. Then the value of the t count is 2.740, and the t table at a significance level of 0.05 is 1.99. Hence, the 2.740 > 1.99 can be concluded that $H_0$ is rejected and Ha is accepted.

The increase in students' critical thinking skills can be seen in Table 5. The calculation results show the average value of the experimental class's critical thinking ability for the pre-test is 54.24, and the post-test is 70.10. The experimental class increased by 15.86. For the value of critical thinking ability in the control class, the pre-test scored 52.38 and the post-test 62.86. The control class increased by 8.62. From the comparison results of improving critical thinking skills, the experimental class excels at 7.24. Both classes experienced an increase, but the experimental class experienced a more significant increase than the control class.

The difference in treatment in the experimental and control classes lies in the orientation of the problem and learning activities. Students in the experimental class are given problems related to sociological issues that continue to develop and are controversial in society (Sismawarni, 2020) and are combined with group investigation activities. While the topics given to control class students are common problems, such as garbage and pollution.

The experimental class with the SSI approach with the GI learning model as a learning context directs students not only to discuss concepts related to environmental change and problems related to this concept but also to carry out activities by being actively involved in discussions about cases related to environmental change. Around them is coal waste flowing into rivers, panning for gold which makes the river water cloudy, garbage disposal that is still carelessly. Students are asked to express their opinions about the impact of these pollutants that damage the environment and answer critical thinking questions related to the articles presented in student worksheets. Figure 2 below is an example of an SSI article given.



**WACANA 2. PENCEMARAN TANAH**

**Pencemaran Tanah Paling Rawan di Kaltim dan Kaltara**

TANA PASER – Kepala Seksi Limbah B3 Dinas Lingkungan Hidup Kabupaten Paser, Sucipto mengatakan, pencemaran tanah di Provinsi Kaltim dan Kaltara tertinggi di antara provinsi lain di Pulau Kalimantan. "Ini agak ironis, dengan status Kaltimra yang menyandang indeks pencemaran lingkungan yang paling tinggi dengan nilai 79,56. Sedangkan daerah lain seperti Kalteng 71,38, Kalbar 67,17, Kalsel 58,6 atau di bawah merah," kata Sucipto di Pendopo Kabupaten Paser, baru-baru ini.

Dia mengatakan, dari 10 kabupaten/kota di Kaltim, ada tiga yang menjadi penyumbang tertinggi dalam pencemaran tanah. Salah satunya adalah Balikpapan. Hal ini karena terdapat perusahaan yang memproduksi gas dan pengumpul oli bekas. "Perusahaan yang memproduksi gas, yang mana penggunaan karbitnya akan mencemari tanah dengan luas areal 5.000 meter persegi. Itu baru luasannya, belum kedalamannya. Karena pencemaran tanah nanti dihitung dari tonase, bukan luasan. Dan itu masih menjadi tanggung jawab perusahaan kalau masih eksis," kata Cipto.

Sementara itu, pengumpul oli bekas bisa membahayakan lingkungan, jika oli bekas tersebut sampai tumpah ke tanah dan aliran sungai. Dalam hal ini, menurutnya, pemerintah daerah mau tidak mau harus melakukan *clean and clear*-nya dan harus di-*upgrade* setiap tahun. "Bagi pengumpul oli bekas, itu menjadi hal yang penting bagi kita semua dengan harapan pelaku usaha betul-betul lebih perhatian terhadap lingkungan," tandasnya.

(sumber: https://balikpapan.prokal.co/read/news/217971-pencemaran-tanah-paling-rawan-di-kaltim-dan-kaltara)

Amati dan lakukan investigasi perairan di lingkungan sekitar Anda masing-masing (amati perairan yang tercemar dan tidak tercemar). Catat bau dan warna dari perairan tersebut, kemudian jelaskan apa indikator air yang tercemar!

Pada pengamatan perairan di lingkungan sekitar ditemukan bahwa warna perairan tersebut berwarna coklat keruh dan berbau tidak sedap atau busuk. Indikator air yang tercemar yaitu : perubahan ph atau konsentrasi Ion Hidrogen,perubahan warna,bau dan rasa air, perubahan suhu air,timbulnya endapan dan bahan terlarut,timbulnya mikroorganisme.

**Figure 2.** Student Worksheet Example

Critical thinking skills between the experimental class and the control class can be different because, in the learning process, the experimental class uses the SSI approach combined with the GI learning model, where learning refers to student activities investigating problems, collecting various information they can get from their surroundings and how they communicate the results of their investigation. This learning model involves students playing an active, creative, critical role and working together to find a concept based on the information provided by the teacher. The SSI approach with the GI model is more oriented towards student-centered classroom activities. It allows students to learn and obtain material from various sources with the teacher as a facilitator. For this reason, to get results that align with expectations, teachers must design learning tools and apply learning strategies that are as attractive as possible and allow teachers to engage and guide students in applying their knowledge (Cahyati & Subali, 2022).

In the literature, critical thinking skills are defined as the ability to think analytically and seriously, apply and use concepts, freedom of thought, use knowledge and responsibility to make decisions, consider to make decisions, interpret problems at hand, and train students to get used to thinking scientifically in solve problems (Ridho et al., 2020; Sulastri et al., 2022). Critical thinking skills are needed to deal with issues in everyday life.

Using socio-scientific issues during learning close to students' daily lives can motivate students to carry out meaningful learning (Ilfiana et al., 2021). This is in line with research conducted by Pratiwi et al. (2016) and Wilsa et al. (2017), the use of open-minded and controversial issues, both conceptually and procedurally, that have the possibility of rational solutions can develop thinking skills. Critically attract students' attention because these issues are related to real life. This is also in line with research conducted by Afifudin (2008 in Zubaidah et al., 2018) that using the GI learning model can also increase students' activity and participation in finding their material (information) with the help of various learning resources such as related books, and internet-based. The GI learning model emphasizes the active participation of students in determining topics, investigating problems, analyzing findings, and presenting research results. Classes that use the SSI approach with the GI learning model have more opportunities for discussion or debate activities to hone their critical thinking skills.

The learning syntax used in this study is intended to improve students' critical thinking skills by focusing on active student involvement in learning and understanding that critical thinking is a construction and evaluation of reasoning, not just showing the correct answer or just an opinion (Pradana et al., 2020). In the learning process, at the stage of group division, students will be given responsibilities in groups for themselves and others in the group. After students are in their respective groups at the investigation stage, they will be given the freedom to be creative and imagine so that their self-confidence will also increase. Students who work in groups will practice working together through a discussion stage, giving them a place to experiment in exchange ideas. At the discussion stage, each student is required to express their opinion so that students will get used to speaking systematically (Astiti, 2018; Arinda et al., 2019; Izzati et al., 2019).

According to observations at the beginning of the meeting, students looked passive. Still, after explaining the SSI approach with the GI model, students began to open up to communicate with the teacher, which led to an active learning environment. Previously, students also looked shy and did not dare express their thoughts. Therefore, the SSI approach with the GI learning model can make teachers maximize student activities in critical thinking. Through interactive activities in the classroom, students have enough time to be actively involved in the learning process (Gutierez, 2015). Social interaction between students can positively influence the development of students' critical thinking skills.

**Figure 3.** student activities

This research integrates socio-scientific issues through group investigation, discussion, debate, and mutual evaluation. Students' focus on teachers is minimized through the SSI approach with the GI model, and students are more responsible for dealing with problems. Teachers have an essential role in presenting more varied learning to trigger the growth of students' critical thinking skills. With group activities to investigate a problem, students can construct or build their knowledge, experience the pain, find solutions, exchange information with fellow students in their group, and not just memorize material from the teacher. In addition, using the SSI approach can stimulate students to use their logical abilities to solve problems related to everyday life (Sismawarni, 2020).

The SSI approach with the GI learning model can facilitate students to be actively involved during learning, shaping their knowledge personally or socially. In addition, students can train their thinking and communication skills to properly and correctly give information through speaking or writing (Pusparini, 2017).

## Conclusion

This study aims to make students more active during learning. Using the SSI approach relevant to students' daily lives can encourage and enable students to actively evaluate the strengths and weaknesses of science in their lives. With the GI model, students are expected to practice their ability to seek, give, and receive information from their group members. The results obtained from the independent sample t-test and N-Gain test showed a significant difference between the experimental class using the SSI approach and the GI learning model and the control class using the conventional learning model. The mean values of the pre-test and post-test of the experimental class were 54.24 and 70.10. in contrast, the mean values of the pre-test and post-test of the control class were 52.38 and 62.86. the experimental class got a higher increase than the control class, with a difference in the value of 7.24.

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