RESEARCH ARTICLE

The application of blended learning with rADI model to improve argumentation skills and concept mastery

Dea Yuliyanti[a,1], Widi Purwianingsih[a,2,*], P. Peristiwati[a,3]

[a] Study Program of Biology Education, Faculty of Mathematic and Science Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229 Bandung, West Java 40154, Indonesia

[1]yuliyantidea07@upi.edu; [2]*widipurwianingsih@upi.edu; [3]peristiwatidj@upi.edu

Abstract: Post-pandemic policies encourage teachers and students to carry out learning in offline, where they used to go online before. One learning strategy that can be applied in this condition is blended learning, which combines the advantages of offline and online learning. In improving the quality of learning outcomes and developing students' 21st-century skills, especially argumentation skills, blended learning strategies can be combined with inquiry-based learning models, one of which is the revised Argument-Driven Inquiry (rADI). This study aims to obtain an analysis of data related to the application of blended learning with rADI model in improving students' argumentation skills and concept mastery in Monera materials, especially regarding Bacteria. The research method used in this study was pre-experimental with a one-group pretest-posttest design. This research was conducted on students of class X MIPA at a high school in Bandung which consisted of 26 students. The data were obtained from the pre-test and post-test results of argumentation skills and concept mastery, and questionnaires on students' responses to learning. The results showed an increase in students' argumentation skills with an N-Gain score of 0.81 and students' concept mastery with an N-Gain score of 0.78 after applying blended learning with rADI model. The increase in argumentation skills and concept mastery was significant with N-Gain scores included in the high category. In addition, students' response data showed a good response to the application of blended learning with rADI model.

Keywords: argumentation skills; blended learning; concept mastery; rADI model

***For correspondence:**
widipurwianingsih@upi.edu

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Introduction

The latest post-pandemic policies COVID-19, encourage learning to be carried out again offline starting from the 2022/2023 school year. Despite the many challenges that have been faced by teachers and students when Distance Learning and Limited Face-to-Face Learning, made them accustomed to using technology and carrying out online learning. This allows the sustainability of online strategies to be combined with current offline learning through blended learning for a long period. The results of research conducted by Hasan (2022) regarding the application of blended learning after the COVID-19 pandemic, shows that blended learning can be the best solution to improve learning outcomes and shape the character of elementary school students. The application of blended learning can improve digital literacy competence which is one of the demands of 21st-century skills (Puspitarini, 2022). Furthermore, research conducted by Febriansyah (2022) shows that the application of blended learning with Problem Based Learning (PBL) model is proven to be able to improve the problem-solving skills and creative thinking of class X students in Environmental material. This shows that the rapid development of technology can be applied in the world of education through blended learning which is a strategy, means, and alternative to improve students' learning outcomes and 21st-century skills (Hadiyanto et al., 2021).

Argumentation skills are one of the skills needed by 21st-century students because conveying arguments is an important part of the thinking process (Astira et al., 2019) and a form of communication (Ekanara et al., 2018). The scientific argumentation component consists of claims, warrants, evidence, counter-arguments, and supporting arguments (Lin & Mintzes, 2010). Students'

skills in conveying scientific arguments during learning are considered very low because these skills are not trained enough (Sari, 2018). Further, research results by Astira et al. (2019) show that the argumentation skills of high school students when studying Biology are still dominated by just giving claims and reasons, while students are still lacking in providing evidence and refutations. One learning model that can facilitate students to practice argumentation skills is the revised Argument-Driven Inquiry (rADI) model (Songsil et al., 2019) which is a development of the Argument-Driven Inquiry (ADI) model.

In conveying scientific arguments, students must be able to understand and master concepts related to an issue or problem raised so that the argument is based on the correct concept (Divena et al., 2021). Damhuri et al. (2014) stated that students' low mastery of concepts was due to the dominant role of the teacher in learning, which resulted in a lack of independence and activeness in students. Therefore, a student-centered learning process is needed so that students can independently construct concepts through critical and analytical thinking processes, namely inquiry-based learning (Lahadisi, 2014). One of the inquiry learning processes is implemented through the rADI model which has proven effective in increasing students' mastery of concepts (Febrina, 2021).

The rADI model emphasizes the topic of Socioscientific Issues (SSI) when learning. SSI is a controversial issue or problem that occurs in social life and related to science. Topics regarding SSI in learning require students to be actively involved in dialogue, discussion, or debate (Zeidler et al., 2009). Submission of arguments about SSI makes students more interested in science because science becomes more relevant to life (Herlanti et al., 2012).

One of the materials that can be related to the topic of SSI is Monera material, specifically bacteria (Herlanti et al., 2012). The use of this material is due to the role of bacteria in life, providing real issues or impacts on health or the environment, which means that bacteria are always around and students need to be aware of their existence. Maisari & Pranoto (2021) revealed that the factors that caused students' difficulties in learning Monera included students who were not interested in learning Monera due to inadequate learning media and teachers who were unable to connect the material being taught with everyday life. This is the reason that the use of SSI topics that contain real-life issues is an appropriate alternative for teaching the Monera concept to make it more contextual, applicable, and interesting.

Reviewing the transition from online to offline learning where students were already accustomed to using technology during previous online learning, blended learning is a suitable strategy to be applied in the current situation. This can be a combination that produces advantages. Based on the problems experienced by students due to low argumentation skills and mastery of concepts, caused by irrelevant learning methods or strategies accompanied by a lack of linking concepts to real life, a learning model is needed that can facilitate students in overcoming these problems. The appropriate learning model is the rADI model which emphasizes argumentation skills and construction of concepts related to life. This is a way to improve students' 21st-century skills through student-centered learning.

Therefore, the researcher intends to identify the application of a blended learning strategy combined with the rADI model in improving students' argumentation skills and concept mastery in Monera. Researchers also identified student responses to learning.

Method

The method used in this study was a pre-experimental method with a one-group pre-test post-test research design involving only one experimental class without a control class. This research was conducted at a high school in Bandung City involving 26 students from class X MIPA. The sampling technique was carried out by purposive sampling in which to select groups of students who had readiness and facilities that could support the implementation of blended learning.

In the learning process, blended learning with rADI model were applied, namely learning by combining offline and online strategies in the steps of the rADI model: 1) Engagement: determine students' prior knowledge (offline and online); 2) Inquiry-based learning activities: data and research activities in group (online); 3) Scientific explanation: free exchange of scientific explanation (offline); 4) Expanding the concept using a new topic (online); 5) Data/research activities in group 2 (online); 6) Make tentative claims about SSI as a group (online); 7) Engaging in argumentation in a class (offline); 8) The creation of a written investigation report by groups of students (online); Engaging in peer review and revising group reports (offline and online).

The data obtained in this study are quantitative through test and non-test instruments. The test instrument consists of pre-test and post-test questions on argumentation skills and mastery of concepts in Monera material. The pre-test and post-test questions for argumentation skills use description questions which consist of 4 questions (open-ended questions) with argumentation component based on Lin & Mintzes (2010) (Table 1). Furthermore, the pre-test and post-test questions for mastery of the concept use 10 description questions consisting of cognitive levels C2 to C5. While the non-test instrument uses a questionnaire on student responses to learning.

Table 1. Indicator of Argumentation Skills

Argumentation Component	Indicator
Claim	Make pro or con claim against the SSI being discussed
Warrant	Provide reasons to support the claim
Evidence	Provide credible scientific data or evidence to support claim
Counter-Argument	Provide conflicting claim with valid reasons
Supportive Argument	Refute counter-argument with valid reasons

The results of the pre-test and post-test of argumentation skills are given a score in advance according to the argumentation rubric by Songsil et al. (2019). The category of argumentation skills based on scores obtained by students refers to Songsil et al. (2019) (Table 2).

Table 2. Category of Argumentation Skills

Score per-component argumentation	The overall score range of the argumentation component	Category
4	13-16	Excellent
3	9-12	Good
2	5-8	Fair
1	1-4	Improve

The results of the pre-test and post-test of students' concept mastery are given a score first which is then converted into a value Formula 1.

$$\frac{\text{score obtained}}{\text{maximal score}} \text{ x } 100 \quad (1)$$

The pre-test and post-test scores of students' concept mastery were averaged, then grouped into the following cognitive level categories by Arikunto (2009) (Table 3).

Table 3. Cognitive Level Categories

Value Range	Category
81-100	Very High
61-80	High
41-60	Fair
21-40	Low
0-20	Very low

Data on the results of the pre-test and post-test of students' argumentation skills and concept mastery were analyzed using SPSS version 25. Based on the normality test, the data obtained were not normally distributed, so it was continued with the Wilcoxon nonparametric test. Then, an analysis was carried out with the N-Gain test which aims to see how much the effectiveness of the blended learning with rADI model application using calculation with the Formula 2 and then categorized by Hake, (1999) (Table 4).

$$\text{N} - \text{Gain} = \frac{\text{post test score} - \text{pre test score}}{\text{ideal score} - \text{pre test score}} \quad (2)$$

Table 4. N-Gain Score Criteria and Interpretation

N-Gain	Interpretation
g ≥ 0.7	High
0.7 > g > 0.3	Medium
g < 0.3	Low

Student response questionnaires in this study were assessed based on the Likert Scale consisting of strongly agree, agree, disagree, and strongly disagree by Divena et al., (2021) (Table 5). The statements given amounted to 15 items regarding the learning carried out. The questionnaire used in this study was processed by calculating the scores obtained by students for each statement item in the questionnaire.

The results of the student response questionnaire to the blended learning with rADI model were analyzed using calculation with the Formula 3 and then categorized by Sugiyono, (2007) (Table 6).

$$\frac{\text{score obtained}}{\text{maximal score}} \text{ x } 100\% \quad (3)$$

Table 5. Score of Statements on Students Response Questionnaire

Response	Score	
	Positive	Negative
Strongly Agree	4	1
Agree	3	2
Disagree	2	3
Strongly Disagree	1	4

Table 6. Questionnaire Percentage Categories

Percentage	Category
81%-100%	Very Good
61%-80%	Good
41%-60%	Fair
21%-40%	Poor
0%-20%	Very Poor

Results and Discussion

Average of Students' Argumentation Skills

Data on average of students' argumentation skills were obtained from the pre-test and post-test before and after applying the blended learning with rADI model that shown in Figure 1 and Figure 2 . The topic used to measure students' argumentation skills during the pre-test and post-test was the SSI topic related to "Use of river water contaminated with *Escherichia coli* by the poor society for their daily needs".

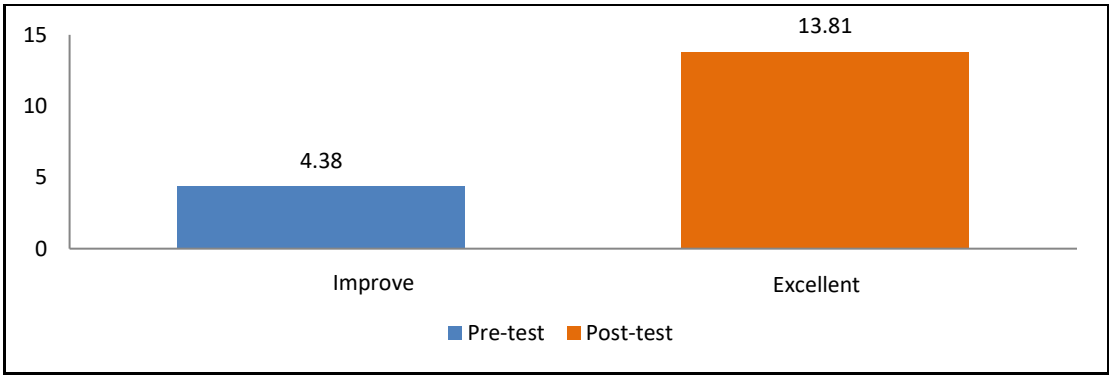

Figure 1. Average Scores of Students' Argumentation Skills

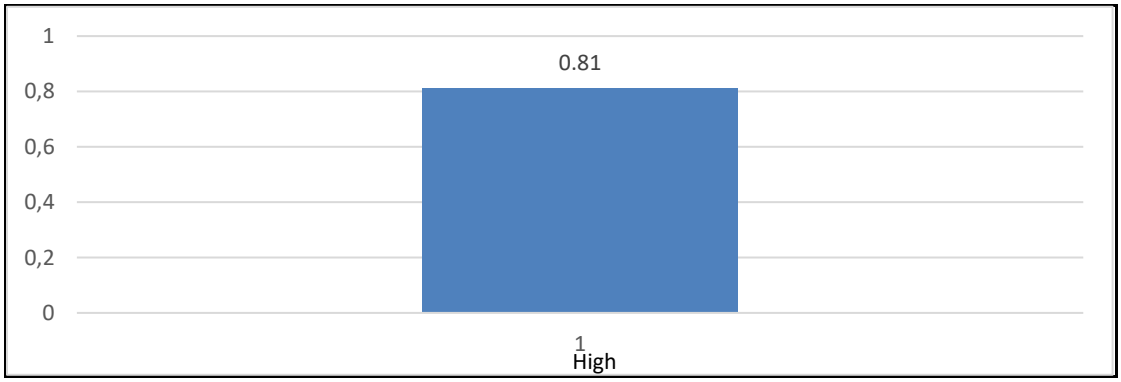

Figure 2. N-Gain Score of Students' Argumentation Skills

Based on Figure 1, the results show that the average post-test scores of students' argumentation skills have increased compared to the pre-test scores. For the pre-test argumentation skills, an average score of 4.38 was obtained which was included in the improve category, while the post-test obtained an average value of 13.81 which was included in the excellent category. Based on Figure 2, this increase in average value is significant as evidenced by the acquisition of an N-Gain score of 0.81 which is included in the high category.

This increase occurred due to the application of the rADI model in learning which facilitated students in practicing argumentation skills. This is because of the rADI syntax, especially the activity steps for collecting data (inquiry-based learning activities: data and research activities in the group) and the steps for making tentative arguments which encourage students to improve their argumentation skills. These results are in line with the research of Songsil et al. (2019) which showed that the application of the rADI model was effective in improving students' argumentation skills compared to the application of the inquiry method and ordinary discussion.

In the RADI model, two exercises are carried out in compiling arguments with two different SSI topics, so that students' argumentation skills can be trained and increased (Songsil et al., 2019). Based on the progress of students' argumentation skills, during the pre-test, students' argumentation skills were in the improve category. Then, when working on Task 1, students' argumentation skills increased which were in the good category, followed by working on Task 2 with argumentation skills that continued to increase, namely in the excellent category. This category is maintained during the post-test where students get an excellent category.

In addition, the application of a blended learning strategy makes it easier for students to participate in learning more effectively so that students' argumentation skills can increase. This is supported by Hadiyanto et al. (2021) research which shows that the application of blended learning can improve students' 21st-century skills compared to conventional methods, where argumentation skills are part of 21st-century skills because they involve thinking processes (Astira et al., 2019) and communication (Ekanara et al., 2018). The learning process is supported by combining offline learning in class with online through Google Meet, Google Classroom, and WhatsApp Group.The existence of collaboration that is packaged through communication devices, such as forums, chatrooms, or discussions can improve the construction of students' knowledge and skills through social interaction with other students (Charman, 2005 in Nasution et al., 2019).

The application of the blended learning with rADI model encourages students to be actively involved in learning, both in discussions online to create arguments or by debating offline in class. The discussion method can foster student motivation by involving them directly in learning. This method can improve scientific attitudes, thought processes, and student learning outcomes (Ermi, 2015). Furthermore, the application of the debate method gives students motivation in learning to defend or win their arguments and increase their knowledge (Freeley & Steinburg, 2004). Thus, the combination blended learning with rADI model applied has an impact on increasing the average score of students' argumentation skills.

Students' Argumentation Skills in Each Argumentation Component

Analysis of students' argumentation skills for each component was also carried out to find out whether the student argumentation category for each component was good or lacking before and after the blended learning with rADI model were implemented. The following Table 7 is the distribution of the average pre-test and post-test scores of students as well as the N-Gain score for each argumentation component.

Table 7. Average Score of Students' Pre-test and Post-test for each Argumentation Component

Component	Average value				N-Gain	Category
	Pre-test	Category	Post-test	Category		
Claim & Warrant	1.77	Fair	3.46	Excellent	0.76	High
Evidence	1.08	Improve	3.85	Excellent	0.82	High
Counter Argument	0.88	Improve	3.31	Good	0.78	High
Supportive Argument	0.65	Improve	3.19	Good	0.76	High

Based on Table 7, it can be seen that the pre-test scores for each argumentation component which were initially in the improve and fair categories have increased to become good and excellent categories. The N-Gain scores for each argumentation component are all in the high category with the highest N-Gain value for the evidence component, which is 0.82. More details can be seen in Figure 3 and Figure 4.

Based on Figure 3, components evidence occupies the highest average score for the post-test results. This component experienced a significant increase from the pre-test results. This is due to the existence of inquiry-based learning steps: data and research activities in groups which can facilitate students in gathering evidence or argumentation data. At this step, students are directed to compile good evidence supported by learning resources or support. The existence of performance support materials provided in Google Classroom and self-paced learning in blended learning can support the learning process that supports student competence in mastering a content or material (Charman, 2005 in Nasution et al., 2019; Suprabhan & Subramonian, 2015). Besides that, this increase was also influenced by the application of inquiry-based learning in the rADI model. Inquiry-based learning can encourage students to learn independently or be student-centered by investigating a problem that can train students' skills (Riyanti, 2022).

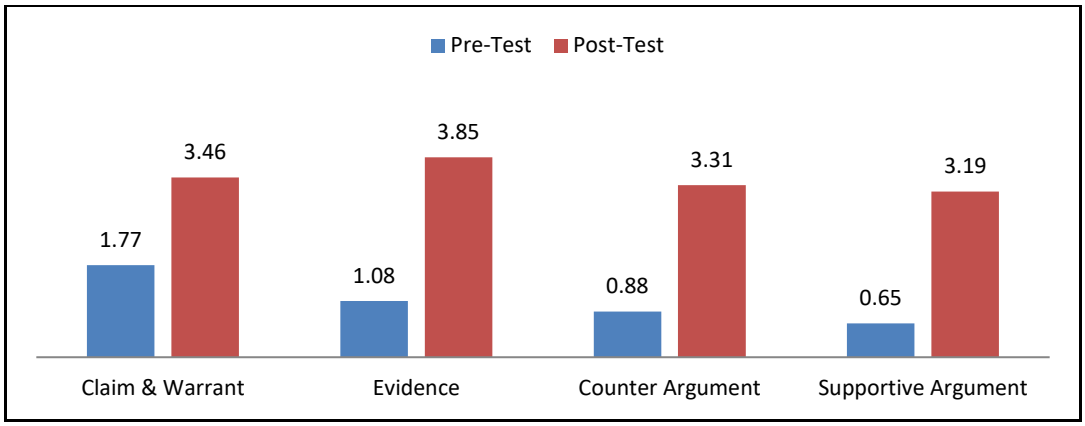

Figure 3. Average Scores of Pre-test and Post-test for each Argumentation Component

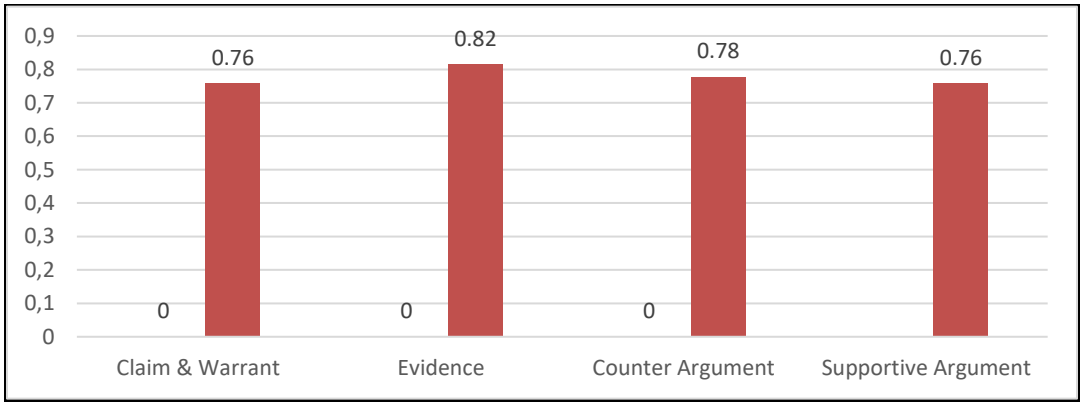

Figure 4. N-Gain Scores for each Argumentation Component

While the further, counter-argument and supportive argument has the lowest average score on both the pre-test and post-test. This is because the preparation of arguments in the parts encourages students to think in two directions. After all, students in this process are encouraged to make arguments that contradict the previous arguments, resulting in a new cognitive load. Making counter-arguments and supportive arguments is a more difficult process than other argumentation components and certainly requires high-level thinking skills for most students, including students who excel (Lin & Mintzes, 2010; Febrina, 2021). A study by Songsil et al. (2019) also showed that most of the students were able to develop their argumentation skills, but the supportive argument component was the lowest argumentation component that was difficult for students to make.

The N-Gain scores for each argumentation component can be seen in Figure 4 which shows how effective the application of the rADI blended learning model is in increasing students' argumentation skills. Based on Figure 4, all argumentation components consisting of claims, warrants, evidence, counter-arguments and supportive arguments obtain an N-Gain score which is included in the high category. The evidence component obtained the highest N-Gain score of 0.82, followed by the counter-argument component with an N-Gain score of 0.78. Furthermore, the claim & warrant, and supportive argument components obtained the same N-Gain score of 0.76.

This finding is different from the N-Gain category obtained by Febrina (2021) regarding the application of the rADI model with an online learning strategy which obtained an N-Gain score in a low category on

the counter-argument and supportive argument components. This is because learning through online learning is carried out without direct face-to-face meetings between the teacher and students which makes students less active and less monitored during engaging argumentation in class sessions. Meanwhile, through blended learning, there are sessions for presenting arguments using the offline debate method which can make it easier to correct students on which components of the argumentation are inaccurate and need to be improved. In addition, direct interaction with teachers and other students makes students as a whole more active, so that learning of this step of the rADI model becomes more intense compared to online.

The application of blended learning makes student learning more monitored because it involves face-to-face meetings (live events) (Charman, 2005 in Nasution et al., 2019). The N-Gain score in this high category was obtained because students were encouraged to be more active and independent when learning. According to Hasibuan (2006) in Nasution et al. (2019), the application of blended learning makes students become active learners, able to construct knowledge subjectively, dynamically and develop, and can process and understand information more quickly. Thus, this shows that the blended learning rADI model is more effective than the online learning rADI model in improving students' argumentation skills, especially in training counter-arguments and supportive arguments which are considered more difficult than other argumentation components.

Students' Concept Mastery

Students' concept mastery data was obtained from pre-test and post-test results before and after applying the blended learning with rADI model that shown in Figure 5 and Figure 6. The concepts asked to students refer to KD 3.5 of the Revision 2013 Curriculum. The concepts of Monera material related to structure, way of life, reproduction, and the role of bacteria in life.

In Figure 5 it is clear that the increase in students' concept mastery scores before and after the implementation of the blended learning with rADI model. The average post-test score of students' concept mastery has increased compared to the pre-test scores. For the pre-test concept mastery, an average score of 24.27 was obtained which was included in the low category, while the post-test obtained an average value of 83.65 which was included in the very high category. This increase in average value is significant as evidenced by the acquisition of an N-Gain score of 0.78 which is included in the high category based on Figure 6. This increase is due to the inquiry steps in the rADI model which encourage students to explore or construct concepts independently. Similar to the ADI model which applies inquiry-based learning, this model provides opportunities for students to actively build their concepts (Riyanti, 2022). Divena et al. (2021) show that the application of the ADI model can improve students' concept mastery in Reproductive System. Furthermore, research by Febrina (2021) also shows that the application of the rADI model can improve students' mastery of concepts in Environmental. Thus, the inquiry-based learning model can encourage students to improve their concept mastery.

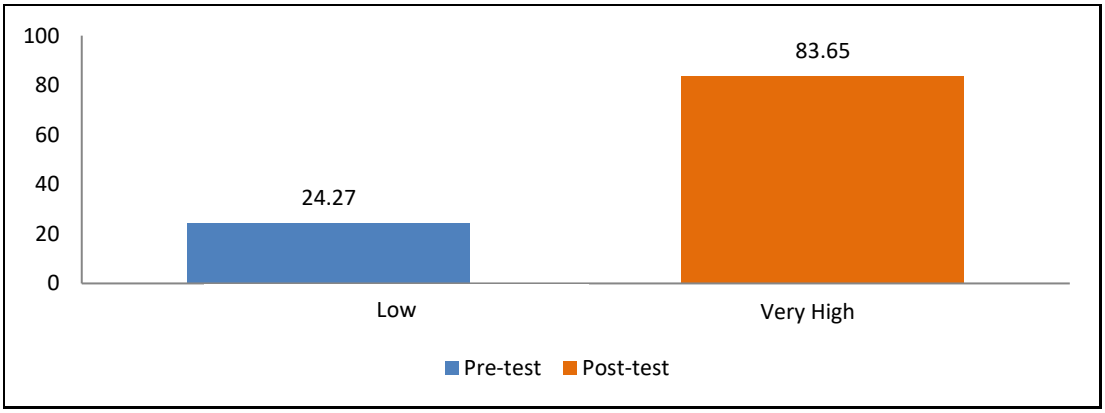

Figure 5. Average Scores of Students' Concept Mastery

The increase in students' concept mastery also occurred because of the blended learning strategy applied. Blended learning encourages students to learn actively independently, especially in constructing the concepts they want to master. This is in line with the research conducted by Fatkhulloh & Haryanto (2020) which shows that blended learning can replace face-to-face learning and affect students' cognitive achievement. Wijiastuti & Nurhayati (2021) also shows that blended learning is effective for increasing students' understanding of concepts and motivation during learning. That's because blended learning stimulates students to increase their learning activities and efforts to explore and elaborate on all the information they need (Hew & Cheung, 2014). In addition, there is freedom

and flexibility for students to build concepts independently, thus giving them satisfaction when learning (Al Zumor et al., 2013).

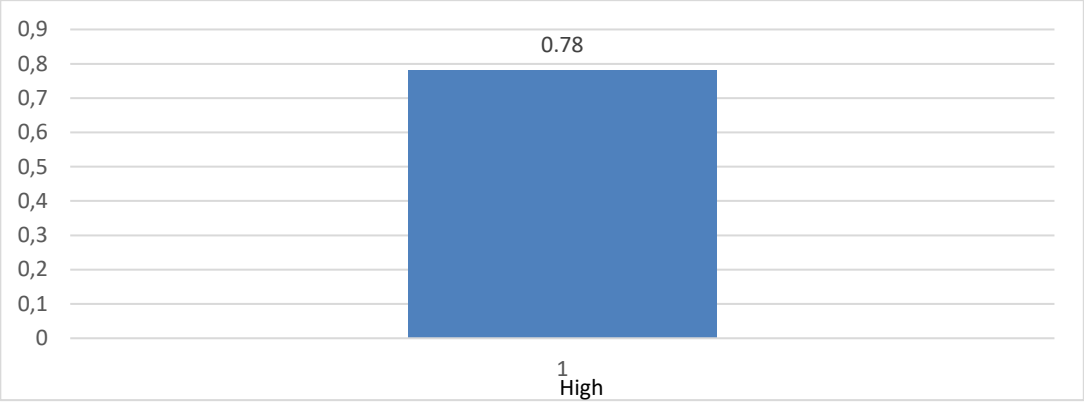

Figure 6. N-Gain Score of Students' Concept Mastery

According to Jonassen & Kim (2010), argumentation skills are students' skills in re-expressing learning material complete with evidence which in the end can conclude. In this case, the disclosure of the material is a concept that is presented in the student's argument. For example, on the SSI topic of pre-test and post-test arguments regarding the use of river water contaminated with *E.coli* by the poor society, students make arguments by expressing the concept of bacteria related to the way of life, structure, and the role of *E.coli* bacteria. Then, in Task 1 regarding biological weapons (bacteria) vs nuclear weapons, students make arguments by revealing concepts related to reproduction, resistance, genetic manipulation, and the role of bacteria. Furthermore, in Task 2 regarding the use of earthworm extract as an alternative treatment for typhoid fever, students made arguments by expressing the concept of bacteria related to the structure, resistance, and role of *Salmonella typhi*. These concepts are properly integrated into a single argument. However, before integrating these concepts, students need to understand the basic concepts of each concept contained in their arguments.

Concept mastery is a cognitive ability that is an important attribute related to the performance of their arguments (Lin & Mintzes, 2010). The increase in argumentation skills was also followed by an increase in concept mastery. This finding is in line with the research of Febrina (2021) which shows that there is a significant relationship between argumentation skills and mastery of student concepts through the application of the online learning with rADI model, which means that when students' argumentation skills increase, students' concept mastery also increases.

The existence of steps for making tentative arguments and inquiries of research and data in the rADI model encourages students in addition to developing arguments, students also develop concepts that compose their arguments, so that these arguments are based on the right concepts. At this step, students are given space to stimulate thinking skills, so that when students have problems making arguments, students concepts mastery is also emphasized (Divena et al., 2021). Llewellyn (2013) states that inquiry learning to increase argumentation can encourage students' understanding of concepts. Research conducted by Cross et al. (2008) also showed that argumentation has an impact on contextual mastery, supporting students to find new ideas to expand their knowledge and correct misconceptions.

Students' Response to Learning

Students' response data were obtained from a questionnaire given to students after learning was completed. The results of this questionnaire help researchers to find out student responses to the process of learning Monera material using the blended learning with rADI model. The responses asked the students related to the implementation of the steps (syntax) of the blended learning with rADI model. The results showed as many as 81% of students rated the application of this learning with good student responses and as many as 19% of students rated the application of this learning with very good responses. The results of this response can be proof of the successful implementation of learning and the high enthusiasm of students in following every step of the blended learning with rADI model in the Monera material, observing that there is no student response in the fair, poor, or very poor categories.

Conclusion

Based on the findings and discussion that has been presented, it is concluded that the application of the blended learning with rADI model in Monera material can improve students' argumentation skills with an N-Gain score of 0.81 and students' concept mastery with an N-gain score of 0.78 where both in the high category. Student response data also showed a good response to the application of the blended learning with rADI model.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

D. Yuliyanti: methodology, analysis, and writing original draft preparation. W. Purwianingsih: methodology, analysis, writing original draft preparation, and revision. **P. Peristiwati:** review and editing.

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