RICOSRE and Miro: Teaching Approach for Improving Scientific Argumentation Skills in Ecosystem Materials

ABSTRACT

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| This study aims to determine the effect of the RICOSRE learning model supported by Miro on students' scientific argumentation skills in ecosystem material. The study design used is a nonequivalent pretest-posttest control group design. This study was conducted in 10th Grade at a senior high school in Tasikmalaya, Indonesia, from September 2024 to May 2025. The population in this study was all tenth grade classes, consisting of 12 classes. The sampling technique used purposive sampling. We involved three classes as the experimental class, positive control class, and negative control class. The study was conducted by applying the treatment to the experimental class, which used the RICOSRE learning model supported by Miro. Meanwhile, the positive control class used the RICOSRE learning model, and the negative control class used the discovery learning model. Scientific argumentation skills were measured using a test instrument consisting of 13 essay questions covering three components: claim, evidence, and reasoning. The data analysis technique used was ANCOVA with *P* = .05, followed by pairwise comparison using the LSD test. Although the effectiveness of RICOSRE and Miro has been studied separately, no research has examined the integration of the two to improve students' scientific argumentation skills in biology, particularly in the material on ecosystems. The results of the ANCOVA test analysis showed a significance value of .000, meaning that the sig. value was < .05, indicating a significant effect on students' scientific argumentation skills in the use of different learning models in each class. Further testing using the LSD test showed that the Miro-assisted RICOSRE learning model was more effective than classes using RICOSRE and classes using discovery learning. Based on this, it can be concluded that the RICOSRE learning model supported by miro has a significant effect on improving students' scientific argumentation skills. |

*Keywords: RICOSRE Learning Model; Miro; Scientific Argumentation Skills, Ecosystem Materials*

1. INTRODUCTION

Education in the 21st century is increasingly developing, requiring learning that demands students to have 21st-century skills. Learning must be designed in accordance with the 4C skills, namely creativity and innovation, critical thinking and problem solving, collaboration, and communication (Setiawan & Fadilah, 2023). Critical thinking skills are closely related to scientific argumentation skills (Haruna & Nahadi, 2021; Giri & Paily 2020) so that scientific argumentation skills become the foundation for critical thinking. Argumentation skills are an integral part of communication (Gunawan et al., 2021). Therefore, scientific argumentation skills are crucial to develop in support of 21st-century skills such as critical thinking and communication.

Scientific argumentation skills are the ability of a person to make statements supported by scientific evidence and reasoning. Scientific argumentation involves the process of constructing statements accompanied by evidence and logical reasoning with the aim of justifying beliefs, attitudes, or values, defending them, and influencing others (Suraya et al., 2019). Argumentation is considered an intellectual resource for students because it can be used to solve problems (Chen et al., 2019). Argumentation skills are one of the learning objectives in science education, requiring students to be able to provide scientific explanations of natural phenomena and use them to solve problems (Hardini & Alberida, 2022). Based on this, the development of scientific argumentation skills is important for students so that they not only understand concepts but also can reason scientifically, communicate effectively, and solve problems in science learning, including biology.

Biology learning requires critical analysis, inductive reasoning, and deductive reasoning to address issues related to environmental phenomena and is composed of facts, rules, principles, theories, laws, and hypotheses related to daily life and interactions with the environment (Apriyani & Alberida, 2023). One of the topics in biology education is ecosystems. Ecosystem-related topics are closely tied to daily life, which requires solutions to problems related to surrounding ecosystems. Therefore, an appropriate learning model is needed for this topic to make the learning process more meaningful.

Based on observations at a senior high school in Tasikmalaya, Indonesia, indicate that the learning model implemented only uses the discovery learning model and rarely uses tools such as attractive and interactive platforms. The discovery learning model is more suitable for discoveries aimed at developing concepts predetermined by the teacher so that students are not given the freedom to generate their own ideas (Arlina et al., 2023). This is supported by the results of a preliminary study that administered a scientific argumentation ability test to 50 tenth-grade students at a senior high school in Tasikmalaya, Indonesia, showing that 56% of students could present claims ideally, 34% could present evidence ideally, and 28% could present reasoning ideally. Based on these percentages, it can be concluded that many students are still unable to provide opinions accompanied by scientific evidence and logical connections between evidence and opinions that are complete and accurate. Therefore, students' scientific argumentation skills need to be improved in the learning process.

A learning approach that provides opportunities for students to learn to argue in science learning is needed (Acar et al., 2015). One effort to improve students' scientific argumentation skills is to apply a learning model that requires students to solve problems (Siska et al., 2020). The RICOSRE learning model is one of the learning models based on problem solving (Mahanal & Zubaidah, 2017). RICOSRE is an acronym for the syntax of the learning model, which consists of reading, identifying the problem, constructing the solution, solving the problem, reviewing the solution, and extending the solution (Mahanal et al., 2022). However, this learning model has a weakness in that it can lead to low student engagement and requires a significant amount of time. Therefore, methods and tools are needed to maximize the implementation of this learning model. The learning method that can be applied in the RICOSRE learning model is brainstorming. The use of technology can help maximize the RICOSRE learning model and brainstorming method. One technology that can be used to support learning is Miro.

Miro is a virtual whiteboard platform that facilitates effective collaboration in brainstorming (Magdalena & Septian, 2023). Miro has several advantages over other virtual whiteboard platforms, including in terms of idea generation, development, and evaluation, as well as more comprehensive and diverse communication (Deckert et al., 2021). The Miro virtual whiteboard can facilitate students in expressing their opinions (Peplaski et al., 2022). Students can develop solutions through brainstorming, problem-solving, reviewing problem solutions, and expanding solutions within the RICOSRE learning model using Miro.

Previous studies have examined the RICOSRE learning model, miro, and scientific argumentation skills. The RICOSRE learning model has been proven effective in improving critical thinking skills (Mahanal et al., 2019), learning outcomes (Siahaan et al., 2023), creative thinking (Khasanah et al., 2022), problem-solving skills (Manisa et al., 2020), analytical thinking and communication (Haka et al., 2023), and scientific argumentation skills (Noviyanti, 2019). Miro has been proven effective in helping students become more active and interactive in learning (As’ad, 2021). However, there has been no research integrating the RICOSRE learning model with Miro on scientific argumentation skills. Therefore, there is a need for new research to integrate the RICOSRE learning model, Miro, and scientific argumentation skills. This study provides new insights into this area, particularly in the subject of biology. This study aims to determine the effect of the RICOSRE learning model assisted by miro on students' scientific argumentation skills in biology learning on the topic of ecosystems. This research is important to address the need for improving the quality of learning and scientific argumentation skills, which are essential competencies in supporting 21st-century education. This research contributes practically to improving the quality of students' scientific argumentation abilities, and as an inspiration for teachers in developing professional competence in teaching by using a variety of learning models and media when teaching in class.

2. MATERIAL AND methods

This study uses an experimental method. The type of experimental research used is quasi-experimental. The research design used in this study is a nonequivalent pretest-posttest control group design. This design uses three groups that are given different treatments to see their effects through scores before and after the treatment. The research was conducted at a senior high school in Tasikmalaya, Indonesia from September 2024 to May 2025.The population in this study was all 10th grade at a senior high school in Tasikmalaya, Indonesia in the 2024/2025 academic year, consisting of 12 classes with a total of 430 students. The sampling technique used purposive sampling, considering the advice of biology teachers regarding student activity in the learning process in the classroom and looking at the average scores of previous daily tests, which tended to be similar. Thus, three classes were selected as the experimental class, positive control class, and negative control class.

This study was conducted by applying the treatment to the experimental class using the RICOSRE learning model assisted by Miro. The positive control class used the RICOSRE learning model, while the negative control class used the discovery learning model. Before the treatment was administered, the researcher conducted a pretest to measure the students' initial scientific argumentation skills. Subsequently, learning was conducted according to the treatment of each class during two meetings on the ecosystem material. After the treatment, the researcher administered a posttest to measure the improvement in scientific argumentation skills. The pretest and posttest data were then analyzed using statistical tests to determine the significant effect of the learning model applied.

Scientific argumentation skills were measured using a test instrument consisting of 13 essay questions that had been tested for validity and reliability beforehand. Validity testing is carried out through expert judgment techniques by lecturers in related courses and conducting instrument trials in classes that have studied ecosystem material and have an understanding of ecosystem material. The validity and reliability tests were assisted with SPSS software version 24 for Windows. The results of instrument testing are presented in table 1 below. Based on the results of the validity test, 13 questions were declared valid and suitable for use in research. The results of the reliability test are presented in table 2 below. Based on the results of the reliability test, it shows that the instrument has a very high reliability value.

**3. RESULTS AND DISCUSSION**

**Table 1. Results of validity instrument**

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **r table Value** | **Obtained r Value** | **Validity Statement** |
| 1. | .396 | .414 | Valid |
| 2. | .396 | .666 | Valid |
| 3. | .396 | .539 | Valid |
| 4. | .396 | .350 | Not valid |
| 5. | .396 | .734 | Valid |
| 6. | .396 | .329 | Not valid |
| 7. | .396 | .788 | Valid |
| 8. | .396 | .266 | Not valid |
| 9. | .396 | .763 | Valid |
| 10. | .396 | .797 | Valid |
| 11. | .396 | .483 | Valid |
| 12. | .396 | .246 | Not valid |
| 13. | .396 | .320 | Not valid |
| 14. | .396 | .775 | Valid |
| 15. | .396 | .362 | Not valid |
| 16. | .396 | .328 | Not valid |
| 17. | .396 | .745 | Valid |
| 18 | .396 | .778 | Valid |
| 19. | .396 | .819 | Valid |
| 20. | .396 | .783 | Valid |

**Table 2. Result of reliability instrument**

|  |
| --- |
| **Reliability Statistics** |
| Cronbach’s Alpha | N of Items |
| .919 | 13 |

The indicators of scientific argumentation skills refer to the components developed by McNeill et al. (2006), consisting of three components: claim, evidence, and reasoning. Answers were scored using a rubric based on the levels of scientific argumentation ability according to McNeill et al. (2006) in Table 3 below, with a maximum score of 2 for each component

**Table 3. Base rubric for scientific argumentation skills**

|  |  |
| --- | --- |
| **Component** | **Level** |
| **0** | **1** | **2** |
| Claim | Does not make a claim or makes an inaccurate claim | Makes an accurate but incomplete claim | Makes an accurate and complete claim |
| Evidence | Does not provide evidence or only provides inappropriate evidence (evidence that does not support claim) | Provides appropriate but insufficient evidence to support claim; may include some inappropriate evidence | Provides appropriate and sufficient evidence to support claim |
| Reasoning | Does not provide reasoning or only provides reasoning that does not link evidence to claim | Provides reasoning that links the claim and evidence; repeats the evidence and/or includes some scientific principles but not sufficient | Provides reasoning that links evidence to claim; includes appropriate and sufficient scientific principles |

The hypothesis test used in this study was the ANCOVA (Analysis of Covariance) test with a *P* = .05 using SPSS version 24 for Windows software. A follow-up test was conducted if the hypothesis test rejected H0. The follow-up test used in this study was a pairwise comparison with the LSD (Least Significant Difference) test using SPSS version 24 for Windows software.

RICOSRE is a learning model that consists of six stages, namely Reading, Identifying the problem, Constructing the solution, Solving the problem, Reviewing the solution, and Extending the solution. The implementation of RICOSRE model and Miro is presented in Figure 1 below. Miro is used in the Identifying the problem, Constructing the solution, Solving the problem, and Reviewing the solution.

**Reading**

students read relevant literature, both provided by the teacher and explored independently, related to the learning material.

**Identifying the problem**

Students identify problems in the literature provided by the teacher and then write down the main problems on the Miro platform.

**Constructing the solution**

Students conduct brainstorming in groups and write down their ideas for solving problems on the Miro platform.

**Extending the solution**

Students extend solutions based on feedback from teachers and other students.

**Reviewing the solution**

Students communicate their chosen solutions. Teachers and other students can comment on digital sticky notes in Miro.

**Solving the problem**

Students choose the most effective solution based on its strengths and weaknesses on the Miro platform.

**Fig. 1. Implementation of RICOSRE learning models and Miro**

Before conducting the hypothesis test, there are prerequisite tests that must be carried out, namely the normality test and the homogeneity test. The normality test uses the Kolmogorov-Smirnov test, and the homogeneity test uses the Levene Test Statistic (*P* = .05). Table 4 shows the results of the normality test and homogeneity test. Based on Table 4, it can be seen that the research data is normally distributed and taken from a homogeneous variance.

**Table 4. Results of normality and homogeneity tests**

|  |  |  |
| --- | --- | --- |
| **Group** | **Sig. of Kolmogorov Smirnov Test** | **Sig. of Levene Test** |
| Pretest RICOSRE miro | .200\* | .930 |
| Pretest RICOSRE | .088 |
| Pretest Discovery Learning | . 127 |
| Posttest RICOSRE miro | .200\* | .985 |
| Posttest RICOSRE | .200\* |
| Posttest Discovery Learning | .200\* |

*\*This is lower bound of the true significance*

The next step is to test the hypothesis. The hypothesis test in this study uses the ANCOVA test, with pre-test scores as covariates (*P* = .05). If the analysis results show significant values, then the LSD test is used to determine the differences in average scores between the three treatment classes. The ANCOVA test results can be seen in Table 5. Based on the ANCOVA test results in Table 5, the significance value is 0.000. These results indicate that treatment with different learning models has a significant effect on students' scientific argumentation.

**Table 5. Results of the ANCOVA Test**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **Type III Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| Corrected Model | 8454.892a | 3 | 2818.297 | 261.442 | .000 |
| Intercept | 952.828 | 1 | 952.828 | 88.390 | .000 |
| Pretest | 8030.737 | 1 | 8030.737 | 744.980 | .000 |
| Learning Model | 215.483 | 2 | 107.742 | 9.995 | .000 |
| Error | 927.063 | 86 | 10.780 |  |  |
| Total | 239612.000 | 90 |  |  |  |
| Corrected Total | 9381.956 | 89 |  |  |  |
| *a.R Squared* = 0,901 (*adjusted R squared* = 0,898) |

Therefore, the Least Significant Difference (LSD) test was conducted to determine the significant differences between one group and another. The LSD test results are presented in table 6 below. Based on the LSD test in Table 6, the highest difference in scientific argumentation skills was found in RICOSRE assisted by miro with discovery learning. The comparison between RICOSRE assisted by miro and discovery learning had a Mean Difference value of 3.793. The results of the Least Significant Difference (LSD) test can be presented in notation form in table 7 to clarify the test results. Based on the LSD notation in table 7, it indicates that all classes experienced an increase in scores after the treatment, but the highest corrected mean scores and the highest increase occurred in the class that used miro-assisted RICOSRE. Based on this statement, it can be concluded that the RICOSRE learning model assisted by miro has the best effect in improving students' scientific argumentation skills.

**Table 6. Results of the LSD Test**

|  |  |  |  |
| --- | --- | --- | --- |
| **(I) Group** | **(J) Group** | **Mean Difference (I-J)** | **Sig.b** |
| RICOSRE miro | RICOSRE | 1.747\* | 0.043 |
| Discovery Learning | 3.793\* | 0.000 |
| RICOSRE | RICOSRE miro | -1.747\* | 0.043 |
| Discovery Learning | 2.046\* | 0.018 |
| Discovery Learning | RICOSRE miro | -3.793\* | 0.000 |
| RICOSRE | -2.046\* | 0.018 |
| *Based on estimated marginal means* |
| *\*The mean difference is significant at the 0,05 level.* |
| *b. Adjusment for multiple comparisons: Least Significant Difference (equivalent to no adjusments).* |

**Table 7. LSD Notation Scientific Argumentation Skills**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Group** | **Pretest** | **Posttest** | **Difference** | **Increase** | **Corrected Mean**  | **LSD Notation** |
| RICOSRE miro | 36.40 | 53.47 | 17.07 | 47% | 52.42 | a |
| RICOSRE | 34.80 | 50.03 | 15.23 | 44% | 50.67 | b |
| Discovery Learning | 35.03 | 48.23 | 13.20 | 38% | 48.63 | c |

There are three components evaluated in the scientific argumentation test given to students. The differences in the effects of each model can be seen from the average posttest scores for each component of scientific argument presented in Figure 2 below. The maximum score for each component is 2. Based on Figure 2, miro-assisted RICOSRE has a higher average score in each component than RICOSRE and Discovery Learning.



**Fig. 2. Average Pretest and Posttest Scores for Scientific Argumentation Component**

The RICOSRE learning model assisted by Miro has a superior influence in improving scientific argumentation skills because the Miro platform can be used to visualize ideas and enable students to collaborate effectively, such as brainstorming with digital sticky notes to planning and managing tasks well (Allah, 2023). Additionally, integrating digital whiteboard platforms like Miro into the learning process creates an interactive, engaging, and motivating learning environment, thereby enhancing students' focus, interest, understanding, self-confidence, and satisfaction with the learning process (Fitriyah & Mutammiroh, 2025). The use of Miro in the RICOSRE model not only enriches the learning process but also strengthens the quality of thinking and overall engagement of students.

The RICOSRE learning model can raise several issues that must be examined by students. These issues can encourage students to analyze data and build arguments supported by facts or theories through the process of training in formulating evidence-based solutions (Rianti et al., 2024). Miro in the RICOSRE learning model, facilitates learners in visualizing and organizing solution ideas more systematically, thereby making it easier to construct arguments for solution ideas and reasons for selecting solutions, including the strengths and weaknesses of each solution. Meanwhile, the discovery learning model is more suitable for developing general concepts and skills but does not allow students to form their own opinions as these are already determined by the teacher (Arlina et al., 2023). Therefore, the learning process in the RICOSRE model is superior in empowering scientific argumentation skills through systematic argument formulation compared to the discovery learning model, which only trains students to develop general concepts and skills. This is in line with the research by Rahayu, et al. (2022), which states that the application of learning strategies by organizing arguments can help improve the quality of students' scientific arguments.

The Miro platform can help students convey their claims about problem-solving ideas more comfortably and systematically. This is in line with the statements of Rahayu & Setiawati (2024) and Peplaski et al. (2022), who explain that digital whiteboard platforms can facilitate students' arguments by allowing them to express their opinions in writing, enabling students who are less confident in expressing their opinions verbally to write their opinions more comfortably on the platform.

The average scores on the evidence component in each class tend to be similar because the learning model used trains students to seek data or scientific evidence from relevant information sources to support their opinions on specific ideas or concepts. The RICOSRE model and discovery learning require an understanding of concepts as the basis for constructing scientific arguments. Based on Acar et al. (2017), argumentation skills improve with mastery of concepts. The RICOSRE learning model in the experimental class and positive control class includes a reading syntax that can serve as a foundation for students to gather factual and scientific information to be used as evidence in their arguments. Additionally, in the constructing the solution syntax, students formulate solutions by linking the evidence found to support the proposed solution. This is in line with the statement by Badriah et al. (2023), which states that the reading stage can help students obtain the information they need through reading valid, credible, and relevant information sources, while the constructing the solution stage can encourage students to find and analyze more information to support solutions to identified problems.

In the discovery learning model in the negative control class, there is a data collecting syntax that trains students to search for and collect valid, credible, and relevant information, thereby directly training their ability to collect and determine scientific evidence or data to answer questions. This is in line with Fasira et al. (2024), who state that in the data collecting stage, students try to find data and seek the truth in the form of facts from observations, investigations, and reading materials so that students are trained to express opinions accompanied by supporting facts. In the evidence component, the Miro platform does not have a significant influence because Miro does not provide data, facts, or scientific information that can be used as evidence, but only facilitates the presentation of evidence.

The RICOSRE class assisted by Miro obtained the highest mean reasoning score among other classes because the Miro platform in the RICOSRE model functions to help students visualize their thinking processes. This visualization can develop scientific arguments because it allows students to see the relationship between claims and evidence, making it easier to explain their reasoning. This is in line with the statement by Evagorou et al. (2015), who explain that student engagement in the visualization process can enhance their ability to construct scientific knowledge, including comparing, describing, verifying, and understanding the relationships between various data.

The RICOSRE model has a syntax that can evaluate the truth of the data or information obtained, thereby explaining why the data or information supports the opinion of the problem-solving solution. This is consistent with the statement by (Badriah et al., 2024) that during the constructing the solution stage, students are encouraged to develop critical information evaluation skills and use scientific theories and principles to build logical solutions. Meanwhile, in the discovery learning model, there is no syntax that can connect the data or information obtained with the claim or opinion of a concept, but only concludes the information without explaining the reasons scientifically through the generalization syntax. Based on the statement by McNeill et al. (2006), concluding by repeating evidence without scientific principles makes reasoning less strong.

The increase in scores on the claim component in all classes is related to the characteristics of the material taught, namely about contextual ecosystems. Ecosystem material contains socialscientific issues such as deforestation, habitat loss, and other contextual issues that are closely related to everyday life. Based on the statement by Christenson et al. (2017) that the socioscientific issues approach can develop students' critical thinking and science literacy skills so that they can debate with socioscientific arguments. Ecosystem material requires students to analyze various phenomena such as the interdependence of biotic and abiotic components and natural and human factors on ecosystem balance. These phenomena require students to convey their claims or opinions. Additionally, the improvement in reasoning scores across all classes is closely linked to students' ability to connect scientific data or evidence with their claims or opinions through the application of scientific principles in ecosystems, such as the interactions between biotic and abiotic components, to explain a phenomenon or problem.

4. Conclusion

Based on the findings of the research conducted, it can be concluded that the RICOSRE learning model assisted by miro has an effect on students' scientific argumentation skills in the ecosystem subject in grade 10th at a senior high school in Tasikmalaya, Indonesia, thus serving as an alternative option for teachers in selecting learning models and methods. Statistical tests indicate that the RICOSRE learning model assisted by miro has the best effect in improving students' scientific argumentation skills compared to the RICOSRE learning model without miro assistance and classes using discovery learning. Further research is recommended to consider integrating the Miro platform into other learning models, such as Problem-Based Learning, Project-Based Learning, Discovery Learning, and others. Additionally, the Miro-assisted RICOSRE learning model can be tested to enhance essential skills required for the present and future, such as critical thinking, creative thinking, analytical thinking, and others.

Consent:

All authors declare that ‘written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

Ethical approval:

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

Disclaimer (artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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