Journal of Natural Science and Integration
P-ISSN: 2620-4967|E-ISSN: 2620-5092
Vol. 7, No. 1, April 2024, pp 15-28

Available online at:
http://ejournal.uin-suska.ac.id/index.php/JNSI
DOI: 10.24014/jnsi.v7i1.27765

Science Learning with SSI Context Based on Direct Learning to Improve the Ability to Make Inferences and Think Logically

Intan Salsabila Almasari[1]*, Wirawan Fadly[1]

[1]*Department of Science Education, IAIN Ponorogo, Indonesia*

**Correspondence Author:* wisssyauq1930@gmail.com

ABSTRACT
This research aims to determine the effect of learning methods on participants' logical thinking abilities and learning outcomes. A quasi-experiment was used with a sample size of 63 grade 7 students from one of the junior high schools in Ponorogo and treatment for 1 month to achieve this goal. The analytical data used were questionnaires before and after treatment, interviews, and pre-test and post-test summative assessments. The analysis technique used is conventional calculations to show the percentage of logical thinking ability with high, medium, and low categorization. Furthermore, the summative assessment results of the independent T-test and N-gain test with software analysis and the Cohen Size Effect Test aim to measure the effectiveness of the learning method. The results of the research concluded that the Direct Learning method applied to the experimental group increased students' logical thinking abilities on the indicator of making conclusions by 27% and was considered more effective by 14% compared to the control class which used conventional methods. As an example, the Direct Learning method based on the SSI approach to improve students' logical thinking abilities is studied in more depth and applied according to students' potential. In this case, it will be useful in increasing understanding of science learning.

Keywords: *make inferences, direct learning, logical thinking, science learning, socio-scientific issues*

INTRODUCTION

The presence of an increasingly unstoppable flow of information and scientific innovation has positive and negative sides that greatly influence our lives. One of the positive aspects is the convenience in various aspects of our lives which previously could only be done manually, but can now be completely automated. However, behind this convenience and automation, negative effects emerge, such as laziness in learning new things and lack of creativity. Furthermore, this will affect the quality of human resources. Therefore, it is necessary to provide efforts and solutions to tackle this issue in order to improve the quality of human resources. in the process of learning and innovating to discover new things, human resources can think logically, have high curiosity, access and analyze information, and have several other practical abilities (Anggraini & Irawan, 2021; Faridah et al., 2023). In line with these objectives, science learning is present to provide a scientific basis that can be applied by utilizing the surrounding nature. Natural Science, an acronym for IPA, is one of the learning materials taught at almost every level of education in Indonesia. It was starting from elementary school to college. Education is one of the strategic ways to improve the standard of living and human capacity to address environmental and sustainable development issues and problems (Vilmala et al., 2022).

Science learning does not only contain theories, concepts, and principles, but science also teaches about how to learn from nature systematically through the use of empirical methods combined with critical thinking with the ultimate goal of discovery and a phenomenon that is based on facts that can support (Panjaitan, 2017; Wedyawati & Lisa, 2019). These results are a process of science learning that prioritizes learning through direct experience to develop competencies so that they can understand and explore nature scientifically (Hendrayana, 2017).

Unfortunately in some cases of science learning in Indonesia, students tend to think that science learning is complex material and quite difficult to understand. Therefore, several learning methods were developed which were considered more suitable for science learning, such as the Direct Learning method (Ismail, 2018). Ismail explained that this model is suitable for science learning because it can develop students related to procedural knowledge and well-structured declarations. The success of science learning with direct learning methods on students' ability to think logically has been previously researched and outlined in several scientific journals (e.g., Kusumawati, 2016; Puryadi et al., 2016).

Science learning, which is then associated with the Socio Scientific Issues (SSI) approach, is considered necessary and has great potential as a basis for real learning because it can connect societal problems with students' exploration of science content (Hernández-Ramos et al., 2021; Zarkasih et al., 2023). The SSI approach stimulates learners to develop knowledge and understanding of concepts but also scientific processes so that it helps in making personal decisions and participating in the wider community. This approach contains many phenomena, including vocabulary recognition to contextually and conceptually based knowledge. In its application in learning, this approach focuses on theory and examines various phenomena, which are then reinforced with scientific theory to develop students' thinking skills and literacy activities (Sari et al., 2021).

One of the main goals of science learning is to assist in developing theory and practical action in the decision-making and actions of advanced societies both technologically and scientifically. The essence of science can then be used as a basis and basis for implementing science learning (Friedrichsen et al., 2021; Tursinawati, 2016). The nature of science can help make the correct arguments and decisions concerning socioscientific issues (Khishfe, 2021). These two indicators are part of the ability to think logically. Logical thinking is a coherent, reasonable way of thinking based on specific objective facts (Anggraini & Irawan, 2021; Surat, 2016). The above definition is supported by the opinion of (Annisa & Fatmahanik, 2023; Faradina & Mukhlis, 2020), which explain that the human ability to integrate or connect learning with specific events and is based on scientific facts so that they are then able to consciously and consistently reach conclusions and Decisions are interpreted by the ability to think logically. Furthermore, logical thinking skills can be developed in evaluating ideas, deepening concrete information, and developing experiences (Fadiana et al., 2019). There are several indicators of the ability to think logically, namely starting with the order of thinking, the ability to argue, and ending with concluding (Anggraini & Irawan, 2021; Annisa & Fatmahanik, 2023). Order in thinking is the ability where students can mention and be able to analyze facts and various information that has been obtained related to the phenomenon being analyzed. Learners can plan the process carried out on facts and information that have been previously analyzed. Students need to apply the ability to think logically and optimally. This follows the statement that most students are only able to provide or see a phenomenon without being supported by reasons/facts that can be validated (Khishfe, 2021).

Previous research (Anggraini & Irawan, 2021; Annisa & Fatmahanik, 2023; Khishfe, 2021) examined the relationship between science learning and logical thinking abilities. Research conducted by Anggraini et al. (2021) studied the relationship between logical thinking abilities and secondary school students' understanding of science learning in material with environmental pollution. The results of the analysis discovered that there are differences in students' level of ability, which are in line with the level of ability in logical thinking. Then, some factors can influence the logical thinking abilities of secondary school students. Annisa et al. (2023) studied the effectiveness of the STEM-based CTL learning model with the logistical thinking abilities of high school students. The research results show that this learning model can significantly improve students' logical thinking abilities. Research conducted by Khrishfe (2020) compared the impact of a learning context driven by SSI (*Socio-Scientific Issues*) and a learning context driven by the NOS conception. This research explains indicators of logical thinking, namely argumentation skills, which are applied to the treatment and comparison groups. Where both groups used the process directly as a method in the research carried out. The treatment group results obtained better results than the comparison group. However, this research needs to explain whether the ability to argue (in this study, changed to the ability to think logically) can improve students' understanding or vice versa. However, it has yet to explain the effect of the Direct Learning method with the SSI approach to improve understanding of science and logical thinking skills.

Unfortunately, this ability is not developed optimally. Logical thinking skills are needed because they can improve students' learning outcomes in science learning. Science learning requires analytical skills and complex ways of thinking. Hence, the ability to think logically becomes one of the abilities that must be applied and developed because it is considered to improve the academic quality of students. Through learning science materials, students are trained to develop thinking skills in reasoning, critical thinking, and logical thinking (Anggraini & Irawan, 2021). In classroom learning activities, the ability to think logically is needed by students, for example, such as in group discussion activities and problem-solving. In these activities, of course, an ability is needed to connect everything around it so that it can be understood by logic and implemented as a means to solve a problem (Fauzan et al., 2020; Sofia et al., 2023). Logic is associated with an ability to think in drawing final results and conclusions to find reasonable (logical) answers to a phenomenon encountered (Faradina & Mukhlis, 2020). This research is essential, considering that the variables used in this study have yet to be widely developed. At the same time, logical thinking skills are essential to develop in order to be able to balance the thinking skills of students, especially in science learning. Moreover, science learning itself should be learning that has actual output, not just theory, to integrate social life with science theory. Thus, this study aims to explore how science learning with direct learning methods can improve the logical thinking skills of grade 7 junior high school students in the material Substance and its Changes.

METHODOLOGY

The dataset used in this research came from a sample of 7th grade junior high school students registered at SMPN 1 Mlarak, Ponorogo Regency, totaling 63 participants (30 male students and 33 female students). These participants were divided into two groups: 1) The Experimental Group consisted of 31 people (15 male students and 16 female students) students who received direct learning-based science learning. 2) The control group consisted of 32 students (15 men and 17 women) who received science learning based on conventional methods. The average age of participants was 12 to 13 years.

This study is a quantitative quasi-experimental research and lasted for 1 month, where participants were given direct learning-based and conventional science learning for four sessions of 40 minutes per week. Participants in both groups were given one open-ended questionnaire and a pre-test as an initial step to measure the level of students' understanding of the science learning to be followed and their logical thinking skills. After that, the experimental group will be treated with Direct Learning-based science learning, and the control group will be treated with conventional-based science learning. At the end of the treatment, the teacher will give an open questionnaire and post-test to measure the learning outcomes and logical thinking skills of the participants from the results of the instruments that have been given. All instruments, questionnaires, and tests used in this study contain material on substances and their changes combined with SSI aspects and indicators of logical thinking ability. The instrument was developed with validation by science educators who were then tested on students. The test results received were then analyzed in depth.

Furthermore, a comparison will be conducted to the results obtained and analyze whether there are changes that occur in participants before receiving treatment and after receiving treatment. The research methods used can be seen in Table 1.

Table 1. Quasi-Experimental Quantitative Research Method

Group	Pre-test	Questioner	Treatment	Questioner	Post-test
Experiment	O_1	O_2	X	O_3	O_4
Control	O_1	O_2	Y	O_3	O_4

Source: (Sugiyono, 2022)

Description:
O_1: Giving pre-test before treatment
O_2: Administration of questionnaires before treatment
O_3: Administration of questionnaires after treatment
O_4: Giving post-test after treatment
X: Direct learning model
Y: Conventional learning model

The questionnaire used is a questionnaire that discusses the context of science learning and relates it to socio-scientific issues. The questionnaire contains a scenario followed by a series of questions related to logical thinking indicators (order in thinking, argumentation skills, and inference) of 5 items that are the same as in the pre-and post-learning questionnaires. This questionnaire was prepared by considering the descriptors of each indicator of logical thinking ability, as listed in Table 2 below. Furthermore, the rubric for assessing logical thinking skills is presented in Table 3.

Table 2. Descriptors of Logical Thinking Indicators

No	Indicators	Descriptors
1.	Order of Thinking	Mention and analyze the facts/information obtained based on the analyzed phenomenon.
2.	Argumentative Ability	Able to express the scientific steps taken along with logical reasons. Including expressing logical reasons for the final answer that was not correct.
3.	Making Conclusions	Be accountable for all strategic processes to solve a problem and draw conclusions.

Source: (Anggraini & Irawan, 2021)

Table 3. Logical Thinking Ability Assessment Rubric

Point	Criteria
4	Able to provide information, procedural, logical reasoning, and Conclusion results from the analyzed phenomenon correctly.
3	Able to provide information, procedural, logical reasoning, and conclusion results from the analyzed phenomenon correctly but needs to be completed.
2	Able to provide information and conclusions from the analyzed phenomena but still need to be able to provide logical, procedural reasons.
1	Able to provide information but less able to provide logical reasons for the procedure and conclusion of the analyzed phenomenon.

Source: (Santoso & Utomo, 2020)

After administering the questionnaire, the participants were engaged in individual semi-structured interviews. The purpose of these interviews was to validate the questionnaire with this group of participants. A random sample of 20 participants was selected for interviews. Five participants from each class were interviewed, and another five participants from each class were selected for post-questionnaire interviews. Different participants were interviewed to avoid the pre-learning interview influencing participants' responses during the post-learning interview. Interviews lasted 15-30 minutes, and participants were interviewed while completing the questionnaire. Interviews were recorded and then transcribed verbatim.

At the beginning of the treatment, the teacher gave a pre-test to participants about substances and their changes. The test was a 5-point description question about initial understanding, such as the form of substances and the formula for the volume of 3-dimensional objects. These items support science learning about substances and their changes. Then, at the end of the treatment, the teacher gave a post-test to students about substances and their changes. The giving of this test aims to measure the final ability to understand understanding during science learning. The test is in the form of multiple-choice questions with as many as 20 items categorized against indicators of logical thinking ability (order of thinking, argumentation ability, conclusion drawing). Furthermore, the two test results were compared to measure the increase in students' ability to think logically and understand science learning. The results were also used to measure the effectiveness of the direct learning model applied to the experimental group on science learning with substance material, and its changes compared to the conventional learning model applied to the control group.

Table 4. Learning Topics and Instructions during the Study

	Topic	Learning Instructions
Week 1	Forms of substances and their changes	Submission of material, filling in LKPD
Week 2	Physical and chemical changes	Material delivery, learning module completion, quizzes
Week 3	Density of substance	Material delivery, quiz
Week 4	Floating and sinking	Material delivery, quiz

Table 4 presents the topics and activities covered during the treatment involving science learning about substances and their changes taught by teachers for both groups. Both groups received science learning. However, the participants in the treatment group or experimental group received direct learning-based science, essentially essential for learners to understand that scientific knowledge can change or is tentative; scientific knowledge is based on observation or empirical, and the background influences scientific knowledge and experience, and biases of scientists are subjective. The reason for choosing these three aspects is that they are like science learning and are assumed to be aligned with logical thinking skills. Thus, the experimental and control groups were in the same context. In addition, it should be underlined that the nature of science, logical thinking skills, and science learning in the socio-scientific scope are an integral part of the selected science learning topic, namely about substances and their changes. The topic of substances and their changes is divided into 4 main subchapters, namely the form of substances and their changes, chemical and physical changes, density of substances, and floating and sinking.

In the following weeks, the topics of physical and chemical changes are discussed, accompanied by several SSI events related to the subject matter. The first example discusses an SSI on global warming, followed by questions on indicators of logical thinking skills (Reasoning, argumentation, and inference). The second example discusses SSI about combustion events, followed by questions about the indicators of logical thinking skills. For the SSI-based science learning, there were additional questions related to the three aspects of science only for the treatment group and paved the way for a direct and reflective discussion on the nature of science to the examples mentioned. For example, participants were presented with two perspectives on the issue of global warming. Each participant was asked to provide facts from the readings, arguments, and a plan of action to address the issue of limiting greenhouse gas emissions. For this example, participants in both the experimental and control groups experienced logical thinking indicators through written and oral interactions. For the experimental group, there was additional discussion on how different perspectives on global warming can be generated from the same data (addressing subjective aspects). There was also a discussion on the role of evidence for global warming and changes in scientific knowledge about global warming based on new evidence or new interpretations (addressing empirical and tentative aspects).

Data analysis was conducted in several stages. First, the interviews were transcribed and analyzed to categorize the participants' responses into high, medium, and low ability. Then, the questionnaires of the interviewed participants were also analyzed to categorize their responses into high, medium, and low ability. The questionnaire scores obtained were then processed in Microsoft Excel to assess the percentage of logical thinking ability from the questionnaire results using the formula (Arifin & Fauziyah, 2021), where the percentage response is obtained by comparing the number of selected respondents to the total number of respondents and multiplied by one hundred percent.

To determine how influential the Direct Learning model is on students' level of understanding, the pretest and post-test results from each group were calculated using a software analysis application to test the Paired T-test. Analysis of the results of interviews and related questionnaires is compared to ensure that no differences are found, thereby ensuring the validity of the questionnaire. Finally, on the test results, an N-gain test was carried out using software analysis and the Cohen Size Effect test to see the effect of the learning model on students' understanding of science. The N-gain formula used is as follows (2).

$$N - gain = \frac{S_{Post} - S_{Pre}}{S_{Max} - S_{Pre}} \qquad (2)$$

Description:
S_{post} = Post-test value
S_{Pre} = Pre-test Score
S_{Max} = Ideal Maximum Value

The interpretation of the effectiveness of N-Gain is divided into Effective (>76%), Quite Effective (56% - 75%), Less Effective (40% - 55%), and Ineffective (<40%) (Hake, 1999). The analysis for logical thinking follows some guidelines. A phenomenon as a fact is taken as the initial claim made by the individual. The participant's argument is taken as an argument in favor of the fact. Concluding is the final step as giving the final results and taking responsibility for the analysis results. Then, the teacher creates an open discussion for each participant to respond to other participants. Participants' responses for each component (order of thinking, argumentation skills, and inference) were categorized according to the rubric described above. First, the different components of logical thinking were categorized separately. However, some relationships were sought between the components. For example, conclusions were considered valid when participants presented clear, logical reasons with the initial argument or at least added some facts and theories to the initial argument.

RESULT AND DISCUSSION

Improving Students' Understanding of Logical Thinking

Prior to conduct the experiment, most of the two groups had an outline of logical thinking and applied it to some science material. That is, students' understanding of logical thinking is profound. Students deserve where students should be able to connect at least the material obtained to become facts in solving problems and be able to provide logical arguments for the situation at hand. After the treatment in the experiment, there was a visible increase in logical thinking indicators where most students in both groups were able to relate learning material to the problems encountered and were able to provide logical reasons for the reasons taken based on the situation at hand. In the results of the data processed, there are value results marked with a triangle symbol (Δ) where the symbol marks the difference in percentage associated with data before and after treatment in experiments from students in both groups that show logical thinking indicators applied in learning.

In the control participants, the average could think logically by including a maximum of 2 indicators. When given a phenomenon, many of them answered freely without any facts that could corroborate it. So that only a few students can show logical thinking skills. However, in the experimental group, the average could think logically by including 3 indicators at once. Only a few students gave free answers when faced with a phenomenon. They answered by providing at least one fact that could strengthen their claim to a phenomenon at hand. **Comparison Before and After Treatment**. The comparison between the two groups (experimental and control) can be seen in Figure 1 until Figure 3.

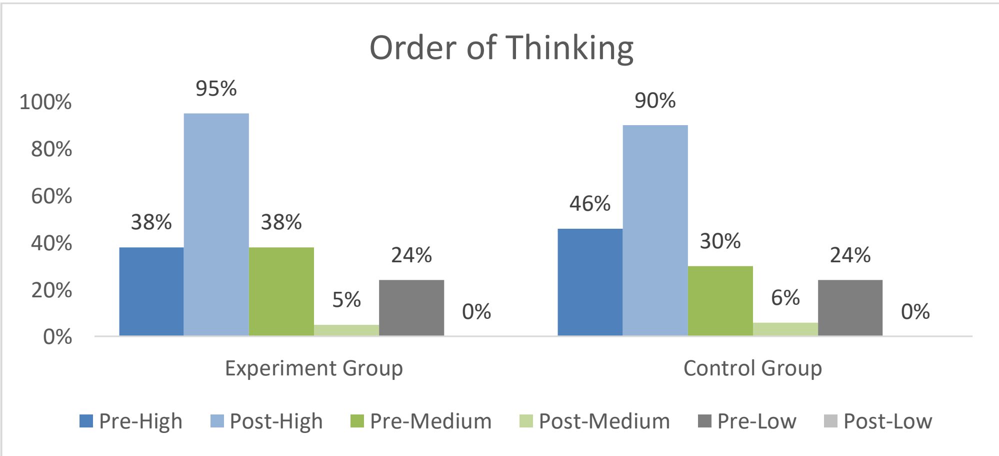

Figure 1. Percentage Graph of Participants with Order of Thinking Indicator

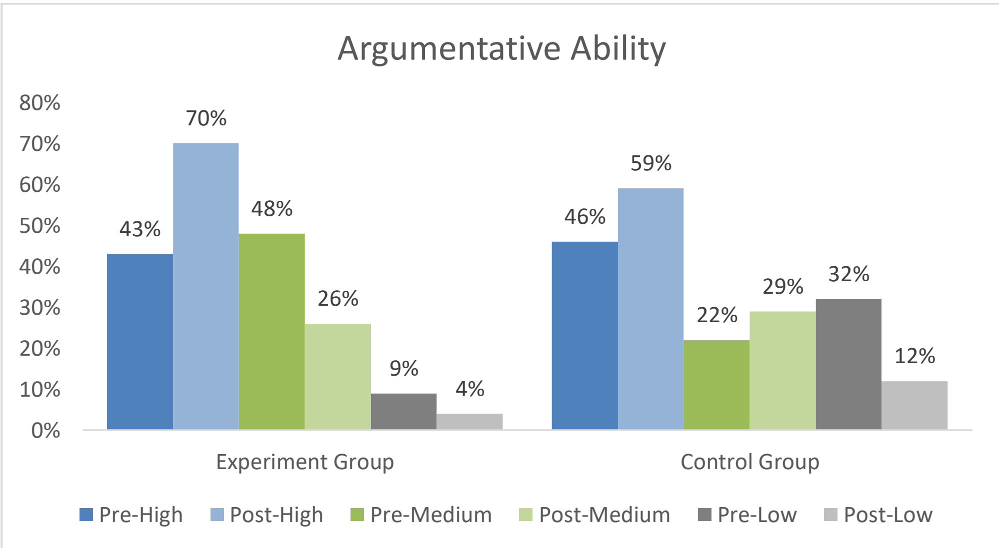

Figure 2. Percentage Graph of Participants with Argumentative Ability Indicator

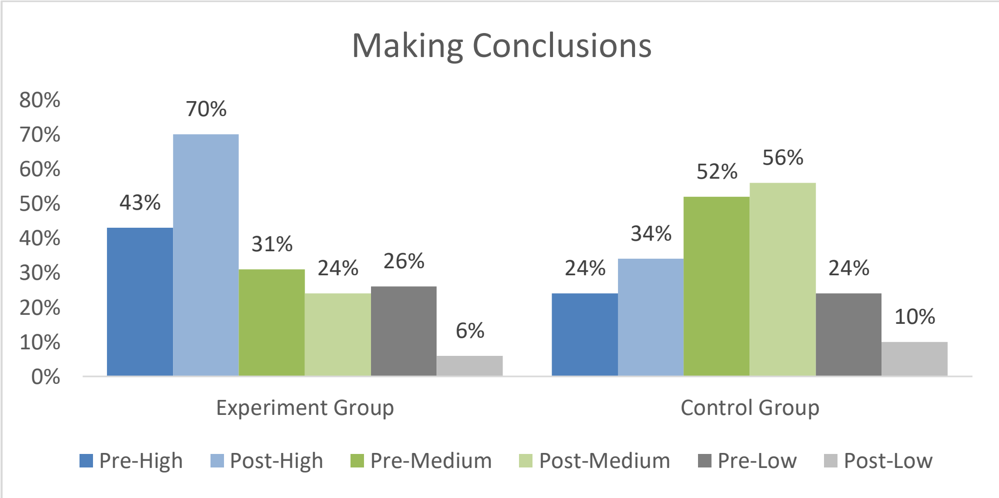

Figure 3. Percentage Graph of Participants with Making Conclusions Indicator

The table has explained the comparison of logical thinking skills according to the indicators interpreted in the questionnaire results before and after treatment. At the beginning of the study using the pre-test, the difference between the two groups was similar in the high categorization of the inference indicator. Participants in both groups draw conclusions that, in some aspects, are considered less relevant to the aspects made by the teacher. In addition, students tend not to include or only a tiny part of the facts that can support students' claims about a phenomenon being studied. An example of a change in the experimental group in the Conclusion drawing indicator is 70%, with an increase of 27%, compared to the control group, with only 34%, with an increase of 10%. The following is an example of inference given by participant S-2A (experimental group), which shows inference supported by related facts, and compared to S-2B (control group), which shows inference without being given facts that can support the Conclusion.

> *Humans can float in seawater because the water in the sea has a greater density of substances compared to the density of substances in the human body*—[S-2A, inference, Experimental group, post-questionnaire, sinking and floating].

> *Humans can float in seawater because seawater is salty water*—[S-2B, inference, Control group, post-questionnaire, sinking and floating].

In terms of logical thinking ability, students in the two groups had different results in improving each indicator of logical thinking ability. This is evidenced by the results of interviews and questionnaires that show an increase in the ability to argue against a phenomenon students face. This ability in post-treatment, some statements are then supported by logical reasons so that they can support claims. In some cases in the field, pre-treatment students need more understanding where students only think about theory without linking it to the case they will face related to the material they learn or vice versa. This is evidenced by the provision of triggering questions and perceptions educators ask during pre-treatment. In post-treatment learning, the results showed that students could apply the theory to the problems related to the material they had learned and vice versa. This is evidenced by the summative assessment, where several HOTS questions test students' logical thinking skills. The results obtained are that most learners from both groups can answer questions correctly and then be able to provide logical reasons for choosing these answers. The improvement of students' logical thinking skills is evenly distributed in each sub-chapter of material studied in one month of treatment with educators. So, in the final results, it is found that there are only a small number of students who have yet to be able to develop indicators of logical thinking skills properly, especially statements and arguments that are supported by logical reasons.

The results of the study showed an increase in the logical thinking ability of students during science learning with the direct learning method implemented. Although there was also an increase in science learning with conventional methods, the results varied, and a significant increase was in the experimental group. This result can be interpreted based on several factors. First, the success of efforts to improve students' ability to think logically depends on context, which is supported by previous research (Anggraini & Irawan, 2021; Defni et al., 2022). Second, learning science with the direct learning method can improve students' ability to develop logical thinking skills (Afriani, 2018; Selpiyanti, 2022). Other possible explanations for improving logical thinking skills in understanding science learning of grade 7 junior high school students are as follows. In the experimental group, there was a significant increase in logical thinking ability with the help of science learning with the direct learning method. Learners in the experimental class can provide logical reasons for a phenomenon studied. Students are also able to include scientific facts to be able to draw conclusions based on the steps that have been undertaken so that the final results of students' thinking tend to be more logical when compared to students in the control class.

Changes in Learners' Science Understanding

Similar to the increase in indicators of logical thinking skills in students, students' understanding of science also increases with the modification of direct learning methods. In addition, this method is also associated with socio-scientific issues that are contextual to students' daily lives. This change can be seen from pre-learning conditions that can only understand the theory, in post-learning students can apply the theory obtained with socio-scientific issues provided by educators. This assessment is based on the test results packaged in the pre-test and post-test which then shows the results of the standard deviation and sig value. The processed data shows the difference in results from before and after treatment from each group.

Comparison Before and After Treatment.

The comparison between the two groups (experimental and control) can be seen in Table 5.

Table 5. Results of Increased Understanding of Science Learning Based on Learning Outcomes

	Experiment Group			Control Group		
	Pre	**Post**	**Δ**	**Pre**	**Post**	**Δ**
Average	40	67	27	31	54	23
Standard Deviation	13,4	15,7		13,1	18,6	

The table has explained the comparison of scientific understanding, which is interpreted by the results of test scores before and after treatment. At the beginning of the study, using the pre-test, the difference between the two groups was similar. Participants in both groups needed an understanding of the prior knowledge that must be possessed before learning about substances and their changes. After learning was carried out for one month, students experienced a relatively similar increase in understanding between the experimental group using the Direct Learning method and the control group using the Conventional method.

Effect of Direct Learning Model

Data on the effectiveness of direct learning is obtained from the interpretation of test results measured by a software analysis to test the value of the Independent T-Test and N-gain and calculate the value of the Cohen Effect Size.

Comparison before and after learning.

As previously explained, students' understanding of science using the Direct Learning method increases compared to understanding science based only on conventional learning methods. This is based on students' ability to understand theory and apply it to socio-scientific problems presented by the teacher. Before learning using the direct learning method was implemented, both groups (control and experiment) showed an understanding of science that was limited to theory. Some students need to study material that should be mastered first. After the implementation of direct learning in the experimental class, students in the experimental class showed an increase in understanding compared to the control class, which only conducted conventional-based learning. In the results of the data obtained from the learning outcomes of the control group, students can arrive at conclusions that differ from each other in a case but have yet to be followed by logical reasons or facts that can support them. In the experimental group, students were able to link the socio-scientific issues faced with the theory that the educator had given. Not stopping there, the majority of students can provide logical reasons, and some are even able to provide scientific facts that are directly related to the socio-scientific issues that students are facing so that the experimental class can apply the basis of science learning, namely being able to behave scientifically and think logically.

The interpretation results using the software analysis application to calculate the Independent T-Test explain three crucial points in the interpretation: 1) The average learning outcomes of the experimental group in the Post-test 68 < the control group 54, so descriptively, there is an increase in learning outcomes. 2) The Sig value of Levene's Test for Equality of Variances is 0.570 > 0.05, so it can be interpreted that the data variance between the experimental and control groups is homogeneous. 3) Sig value. (2-tailed) the Equal Variances Assumed section is 0.002 < 0.05, so it can be concluded that H_0 is rejected and H_a is accepted. Thus, there is a significant (absolute) difference between the average learning outcomes of participants between the experimental group and the control group.

Based on the results of the N-gain test calculation in Table 6, the data shows that science learning with the Direct Learning method has a score of 50% with a minimum score of 24% and a maximum of 78%. While science learning with conventional methods has an N-gain score of 36% with a minimum score of 2% and a maximum score of 87%. The difference in N-gain scores shows that 14% is more effective using the Direct Learning method of science learning than conventional methods. The results show that science learning with the Direct Learning method applied is considered less effective because it has a score of 50%. Meanwhile, science learning with conventional methods, with a score of 36%, is considered ineffective. The assessment applies to this study, which uses substance material and its changes to test the logical thinking ability of grade 7 students at SMPN 1 Mlarak.

Table 6. The Software Analysis N-gain Test Results

Experiment Group		Control Group	
Average	50.065	**Average**	36.146
Minimum	24.39	**Minimum**	2.35
Maximum	78.26	**Maximum**	86.96

With a Cohen's *d* of 0.75 (medium effect size), 77.3% of the experiment group will be above the mean of the control group (Cohen's U3), 70.8% of the two groups will overlap, and there is a 70.2% chance that a person picked at random from the experiment group will have a higher score than a person picked at random from the control group (probability of superiority). Moreover, to have one more favorable outcome in the experiment group compared to the control group, we need to treat 3.8 people on average. That means that if there are 100 people in each group, and we assume that 20 people have favorable outcomes in the control group, then 20 + 26.3 people in the experiment group will have favorable outcomes.

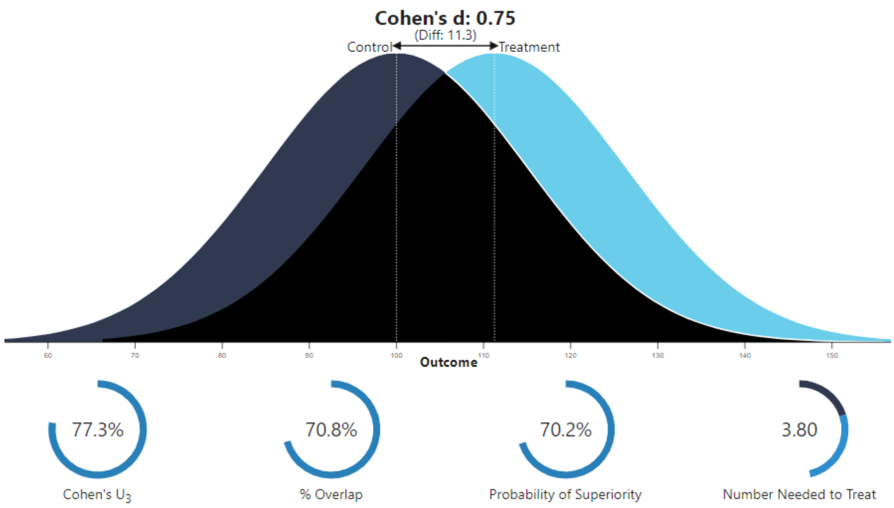

Figure 4. Cohen Size Effect Calculation Results

Based on the illustration in Figure 4, it was found that there were significant differences in the understanding of science learning in the two groups (experimental and control). The average value of learning outcomes obtained from the summative assessment states that learning from the experimental group influences the level of understanding of students in science learning that is higher than the understanding of science learning in the control group. Furthermore, learning in the experimental class collaborated with science learning based on socio-scientific issues that can stimulate students' logical thinking skills. This is supported by previous research (Khishfe, 2021), which states that students still need a higher understanding of science learning. Therefore, many statements state that the ability to think logically can guide students in understanding science learning. However, the opposite is true. This is in line with many studies that show an increase in science understanding by using several learning approaches to improve indicators of logical thinking ability (for example, Annisa & Fatmahanik, 2023; Kurniasari et al., 2018; Triani et al., 2020).

Relationship between Science Learning and Logical Thinking Indicators

There is a relationship between the responses of some students in the experimental group between increasing science learning outcomes and their logical thinking abilities. The following is an example of an experimental group student's response that connects science learning with logical thinking skills. In the first example, a participant from high categorization recognizes the role of facts in a response and how they can change their position as shown below :

> (The phenomenon of the melting of the south pole due to the higher surface temperature of the earth) *Suppose the warmer surface temperature of the earth causes the melting of the south pole. In that case, we should start to keep the surface temperature of the earth safe* [experimental group, post-questionnaire, context of socio-scientific issues].

In the second example, another learner stated that she would change her argument if there were new evidence and specifically if "other studies get more facts," as noted in the quote below:

> (Earth's surface temperature affects the melting of the south pole) *It does not affect it. However, if there are new facts, my words may support the statement with more logical facts* [experimental group, post-questionnaire, socio-scientific issue context].

The results of this research showed that the participants from the experimental and control groups had a significant relationship between improved science learning and logical thinking ability. The improvement of these results indicates that the two variables influence each other. This interaction is seen as an influence on the relationship between science learning comprehension and students' logical thinking ability indicators. Suppose the Direct Learning method based on the SSI approach to improving students' logical thinking ability is studied more profoundly and applied according to students' potential. In that case, it will be beneficial in improving the understanding of science learning.

CONCLUSION

Based on the results of the conducted research, there are three findings and one main conclusion that students' logical thinking ability increases in both groups. That is also directly proportional to the understanding of science learning increased in both groups. However, the group that learned by applying the Direct Learning method had a higher increase in science understanding and logical thinking skills, especially in conclusion, than the control group. Thus, the improvement that occurs is influenced by learning motivation, teacher competence, and the selection of appropriate learning methods. To be concluded, the Direct Learning method with the SSI approach can improve students' understanding of science and logical thinking abilities. In subsequent research, researchers provide suggestions regarding the choice of learning methods adapted to students' abilities. The results of this study show that the Direct Learning method implemented is less effective for sampled students. Furthermore, also consider the time and learning agenda so that it is more interesting. With several improvements and this research being considered, the following research can provide more optimal results.

REFERENCES

Afriani, A. (2018). Pembelajaran Kontekstual (Contextual Teaching and Learning) dan Pemahaman Konsep Siswa. *Al-Muta'aliyah*, *1*(3), 80–88. http://ejournal.kopertais4.or.id/sasambo/index.php/mutaaliyah

Anggraini, D., & Irawan, E. (2021). Analisis Kemampuan Berpikir Logis Siswa Kelas VII pada Tema Pencemaran Lingkungan. *Jurnal Tadris IPA Indonesia*, *1*(2), 228–238. http://ejournal.iainponorogo.ac.id/index.php/jtii

Annisa, A. A., & Fatmahanik, U. (2023). Efektivitas Model Pembelajaran Contextual Teaching and Learning (CTL) Berbasis STEM terhadap Kemampuan Berpikir Logis Siswa pada Pembelajaran IPA. *Jurnal Tadris IPA Indonesia*, *3*(1), 30–43. http://ejournal.iainponorogo.ac.id/index.php/jtii

Arifin, U. S., & Fauziyah, H. N. (2021). Worksheet Based on Socioscientific Issues To Improve Analytical Skill. *INSECTA: Integrative Science Education and Teaching Activity Journal*, *2*(2), 191–196. https://doi.org/10.21154/insecta.v2i2.3492

Defni, S., Fadilah, M., & Yuniarti, E. (2022). Analisis Kebutuhan Pengembangan Instrumen Penilaian Kemampuan Argumentasi Ilmiah Peserta Didik Terintegrasi Isu Sosio-Saintifik dalam Pembelajaran Biologi Needs Analysis Development of Scientific Argumentation Ability Assessment Instruments for Integrated. *Jurnal Pendidikan Biologi*, *2*(1), 96–103.

Fadiana, M., Amin, S. M., Lukito, A., Wardhono, A., & Aishah, S. (2019). Assessment of Seventh Grade Students' Capacity of Logical Thinking. *Jurnal Pendidikan IPA Indonesia*, *8*(1), 75–80.

https://doi.org/10.15294/jpii.v0i0.11644

Faradina, A., & Mukhlis, M. (2020). Analisis Berpikir Logis Siswa dalam Menyelesaikan Matematika Realistik Ditinjau dari Kecerdasan Interpersonal. *Alifmatika: Jurnal Pendidikan dan Pembelajaran Matematika*, *2*(2), 129–151. https://doi.org/10.35316/alifmatika.2020.v2i2.129-15

Faridah, I., Saptono, S., & Isnaeni, W. (2023). Developing E-Module Material on the Digestive System in Animals to Improve Students' Critical Thinking Ability and Independence. *Journal of Innovative Science Education, 12(1),* 117–124. https://journal.unnes.ac.id/sju/index.php/jise/article/view/67397%0A

Fauzan, G. A., Agina, S., & Setiawan, W. (2020). Analisis Kemampuan dan Kesulitan dalam Menyelesaikan Soal Berpikir Logis Matematik Siswa SMP dengan Penggunaan Geogebra. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(1), 53–63. https://doi.org/10.31004/cendekia.v4i1.169

Friedrichsen, P. J., Ke, L., Sadler, T. D., & Zangori, L. (2021). Enacting Co-Designed Socio-Scientific Issues-Based Curriculum Units: A Case of Secondary Science Teacher Learning. *Journal of Science Teacher Education*, *32*(1), 85–106. https://doi.org/10.1080/1046560X.2020.1795576

Hake, R. R. (1999). Analyzing Change/Gain Scores. *Unpublished.[Online] URL: Http://Www. Physics. Indiana. Edu/\~ Sdi/AnalyzingChange-Gain. Pdf*, *16*(7).

Hendrayana, S. (2017). Meningkatkan Keterampilan Berpikir Rasional Siswa Melalui Model Sains Teknologi Masyarakat pada Konsep Sumber Daya Alam. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *2*(1), 73. https://doi.org/10.23969/jp.v2i1.471

Hernández-Ramos, J., Pernaa, J., Cáceres-Jensen, L., & Rodríguez-Becerra, J. (2021). The effects of Using Socio-scientific Issues and Technology in Problem-based Learning: A Systematic Review. *Education Sciences*, *11*(10). https://doi.org/10.3390/educsci11100640

Ismail, A. (2018). *Model-Model Pembelajaran dalam Mata Pelajaran IPA*.

Khishfe, R. (2021). Explicit Instruction and Student Learning of Argumentation and Nature of Science. *Journal of Science Teacher Education*, *32*(3), 325–349. https://doi.org/10.1080/1046560X.2020.1822652

Kurniasari, I., Sasmiati, & Haenilah, E. Y. (2018). Penggunaan Media Alam Sekitar dan Kemampuan Berpikir Logis Anak Usia Dini. *Jurnal Pendidikan Anak*, *4*(1). http://jurnal.fkip.unila.ac.id/index.php/PAUD/article/view/15163

Kusumawati, N. (2016). Pengembangan Media Pembelajaran IPA Dengan Animasi Macromedia Flash Berbasis Model Pengajaran Langsung (Direct Instruction) di Sekolah Dasar. *Premiere Educandum : Jurnal Pendidikan Dasar dan Pembelajaran*, *5*(02), 263–271. https://doi.org/10.25273/pe.v5i02.289

Panjaitan, S. (2017). Meningkatkan Hasil Belajar IPA Melalui Media Gambar pada Siswa Kelas IIA SDN 78 Pekanbaru. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, *6*(1), 252. https://doi.org/10.33578/jpfkip.v6i1.4105

Puryadi, Rahayu, S., & Sutrio. (2016). Pengaruh Model Pembelajaran Direct Instruction Berbantuan Bahan Ajar Berbasis Kontekstual Terhadap Hasil Belajar IPA Terapan Siswa Kelas X SMKN4 Mataram Tahun Ajaran 2015/2016. *Jurnal Pendidikan Fisika dan Teknologi*, *I*(1).

Santoso, T., & Utomo, D. P. (2020). Pengaruh Kecerdasan Matematis-Logis Dan Kemandirian Belajar Terhadap Hasil Belajar Matematika. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(2), 306–315. https://doi.org/10.24127/ajpm.v9i2.2722

Sari, E. N., Fauziah, H. N., Muna, I. A., & Anwar, M. K. (2021). Efektivitas Model Pembelajaran Scramble dengan Pendekatan Socio-Scientific terhadap Rasa Ingin Tahu Peserta Didik. *Jurnal Tadris IPA Indonesia*, *1*(3), 354–363. https://doi.org/10.21154/jtii.v1i3.177

Selpiyanti, S. (2022). *Pengembangan Modul IPA Berbasis Socio-Scientific Issue (SSI) untuk Meningkatkan Higher Order Thinking Skill (HOTS) pada Mata Pelajaran IPA untuk Siswa Kelas VII SMP*. (Doctoral Dissertation, UIN Fatmawati Sukarno Bengkulu).

Sofia, A., Syafrudin, U., & Yulistia, A. (2023). Interactive Media for Increasing Logical-Mathematical Intelligences in Differentiated Instruction Practice. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *7*(6), 7445–7452. https://doi.org/10.31004/obsesi.v7i6.5593

Sugiyono. (2022). *Metode Penelitian Kuantitatif, Kualitatif dan R&D* (4th ed.). AlfaBeta.

Surat, I. M. (2016). Pembentukan Karakter dan Kemampuan Berpikir Logis Siswa Melalui Pembelajaran Matematika Berbasis Saintifik. *Jurnal EMASAINS*, *V*(1), 57–65. https://doi.org/https://doi.org/10.59672/emasains.v5i1.20

Triani, W., Maryuningsih, Y., & Mujib Ubaidillah, D. (2020). Penerapan Pembelajaran Berbasis Socio Scientific Issues untuk Meningkatkan Kemampuan Argumentasi Ilmiah. *Jurnal Pendidikan Sains & Matematika*, *8*(1).

Tursinawati. (2016). Penguasaan Konsep Hakikat Sains dalam Pelaksanaan Percobaan pada Pembelajaran IPA di SDN Kota Banda Aceh. *Jurnal Pesona Dasar*, *2*(4), 72–84.

Vilmala, B. K., Karniawati, I., Suhandi, A., Permanasari, A., & Khumalo, M. (2022). A Literature Review of Education for Sustainable Development (ESD) in Science Learning: What, Why, and How. *Journal of Natural Science and Integration*, *5*(1), 35. https://doi.org/10.24014/jnsi.v5i1.15342

Wedyawati, N., & Lisa, Y. (2019). *Pembelajaran IPA di Sekolah Dasar* . Deepublish.

Zarkasih, Z., Diniya, D., Permana, N. D., & Kirana, I. (2023). Development of Science E-Modules Based on Socio-scientific Issues Integrated with The Quran Verses to Establish Pancasila Student Profiles. *Journal of Natural Science and Integration*, *6*(1), 63. https://doi.org/10.24014/jnsi.v6i1.21855