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PENGARUH MODEL AUDITORY INTELECTUALLY REPETITION BERBASIS SOCIO-SCIENTIFIC ISSUE TERHADAP KETERAMPILAN BERPIKIR KRITIS

THE IMPACT OF THE AUDITORY INTELLECTUALLY REPETITION (AIR) MODEL BASED ON SOCIO-SCIENTIFIC ISSUES ON CRITICAL THINKING SKILLS

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Abstract. Critical thinking skills are one of the four skills that must be prepared in the 21st century. The results of observations in one of the leading high schools in Tolitoli, Central Sulawesi, showed that low critical thinking skills were likely caused by using learning models that were not yet relevant. One effort to develop students' critical thinking skills is through the Auditory Intellectually Repetition (AIR) model based on Socio-Scientific Issues (SSI). This study aims to determine the effect of the SSI-based AIR model on students' critical thinking skills about environmental pollution materials. This type of research is a quantitative quasi-experimental study with a Pre-test-Post-test control group design. The research sample was selected through cluster random sampling from the population of four Grade X science program classes. After randomization, a research sample of 72 out of 144 students was selected, and they were divided into two groups: the experimental group (SSI-based AIR) and the control group (discovery learning). Experts have validated the research instrument used. The research data analysis used the independent sample t-test or Mann-Whitney test. The results of the Mann-Whitney test analysis showed a significance value (two-tailed) of 0.012 ($p < 0.05$). Based on these results, it can be concluded that applying the SSI-based AIR model has a positive impact on students' critical thinking skills regarding environmental pollution materials. Teachers can utilize the findings of this study as an alternative to employing innovative methods in their classrooms.
Keywords: AIR, Biology, Critical thinking skills, SSI

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PENDAHULUAN

A person possesses Critical thinking skills to analyze, select, investigate, and examine information to design a problem-solving strategy (Mira, 2018). In line with this opinion, Yuni (2021) describes critical thinking skills as mental skills, such as finding solutions to problems, drawing conclusions, analyzing opinions, and conducting scientific research. Meanwhile, Agnafia (2019) states that critical thinking skills are reflective thinking skills that can strengthen opinions based on sound reasons and evidence. Based on several views, it can be concluded that critical thinking skills are a planned and structured knowledge process that helps solve problems and strengthen opinions with sound reasons and evidence.

Biology is a compulsory subject in the science program at the senior high school level. Critical thinking skills can be developed through biology because they encompass complete objects and phenomena related to everyday life events (Ellisahep, 2019). Therefore, students can practice identifying problems and expressing their ideas or thoughts to find solutions. Events closely related to everyday life, one of which is environmental pollution, involve materials. Through this material, students can become involved in identifying the causes and effects of pollution at local, national, and global levels. They can express opinions on the best way to handle it, supported by strong reasons.

Based on data obtained through interviews with one of the biology teachers at an accredited leading state high school in Tolitoli, Central Sulawesi, it is known that students' critical thinking skills are still relatively low. Students continue to struggle with solving problems that require analytical reasoning. According to the teacher, this can be seen from the opinions expressed by students, which are generally uniform (non-varied) because they only follow the views of previous friends, which have not been supported by proper reasons or factual evidence. The observations of the learning process indicate that biology learning is still predominantly characterized by the use of the lecture method, which is teacher-centered. Most students simply listen without engaging in functional learning. Learning with this method is thought to involve only the transfer of knowledge from teachers to students, with a lack of two-way interaction. As a result, students tend to be silent during learning. Wardani et al. (2021) explained that one indicator of the success of developing students' critical thinking skills is the teacher's accuracy in choosing a learning model.

Students' critical thinking skills should be directed to improve higher-order thinking skills (Nabilah & Syamsurizal, 2024). This improvement is made possible by providing students with challenging questions or problems during learning that they can solve collaboratively. In addition, Susanto (Ellisahep, 2019) explains that one practical effort to develop critical thinking skills is to hold active and interactive classes where students are seen as thinkers, not just as recipients of instruction, and teachers play a role in facilitating, mediating, and motivating students to learn. Masgumelar and Pinton (2021) state that constructivism is one approach to the learning process that can actively and continuously shape students' knowledge. Through this learning process, students can build their knowledge by engaging their minds through cognitive maturity. One of the collaborative constructivist learning process learning models is the Auditory, Intellectual, Repetition (AIR) learning model. Alpian (2022) explains that the AIR learning model views an effective learning process as implementing three key elements: Auditory (listening and hearing), Intellectual (learning process involving thinking skills), and Repetition (repetition achieved through quizzes or assignments). The AIR model, which embodies the auditory learning style, is linked to students' interests and learning outcomes, aligning with the development of critical thinking skills (AR & Adriyani, 2023). Moreover, current learning is a post-Covid-19 pandemic learning mode. There is a belief that students' current learning styles are a result of past experiences. This result indicates that the auditory learning style is significantly influenced by the effects of learning during the Covid-19 pandemic, which prioritizes a learning style that utilizes hearing through lectures by teachers or virtual group presentations (Widayanti, 2013; Kristianti, 2022; Pinat et al., 2022). Regarding the intellectual process, Handayani et al. (2024) argue that the AIR model enables students to express their opinions freely, using their preferred techniques or language styles. In addition, according to Alpian (2022), this learning model can help students develop critical thinking skills to solve problems. Shoimin (2017) argues that the thinking skills in this learning model's syntax train students to think critically (mind-on), concentrate, and develop their analytical reasoning, problem-solving, and critical thinking skills, ultimately building their opinions. Not only that, Shoimin (2017) also explains that repetition can make it easier for students to understand the material taught by the teacher. Through this learning model, students can develop their critical thinking skills.

In terms of optimizing students' experience in building their knowledge independently, the AIR model is combined with the Socio-Scientific Issue (SSI) approach. This approach can stimulate cognitive development, morals, character, and social awareness (Rahmawati et al., 2018) by incorporating scientific concepts, problems, controversies, and public discussions (Rahmasiwi et al., 2018). Through this combination, students can actively collaborate to build ideas to find the right solution in a socio-scientific context. To date, there has been no comprehensive information or empirical evidence regarding the impact of using the SSI-based

AIR model on critical thinking skills. Therefore, a study entitled "The Effect of the Auditory Intellectually Repetition Model Based on Socio-Scientific Issues on Students' Critical Thinking Skills Regarding Environmental Pollution" needs to be conducted.

METHOD

This research is a quantitative quasi-experimental study with a Pre-test-Post-test control group design. This study employed two groups: an experimental group and a control group (Sugiyono, 2016). The learning in the experimental group utilized the AIR model based on SSI, whereas the learning in the control group employed the discovery learning model. Both groups were measured for critical thinking skills with a Pre-test and Post-test. The Pre-test was administered to assess the initial state of students' critical thinking skills, while the Post-test was administered to evaluate the state after treatment. Furthermore, the results obtained were used to compare the effect of treatment in the experimental group with that in the control group. The research design adopted by Arifin (2011) is explained in Table 1.

Table 1. Pre-test-Post-test Control Group Design

Kelompok	***Pre-test***	**Variable**	***Post-test***
Experimen	O_1	X	O_3
Control	O_2	Y	O_4

Note:

X : SSI-based AIR model learning
Y : Discovery *learning* model (a model commonly used by teachers)
O1 : Average score *of the pre-test* critical thinking skills of the experimental group
O2 : Average *Pre-test* score of the control group's critical thinking skills
O3 : Average score *of the post-test* critical thinking skills of the experimental group
O4 : Average score *of the control group's critical thinking skills* Post-test score

This research was conducted in one of the leading accredited schools, A, located in Tolitoli City/Regency, Central Sulawesi Province. The study was conducted in the even semester of the 2022/2023 academic year, namely from March to June 2023. Learning took place over two weeks. Meanwhile, the implementation of the Pre-test and Post-test was carried out outside of school hours. The data that was successfully obtained was processed from May to June 2023. The population in this study consisted of all class X MIPA program students, totaling 144 students, divided into four classes: X MIPA 1, X MIPA 2, X MIPA 3, and X MIPA 4. Each class consists of 36 students.

The sample determination was carried out using the cluster random sampling technique. After randomization, classes X MIPA 2 and X MIPA 3 were obtained as research samples. All students from the courses taken were included in this study, specifically, 72 students, comprising 36 students from Class X MIPA 2 and 36 students from Class X MIPA 3. Randomization was used to assign participants to the experimental and control groups from the two classes. The results showed that class X MIPA 3 was selected as the experimental group applying the SSI-based AIR model. In contrast, class X MIPA 2 was selected as the control group with the application of the discovery learning model. The learning tools used were the 2013 curriculum syllabus, the Learning Implementation Plan for the experimental and control groups, and the Student Worksheet. All instruments in this study were validated theoretically by expert lecturers, based on their expert judgment. The validity of this instrument was measured to assess whether the instruments prepared by the researcher were valid and suitable for use. The instruments used in this study were the Pre-test and Post-test instruments for critical thinking skills, as well as observation sheets for the implementation of learning in both the experimental and control groups. The form of the Pre-test and Post-test questions is a short description (essay) with 10 questions each. Each question has an assessment category: Very

Poor (SK) with a value range of 0 to 25, Poor (K) with a value range of 26 to 50, Good (B) with a value range of 51 to 75, and Very Good (SB) with a value range of 76 to 100.

The data analysis techniques employed in this study include descriptive statistical analysis and inferential statistical analysis, both of which were assisted by the IBM SPSS 26 application. Descriptive statistical analysis analyzes the minimum, maximum, average, and standard deviation values. Meanwhile, the inferential statistical analysis technique first tests the hypothesis analysis requirements with the Kolmogorov-Smirnov normality test and the Levene variance homogeneity test. If the data is normally distributed, then the hypothesis is tested with the independent sample t-test. Meanwhile, if the data is not normally distributed, the hypothesis is tested with the Mann-Whitney U test, which involves reading the analysis to determine the significance (Sig.). value is less than 0.05 ($p<0.05$), then the research hypothesis is accepted (H1). Two hypotheses will be tested in this study, namely, the null hypothesis (H0) for the analysis of Pre-test data that there is no difference between the initial critical thinking skills of students in the experimental group and the control group and the research hypothesis (H1) for the analysis of Post-test data that there is an influence of the application of the SSI-based AIR learning model on students' critical thinking skills in environmental pollution material.

RESULTS AND DISCUSSION

The research data collected during the study included pre-test and post-test score data, mastery scores on the material (quiz), and affective scores for experimental and control group students. However, only the pre-test and post-test score data will be analyzed, while the others will only be supporting data. The results of the pre-test and post-test data analysis are explained below.

Results

Descriptive statistical analysis was conducted to measure the centralization and distribution of the Pre-test and Post-test values of critical thinking skills that had been obtained. Descriptive statistical analysis was shown by acquiring average, minimum, maximum, and standard deviation values. The Pre-test and Post-test data of the experimental and control groups, in the form of descriptive statistical analysis results of critical thinking skills values, were tabulated in Table 2.

Table 2. Average, minimum value, maximum value, and standard deviation of critical thinking skills of the experimental group and control group before (Pre-test) and after learning (Post-test)

	N	*Range*	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Pre-test Experiment	36	60,00	32,50	92,50	64,8611	15,34071
Pre-test Control	36	50,00	30,00	80,00	61,5972	13,36510
Post-test Experiment	36	30,00	65,00	95,00	77,0139	9,83470
Post-test Control	36	60,00	30,00	90,00	65,7639	18,30124
Valid N (*listwise*)	36					

Table 2 shows that the average value of the Pre-test critical thinking skills of students in the experimental group tends to be higher than the control group. The experimental group obtained an average value of 64.86 with a standard deviation of 15.34, while the control group obtained an average value of 61.59 with a standard deviation of 13.36. Meanwhile, the average value of the Post-test critical thinking skills of students in both groups has increased even though the control group has not yet reached the minimum criteria. The experimental group obtained an average value that tended to be higher than the control group. The experimental

group showed an average value of 77.01 with a standard deviation of 9.83, while the control group showed an average value of 65.76 with a standard deviation of 18.30.

Furthermore, the inferential statistical analysis was carried out using the research hypothesis test. Before conducting the hypothesis test, a prerequisite test was performed to determine the normality and homogeneity of the research data. The prerequisite tests carried out were the Kolmogorov-Smirnov normality test and the Levene variance homogeneity test. The results of the prerequisite test analysis are explained as follows. The results of the normality test analysis of the critical thinking skills pre-test are tabulated in Table 3.

Table 3. Kolmogorov-Smirnov normality test results

	Kelas	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Critical Thinking Skills Results	*Pre-test* Experiment	0,170	36	0,010
	Pre-test Control	0,138	36	0,080

From Table 3, it can be seen that the significance value obtained by the experimental group is 0.010 ($p < 0.05$), while the control group has a significance value of 0.080 ($p > 0.05$). It can be concluded that the pre-test value in the experimental group is not normally distributed, while it is normally distributed in the control group. Following this, a test of the homogeneity of the distribution of the Pre-test value data for critical thinking skills was conducted. The results of the analysis of the homogeneity of variance of the Pre-test value of critical thinking skills are tabulated in Table 4.

Table 4. Results of homogeneity of variance test

		Levene Statistic	*df1*	*df2*	*Sig.*
Critical Thinking Skills Results	*Based on Mean*	0,135	1	70	0,714
	Based on Median	0,230	1	70	0,633
	Based on Median and with adjusted df	0,230	1	68,951	0,633
	Based on trimmed mean	0,169	1	70	0,682

Table 4 shows that the significance value based on the average obtained is 0.714 ($p>0.05$). It can be concluded that the Pre-test scores of the two groups are homogeneous. Based on the results of the analysis in Tables 13 and 14, it can be seen that the Pre-test score data of the control group is not normally distributed, even though the Pre-test scores of the two groups are homogeneous. Therefore, the significance of the difference in the Pre-test scores of critical thinking skills in the two research groups is determined through a nonparametric test, the Mann-Whitney test. The null hypothesis (H0) to be tested using the Pre-test scores of the two groups is that there is no difference in the initial critical thinking skills of students between the experimental group and the control group. The results of the Mann-Whitney hypothesis test are tabulated in Table 5 and Table 6.

Table 5. *Pre-test score ranking* results with *Mann-Whitney*

	Class	N	Mean Rank	Sum of Ranks
Critical Thinking Pre-test	Pre-Test Experiment	36	38,50	1386,00
	Pre-test_Kontrol	36	34,50	1242,00
	Total	72		

Table 5 shows that the N *Pre-test* value in the experimental and control groups was 36, which means that as many as 36 students have done the *Pre-test* of critical thinking skills. The average *Pre-test* score rating in the experimental group was 38.50, with a total rating of 1386.00. Meanwhile, in the control group, the average *Pre-test* score was 34.50.

From Table 6 it can be seen that the value *of Asymp.Sig.(2-tailed)* shows a value of 0.416 (p>0.05), then H0 is accepted. It can be concluded that there was no difference between the initial critical thinking skills of the students of the two study groups. The results of the normality test *analysis and the post-test on* critical thinking skills are tabulated in Table 7.

Table 6. Results of the Mann-Whitney test *Pre-test* value of critical thinking skills

	Critical Thinking Pre-test
Mann-Whitney U	576,000
Wilcoxon W	1242,000
Z	-0,813
Asymp. Sig. (2-tailed)	0,416

a. Grouping Variable: Class

Table 7. Results of the Kolmogorov-Smirnov normality test

	Class	Kolmogorov-Smirnov[a]		
		Statistic	df	Mr.
Result	*Post* Experiment	0,222	36	0,000
	Post Control	0,204	36	0,001

From Table 7, it can be seen that the significance value obtained by the experimental group was 0.000 (p<0.05), while the significance value obtained by the control group was 0.001 (p<0.05). It can be concluded that *the post-test scores* of the two groups were not normally distributed in this study. After that, a homogeneity test was carried out on the distribution of data on *the value of the Post-test* critical thinking skills. The results of the analysis of the homogeneity test of Levene variance value *The value of the Post-test* critical thinking skills are tabulated in Table 8.

Table 8. Results of the variance homogeneity test

		Levene Statistic	*df1*	*df2*	*Sig.*
Result	*Based on Mean*	10,444	1	70	0,002
	Based on Median	5,994	1	70	0,017
	Based on Median and with adjusted df	5,994	1	48,834	0,018
	Based on trimmed mean	9,051	1	70	0,004

From Table 8, it can be seen that the significance value based on the average obtained is 0.002 (p<0.05). It can be concluded that the *post-test scores* of the two groups were not homogeneous in this study. Based on the results of the analysis in Table 7 and Table 8, it can be seen that *the data of the experimental and control groups' post-test values* are not normally distributed and are not homogeneous. Thus, the significance of the difference in *the value of the Post-test* of critical thinking skills in the experimental and control groups was determined through a nonparametric test, *the Mann-Whitney test*. The research hypothesis to be tested is that applying the SSI-based AIR learning model affects students' critical thinking skills and their critical thinking skills regarding environmental pollution materials. The results of the Mann-Whitney hypothesis test are tabulated in Table 9 and Table 10.

Table 9. Results of the *Mann-Whitney* Post-test score ranking

	Class	N	*Mean Rank*	*Sum of Ranks*
Critical Thinking Post-test	*Post-test*_Eksperiment	36	42,63	1534,50
	*Post-test*_Kontrol	36	30,38	1093,50
	Total	72		

Table 9 shows that the N *value of the Post-test* in the experimental and control groups was 36, which means that as many as 36 students have done the *Post-test* of critical thinking skills. The average *Post-test* score rating in the experimental group was 42.63, with a total rating of 1534.50. Meanwhile, in the control group, the average *Post-test* score was 30.38, with a total rating 1093.50.

Table 10. Results of the Mann-Whitney hypothesis test

	Critical Thinking Post-test
Mann-Whitney U	427,500
Wilcoxon W	1093,500
With	-2,498
Asymp. Sig. (2-tailed)	0,012
a. Grouping Variable: Kelas	

From Table 10, it can be seen that the value *of Asymp.Sig.(2 tailed)* showed a value of 0.012 ($p<0.05$). It can be concluded that the research hypothesis is accepted, namely that the application of the SSI-based AIR model has an impact on student's critical thinking skills regarding environmental pollution materials.

Discussion

The results of the Mann-Whitney test analysis for the pre-test scores listed in Table 6 indicate no significant difference in the value of students' initial critical thinking skills between the two research groups. This means that students in both the experimental and control groups possess equal critical thinking skills prior to learning. Thus, the existence of disruptive variables, which can interfere with the relationship between independent variables and bound variables, as Setyanto (2006) feared, did not occur in this study.

The results of the Mann-Whitney test analysis for Post-test scores, as presented in Tables 9 and 10, indicate a significant difference in the value of critical thinking skills among students in the two research groups after learning. This significant difference can be attributed to the influence of applying the Auditory Intellectually Repetition (AIR) model based on Socio-Scientific Issues (SSI). Looking back, the results of the descriptive statistical analysis in Table 2 indicate that the average post-test score in the experimental group is higher than that in the control group, suggesting that applying the SSI-based AIR learning model enhances critical thinking skills.

According to Washington State University, the improvement in students' critical thinking skills in the experimental group was attributed to the relationship between the syntax in the SSI-based AIR model and the critical thinking skill indicator. Based on syntax, students work in groups to solve problems from their chosen pollution cases. Discussions facilitate students' understanding of the problem's context, enabling them to develop their critical thinking and analysis skills (Ahmad *et al.*, 2017). Before the group discussion, the teacher provided exercises for students to identify the problem of one of the pollution examples through learning videos. After learning, the teacher provides *repetition* through quizzes to increase understanding and memory of the material that has been delivered.

In implementing the SSI-based AIR model, the teacher presents an example of eutrophication by showing a learning video and stimulating students to identify the causes and potential solutions from various perspectives. In this case, students express their opinion that eutrophication is caused by agricultural and household waste, such as detergent bottle waste. Students state that handling this case requires attention from the local community, environmental organizations/institutions, and the government through the Tolitoli Regency Environmental Service. This problem-oriented activity is a good first step in learning, as suggested by Bruner (Saputro, 2012). In addition, this activity has also been proven to be one

of the factors contributing to the improvement of students' critical thinking skills (Silaban et al., 2022; Mareti & Agnes, 2021; Fristadi & Haninda, 2015).

Concerning the indicators for identifying problems and linking related issues, students carry out the process of exchanging information in groups by examining pollution incidents in their vicinity. The information collected begins with formulating clear questions (Ennis, 1996; Facione, 2015; Krulik & Rudnick, 1995; Lai & Viering, 2012). Based on teacher observations, students formulate questions, such as: "What is happening to the environment?", "Why did that case occur?", and "How can this case be handled properly?" Through these activities, according to Kamil et al. (2019), students' thinking skills in problem-solving are developed, enabling them to make informed decisions based on previously acquired knowledge and concepts.

Concerning the indicators of formulating hypotheses, analyzing data, and supporting facts, students construct their arguments by starting from theoretical thinking, then analyzing the problem further, and finally compiling ways to solve the hypothesis that can be done (Toharudin et al., 2011). The construction of arguments in the form of hypotheses from the questions formulated is carried out by examining the indicators of experience, logic, and deduction, which are derived from the student's previous knowledge (Salsiah, 2015). After that, students test the validity of their hypothesis by consulting credible references. This test requires analytical skills, which are used to break down the material into smaller parts and determine the relationship between these parts as a whole (Anderson & Krathwohl, 2001).

Anderson and Krathwhol (2001) explain that the analysis process includes differentiating, organizing, and distributing activities. Based on teacher observations, students discuss and formulate hypotheses with all group members. Then, representatives from the group hold interactive discussions with the teacher to confirm the findings from credible references through their internet searches. The teacher helps students sort out the correct information as they rearrange the findings and supporting facts before presenting them at the next meeting. Regarding the indicators of making conclusions, students use inductive or deductive reasoning and consider relevant information (Ennis, 1996; Facione, 2015). Based on teacher observations, students and their group members make decisions based on the findings of their cases by comparing them to confirmed supporting factual data. The conclusions made by each group are considered suitable by the teacher because they have effectively addressed the previously formulated problems.

After the discussion, students are asked to present their results to the class. To test understanding and train students to think accurately and responsively, the teacher gives analytical questions based on the case study presented by the presenter group. Giving questions can train students' thinking and memory (Aqib & Ali, 2016; Sumayani, 2018; Yunarti, 2009). To answer questions from the teacher, students attempt to identify and link concepts related to the source of the problem, and then formulate hypotheses based on their existing knowledge. In its implementation, the questions given by the teacher challenge students to see different perspectives on the cases being investigated. These questions are not limited to the health perspective but can be viewed from a broader perspective, including economic, socio-cultural, and even political losses. Several research studies have shown that asking students questions can enhance their critical thinking skills (Rohani & Yeni, 2020; Sumayani, 2018; Yunarti, 2009).

In its implementation, the teacher gives a short essay quiz at the end of each meeting. The quiz questions contain raw data with or without descriptions, allowing students to practice problem analysis skills and find solutions appropriately and responsively. The raw data in question include data records of changes in land cover in forest areas in Morowali (Fajar et al., 2022) and several images of marine biota entangled in plastic waste. This repetition step can increase memory (Shoimin, 2017) and has been proven to develop critical thinking skills (Arif et al., 2022).

The increase in critical thinking skills in the experimental group is also possible due to ideal heterogeneous learning groups, which facilitate mutual learning within the group (Mushoddik, 2016). This means that the group is determined by equalizing gender and critical thinking skills, as indicated by the results of the pre-test. The increase in critical thinking skills observed in the experimental group is also likely due to the auditory learning style. There is a belief that students' current learning styles are a result of past experiences. This means that this auditory learning style is strongly influenced by the effects of learning during the Covid-19 pandemic, which prioritizes a learning style using hearing through lectures by teachers or virtual group presentations (Widayanti, 2013; Dianti, 2021; Kristianti, 2022; Pinat et al., 2022). Based on teacher observations, after identification, it was observed that more students in the experimental group had an auditory learning style, as indicated by several characteristics described by Widayanti (2013).

Finally, improving critical thinking skills in the experimental group is also possible due to the combination of the AIR model with the SSI approach. This combination makes the AIR model complete and coherent in developing students' critical thinking skills through environmental observation. In its implementation, the teacher prepares several issues and cases of environmental pollution at the global, national, and local levels in Tolitoli Regency, which are included in the Pre-test-Post-test instrument. While learning, the teacher prepares a case of eutrophication that occurred in Nalu Village, Tolitoli Regency, to train students in identifying and solving the problem with the help of learning videos. In the quiz questions, the teacher also provides several cases for students to analyze the causes and handling, such as the case of deforestation in the protected forest area in Sekaroh (Aziz et al., 2022), the case of the estimated overload of garbage piles at the Kabinuang TPA, Tolitoli Regency (Kiding et al., 2021), and others. This aligns with the opinion of Rahmasiwi et al. (2018), who suggest that the issues in the SSI approach stem from scientific concepts, problems, controversies, and public discussions.

Several research results also show that combining models with the SSI approach has an effect. Research by Nurhayati et al. (2016) revealed that learning with the LC-5E model in the SSI context has a significant effect on critical thinking skills. Research by Wilsa et al. (2017) demonstrated that understanding with the SSI-based Problem-Based Learning (PBL) model has a positive impact on the development of critical thinking skills, written and verbal communication, and cognitive learning outcomes. Additionally, research by Fihani et al. (2021) indicates that the SSI approach has been shown to significantly enhance critical thinking skills related to the concept of viruses. Thus, it is evident that the SSI approach makes a significant contribution to supporting the results of this study.

Students' responses in the two groups during learning were considered good, especially in the experimental group. Students appeared more active during learning by frequently asking the teacher and the presenter group questions. Effective critical thinking skills are developed through active and interactive classes, where students are viewed as thinkers rather than just being taught, and the teacher plays a role in facilitating, mediating, and motivating students to learn (Ellisahep, 2019). Therefore, learning with the SSI-based AIR model is considered effective because it enables students to think critically about solving their own problems.

This opinion is supported by several relevant research results regarding applying the AIR model to students' critical thinking skills. Astuti's (2017) study showed that the AIR model affects critical thinking skills. Then, the results of research by Ellisahep (2019) revealed that the AIR model has been proven to impact students' thinking skills on biodiversity material. Finally, the research results by Alpian (2022) showed that the AIR model significantly affected critical thinking skills on the material of the movement system. Thus, the research, "The Effect of SSI-Based AIR Model on Students' Critical Thinking Skills in Environmental Pollution

Materials," was declared successful, as evidenced by the results of hypothesis testing and support from other research data.

CONCLUSION

Based on the results of descriptive statistical analysis, inferential statistics, and discussion, it can be concluded that applying the SSI-based AIR learning model has a positive impact on student's critical thinking skills in environmental pollution materials. The effect observed is an increase in students' critical thinking skills, as evidenced by the rise in the average value of the experimental group's post-test results. According to Washington State University, the increase in critical thinking skills is influenced by the relationship between SSI-based AIR syntax and essential thinking skills indicators, as well as the determination of ideal heterogeneous student groups. Teachers can use this research as an alternative to innovative learning to enhance students' critical thinking skills.

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