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Improvement of student's argumentation skill through problem-based learning in the concept of nervous and endocrine system disorders

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ABSTRACT

21st-century education directs learners to develop the skills of argumentation. Argumentation skills are the intellectual abilities involved in solving problems, making judgments and decisions, and formulating ideas and beliefs. The purpose of this research was to improve students' argumentation skills through the implementation of the Problem-based learning model in the concept of nervous and endocrine system disorders. This study was Collaborative Classroom Action Research with two learning cycles in the concept of Nervous and Endocrine System disorders. This study reveals students' argumentation skills adapted from Dawson & Venville (2009). The results of this research revealed that the level of students' argumentation skills in cycle I was only up to levels 1 and 2. As much as 59% of students were at level 2 argumentation skills and 41% of students were at level 1 argumentation skills. In cycle II, there are students with level 3 argumentation skills. The rest scattered on levels 1 (3% of students) and 2 (35% of students) argumentation skills. Through this research, we found that students' argumentation skills increased from cycle I to cycle II.



INTRODUCTION

Today's education directs students to have 21st-century abilities, the expected abilities include critical thinking, creativity, collaboration, and communication. Argumentation is at the heart of the success of a democratic society in the 21st century (Asterhan & Schwarz, 2016). Students will use argumentation skills in solving every problem they face (Ekanara et al., 2018). Research on argumentation has received attention in science education because constructing scientific arguments can help science learning and become an important scientific skill in learning (Kim et al., 2022) Thus, improving the quality of learning in the classroom is a way to achieve success so that students have 21st-century abilities, one of which is argumentation.

Teachers need to plan and provide learning resources that can facilitate students' mastery of argumentation skills. So, learning resources are needed that can connect knowledge and various new understandings with the realities of social life to fulfill students' conceptual knowledge (Erika & Prahani, 2017). This results in students being required to be able to prioritize their personal experiences through observation activities (listening, seeing, reading, and hearing), association, asking, concluding, and communicating (Zulainy et al., 2021).

After several meetings during learning in class XI MIPA 4 tends to be passive in the discussion or question-and-answer process in class. One indicator of student activity is actively providing arguments in the discussion process in class (Amin et al., 2021). In the group discussion process, it appears that students are discussing the division of tasks at the beginning to answer questions on the students' worksheets, and then each search for information according to the distribution. During this time, learning is also often carried out in lectures. This makes students feel bored in learning biology. After the teacher explained, usually learning is carried out in groups, but the content in the student worksheet has not been directed at conveying students' arguments.

Learning has not led to familiarizing argumentation skills, this could be because teachers are not ready enough to teach argumentation, so they need specific instructions about argumentation (Zhao et al., 2023). Several explanations regarding instructions for making arguments can be read in the literature described in research journals so that teachers can form basic instructions to help them develop argumentation skills and can be put into practice in the classroom (Palma-Jiménez et al., 2023).

The teacher's role is to guide students to be actively involved in learning that is fun and can develop their potential. However, unfortunately, learning in class is often not based on students' experiences and is only rote, resulting in low levels of students' understanding and reasoning (Defni et al., 2022). In fact, according to Suda & Laila (2015) the characteristics of biological material are in the form of objects of study in the form of concrete objects and can be captured by the five senses; developed based on empirical (real) experience; and have systematic steps.

The explanation of the problems above shows that the skills of presenting arguments in students in class XI MIPA 4 for the 2022/2023 academic year need to be developed. Argumentation plays an important role in critical thinking, argumentation abilities are important in learning Biology because they can improve thinking to test students' understanding (Pozos-Radillo et al., 2014). The advantages of empowering argumentation in science learning are increasing motivation in conducting investigations, developing critical thinking skills, improving conceptual understanding, and student learning outcomes (Faize et al., 2018). Scientific argumentation skills can be trained in various ways, such as implementing the learning process through learning models that can improve the way of thinking before explaining various phenomena that occur (Rahman, 2020). One learning model that can improve students' understanding of concepts is Problem-based learning (Pratiwi et al., 2019).

Problem-based learning does not only mean providing problems but is also related to providing opportunities for students to construct knowledge through interactive interaction and collaborative discovery. Problem-based learning provides an ideal educational environment in science learning, where students can solve authentic and unstructured problems through active

argumentation and creating evidence-based claims (Merritt et al., 2017). In problem-based learning, students are allowed to discover knowledge for themselves and interact with other students. Students are accustomed to being faced with a particular problem and then students have to create a solution to that problem so that critical thinking skills can also be trained in students.

Based on the explanation of problems in biology learning that students lack focus are passive in the learning process, and cannot argue well, this research was conducted to be able to solve problems for these students. So that students can improve students' argumentation skills through Problem-based learning. This model is deemed appropriate because the characteristics of the biological material that will be developed, namely regarding disruption of the coordination system, can be related to students' everyday problems. So, class XI MIPA 4 students can be directed to convey arguments when choosing the right solution to solve a problem.

METHODS

The research used is Collaborative Classroom Action Research, which is educational research (action research) carried out directly by researchers, describing data, facts, and phenomena that are taking place in the classroom. The research was conducted using the Kemmis & Taggart model in Arikunto (2010) which states that one cycle consists of four main steps, namely: (1) planning, (2) action, (3) observing, and (4) reflecting.

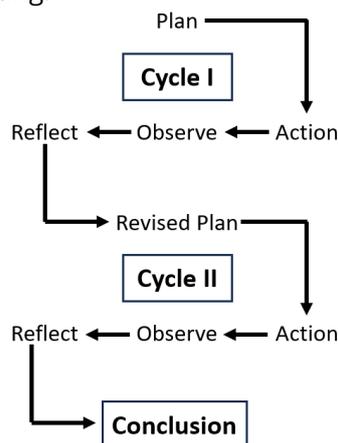


Figure 1. Kemmis & McTaggart action research model procedure

This research was conducted at SMAN 4 Bandung in class XI MIPA 4, with a total of 29 students. The research took place in two learning cycles by applying a learning model in the form of problem-based learning. Researchers chose the same topic (Coordination System material), but with different subtopics, the first cycle discussed the subtopic of nervous system disorders and the second cycle discussed the subtopic of hormonal system disorders. Practical steps teachers must take to optimize student empowerment so that changes occur for themselves and the class.

Cycle I: (1) Plan, the first stage is the researcher carries out curriculum analysis to select material, compile teaching modules, compile assessment instruments, and compile learning activity observation sheet instruments; (2) Action, the implementation of learning in the first cycle is carried out to determine students' argumentation abilities by applying the problem-based learning model, the implementation of learning also takes the form of delivering material, carrying out learning according to PBL syntax. Students work in groups and complete the Student Worksheet which contains five case study questions and one discourse question. At the end of learning, students do a posttest. (3) Observe, this stage is carried out by collaborating between supervisors, tutors, and colleagues, to see the condition of students when they are given lessons conducted by researchers. The results of this observation are used as material for the reflection

stage so that further action can be planned, whether action is needed in the next cycle or not. (4) Reflect, at this stage the researcher analyzes the results obtained from test results and student worksheets, observations, and the results of activities during the implementation of learning. If 60% of students can have written argumentation skills at least at Level 3, then no action is needed for the second cycle. However, if the target has not been achieved, it needs to be continued in the second cycle.

Cycle II: (1) Plan, learning in this second cycle is the result of reflection on learning in cycle 1. The second cycle is carried out to review the effectiveness of the first cycle's learning instruments, then improvements are made based on the results of data analysis from the first cycle, including in the form of learning design, tests, and teacher strategies in class in teaching and learning activities; (2) Action, Learnings' activities are carried out by implementing improvements to the teaching modules in this second cycle. In this second cycle, the researcher tried to guide in making good scientific arguments, then added groups by bringing together students who were less active in learning. (3) Observe, this stage is the same as in the first cycle, namely collaborating between supervisors, tutors, and colleagues, to see the condition of students when they are given lessons conducted by researchers. This observation was carried out to observe any changes from the improvements made by the teacher to improve learning in the previous cycle (4) Reflect, the same as the first cycle, at this stage the researcher analyzed the test results and Student Worksheet from learning in the previous cycle. If it is found that $\geq 60\%$ of students can have written argumentation skills at least at Level 3, then there will be an increase in students' argumentation skills.

Data collection was carried out using assessment instruments in the form of case study questions on the Student Worksheet, written tests in the form of post-tests, and student response questionnaire sheets. In the first cycle, 5 case study questions are provided on the Student Worksheet and 10 multiple choice questions are provided, the answers to which must be accompanied by reasons. On cycles secondly, there are 4 questions on the Student Worksheet and 5 essay questions on the posttest. Then, the results of this written test are analyzed using quantitative and qualitative analysis techniques. Quantitative analysis was carried out by recapitulating the percentage of students' argumentation ability levels.

$$\text{Percentage of argumentation ability level} = \frac{\text{Number of students at a certain level of argumetation}}{\text{the total number of students}} \times 100\%$$

The instruments used in this study were written argumentation assessment sheets and learner response questionnaire sheets. Qualitative analysis was carried out by analyzing the answers to the worksheets and posttest of students through the argumentation skill assessment instrument referring to Toulmin's Argument Pattern (TAP) adapted from (Dawson & Venville, 2009) shown in Table 1.

Table 1 Level of argumentation ability criteria using TAP

Argumentation ability	Description
Level 1	Argumentation only contains <i>Claims</i>
Level 2	Argumentation contains a <i>Claim</i> with <i>Data</i> , <i>Warrant</i> , or <i>Backing</i> . No <i>rebuttal</i>
Level 3	Arguments contain <i>Claims</i> , <i>Data</i> , <i>Warrants</i> , and <i>Backing</i> or <i>Qualifiers</i> . Sometimes there is a weak <i>rebuttal</i> .
Level 4	Argumentation contains all components of argumentation (including <i>Rebuttal</i>)
Level 5	Wider arguments accompanied by some <i>Rebuttal</i>

(Dawson & Venville, 2009)

RESULTS AND DISCUSSION

Students' argumentation ability in cycles I

Argumentation abilities in this research were measured through students' posttest results. The posttest is carried out at the end of the learning activity. The posttest is carried out via the g-form application. There are 4 questions, in open essay form. Students must express the argument based on the answer to the question. The following are the results obtained in Figure 2.

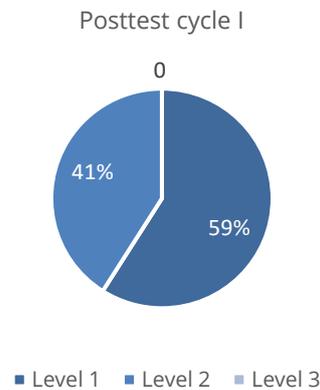


Figure 2. Posttest results of students in learning cycle I

Based on the results of the posttest in the first cycle, it was found that 41% were able to convey their arguments in writing at level 1 (there was a claim). Then as many as 52% already have argumentation skills at level 2 (there is a Claim accompanied by a Warrant or Backing). At the first cycle meeting, no students were found who had argumentation skills at level 3 (there are Claims, Warrants, and Backings, which can be accompanied by weak arguments).

Based on the results of reflection with observers, in the first cycle learning was quite conducive. Students participate in learning well, but during class discussions, they are still passive. Only three students dared to present the results of their work in class discussions. In group discussions, students still divide tasks to find information on answers to questions. Not fully discussing between students to answer questions.

After getting information to answer questions on the Student Worksheet, students do not explain the information they get to their friends. There are still thoughts among students to simply complete and complete the Students Worksheet assigned by the teacher. This allows students to only get certain pieces of knowledge information. In fact, in conveying scientific arguments, knowledge is needed to show supporting evidence for the claims made by learners. Argumentation is a complex reasoning process used in various situations that require content knowledge to construct and/or criticize proposed relationships between claims and evidence (Asterhan & Schwarz, 2016).

Judging from the results of this post-test, it shows that, even with incomplete knowledge, students already can convey arguments. It appears that students can make claims and warrants on the post-test. However, the argument has not been developed further. The difficulty in developing students' arguments is because students are not used to arguing scientifically. In line with the opinion of Nurmalasari & Ariyanti (2021) who stated that the difficulties experienced by students in arguing were because they were not used to arguing, and previous learning did not allow them to express their opinions.

Then, if you look at the results of filling in the Student Worksheet, it shows that all groups of students can write claims in their arguments. In learning, it appears that students have been able to complete the claim with the warrant argumentation component, shown in the excerpt from the Students Worksheet completed by the students in Figure 3.

1. Pada sebuah berita, terdapat seorang artis didiagnosa menderita Meningitis, dengan gejala demam, terkadang kejang-kejang, kaku pada leher. Menurut ahli biologi X, artis tersebut mengalami infeksi pada bagian otaknya terutama di bagian otak depannya karena jamur, kemudian Meningitis tidak berbahaya itu. Ahli Biologi Y menyanggah pendapat tersebut, ia menjelaskan bahwa Meningitis adalah penyakit akibat virus dan bakteri yang berbahaya karena menyerang selaput otak. Berikan pendapatmu terkait permasalahan perbedaan pendapat di atas. (berikan bukti yang relevan pada pendapatmu)

(a)

1. Pada sebuah berita, terdapat seorang artis didiagnosa menderita Meningitis, dengan gejala demam, terkadang kejang-kejang, kaku pada leher. Menurut ahli biologi X, artis tersebut mengalami infeksi pada bagian otaknya terutama di bagian otak depannya karena jamur, kemudian Meningitis tidak berbahaya itu. Ahli Biologi Y menyanggah pendapat tersebut, ia menjelaskan bahwa Meningitis adalah penyakit akibat virus dan bakteri yang berbahaya karena menyerang selaput otak. Berikan pendapatmu terkait permasalahan perbedaan pendapat di atas. (berikan bukti yang relevan pada pendapatmu)

(b)

1. Pada sebuah berita, terdapat seorang artis didiagnosa menderita Meningitis, dengan gejala demam, terkadang kejang-kejang, kaku pada leher. Menurut ahli biologi X, artis tersebut mengalami infeksi pada bagian otaknya terutama di bagian otak depannya karena jamur, kemudian Meningitis tidak berbahaya itu. Ahli Biologi Y menyanggah pendapat tersebut, ia menjelaskan bahwa Meningitis adalah penyakit akibat virus dan bakteri yang berbahaya karena menyerang selaput otak. Berikan pendapatmu terkait permasalahan perbedaan pendapat di atas. (berikan bukti yang relevan pada pendapatmu)

(c)

1. Pada sebuah berita, terdapat seorang artis didiagnosa menderita Meningitis, dengan gejala demam, terkadang kejang-kejang, kaku pada leher. Menurut ahli biologi X, artis tersebut mengalami infeksi pada bagian otaknya terutama di bagian otak depannya karena jamur, kemudian Meningitis tidak berbahaya itu. Ahli Biologi Y menyanggah pendapat tersebut, ia menjelaskan bahwa Meningitis adalah penyakit akibat virus dan bakteri yang berbahaya karena menyerang selaput otak. Berikan pendapatmu terkait permasalahan perbedaan pendapat di atas. (berikan bukti yang relevan pada pendapatmu)

(d)

1. Pada sebuah berita, terdapat seorang artis didiagnosa menderita Meningitis, dengan gejala demam, terkadang kejang-kejang, kaku pada leher. Menurut ahli biologi X, artis tersebut mengalami infeksi pada bagian otaknya terutama di bagian otak depannya karena jamur, kemudian Meningitis tidak berbahaya itu. Ahli Biologi Y menyanggah pendapat tersebut, ia menjelaskan bahwa Meningitis adalah penyakit akibat virus dan bakteri yang berbahaya karena menyerang selaput otak. Berikan pendapatmu terkait permasalahan perbedaan pendapat di atas. (berikan bukti yang relevan pada pendapatmu)

(e)

1. Pada sebuah berita, terdapat seorang artis didiagnosa menderita Meningitis, dengan gejala demam, terkadang kejang-kejang, kaku pada leher. Menurut ahli biologi X, artis tersebut mengalami infeksi pada bagian otaknya terutama di bagian otak depannya karena jamur, kemudian Meningitis tidak berbahaya itu. Ahli Biologi Y menyanggah pendapat tersebut, ia menjelaskan bahwa Meningitis adalah penyakit akibat virus dan bakteri yang berbahaya karena menyerang selaput otak. Berikan pendapatmu terkait permasalahan perbedaan pendapat di atas. (berikan bukti yang relevan pada pendapatmu)

(f)

Notes: Claim Warrant

Figure 3. Results of student worksheet answer in cycle I

Based on the footage of the Student Worksheet work in Figure 3 (a) – (e), the five groups were able to express their claims in their arguments. Then accompanied by a Warrant, from the picture it appears that there are groups that provide simple and long Warrants. If we read again the suitability of the problem provided in the question, it turns out that the Warrants in the four groups are considered conceptually appropriate to support the claims presented. However, in one group, Figure 3 (e), the Warrant given did not match the problem asked for in the question.

Figure 3 (f) shows that students have not shown a claim regarding the available problems. Students only show information about the problem provided in the question. The results of this Student Worksheet support the post-test results which state the distribution of students' argumentation abilities at level 1 because, in the learning process, students can convey claims.

Students' argumentation ability in cycles II

In the second cycle, learning is carried out to improve the first cycle. The improvements made were to form an active class, and the researcher tried to change the group of students. Researchers grouped passive students in the same group. The hope is that in groups, students can have the responsibility to answer questions, conduct discussions, and have the courage to express opinions in group/class discussions. To motivate students, teachers give *rewards* to students who dare to express their arguments with star ratings. This assessment will be included to add value to the skill. Next, researchers guide students to be able to make good and correct scientific arguments. The teacher instructs students to be able to search for information on the material discussed from various sources. So that it becomes their provision in conveying arguments. According to Lin & Mintzes (2017) teachers can guide students to understand many perspectives about problems and build arguments so that students can take important positions and make claims, assert warrants, and provide evidence to defend themselves.

Data on argumentation ability in the second cycle was also obtained based on the post-test results. The following are the results obtained in Figure 4.

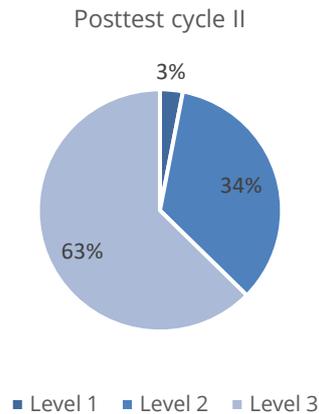
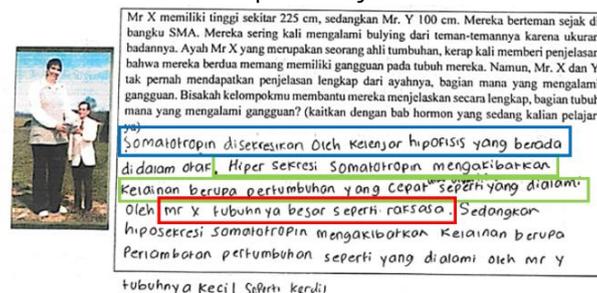


Figure 4. Post-test results of students in learning cycle II

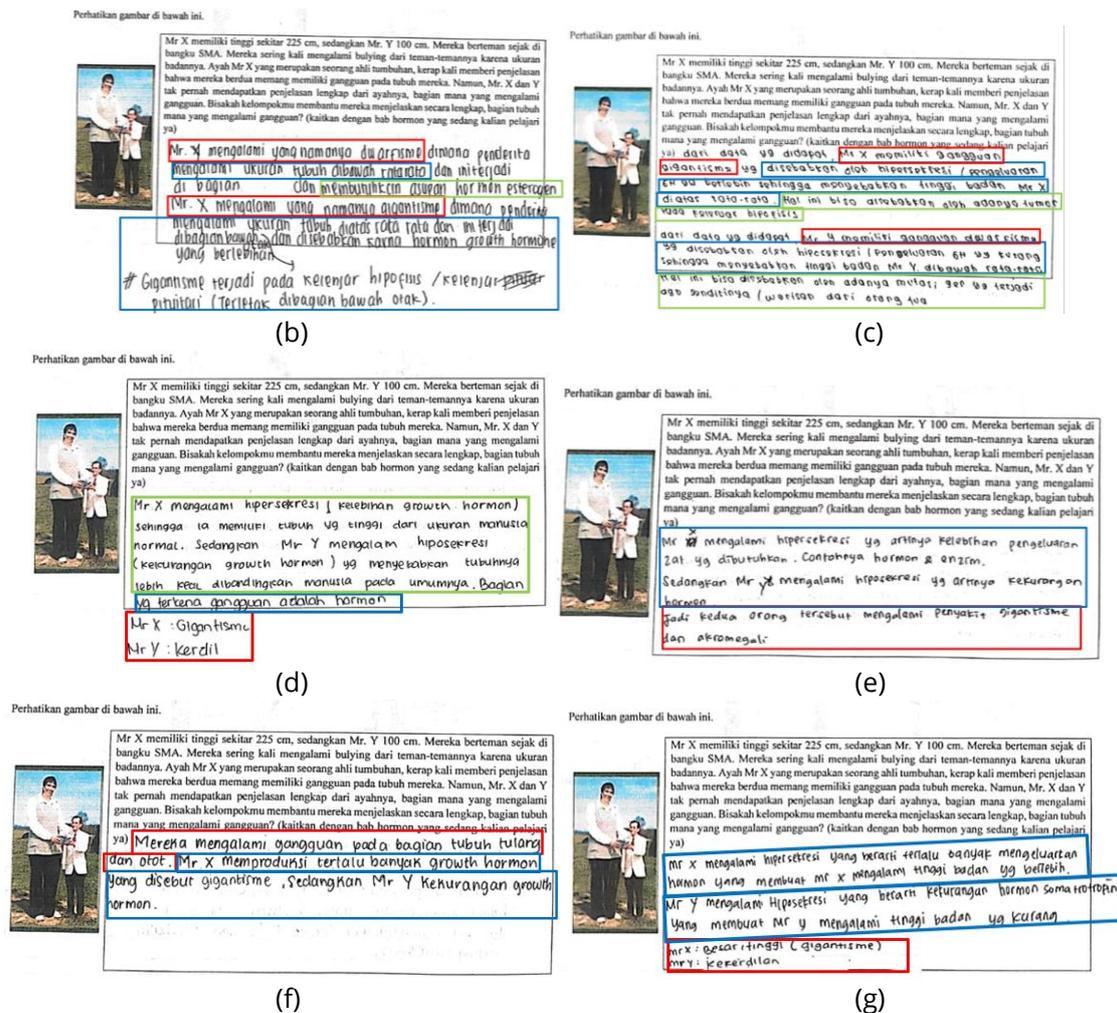
Figure 4 shows the level of students' argumentation abilities. Data shows that 3% of students have argumentation skills at level 1. Then, 34% of students have argumentation skills at level 2. The remaining 62% already have argumentation levels at level 3 (there is a claim accompanied by a warrant and backing). In the second cycle of learning, students are starting to get used to learning using the problem-based learning model. Students began to show their activeness, each group had representatives who dared to convey their arguments in class discussions. Then in the second cycle, there was an increase in students' argumentation abilities. In the second cycle of learning, the largest distribution was at level 3 argumentation ability. Most students were able to express a claim accompanied by a Warrant and Baking.

However, when looking at the posttest answers, some students answered the questions in the questions with conceptual errors. If only viewed based on the argumentation component based on Toulmin's rules (Toulmin's Argumentation Pattern), students can write their arguments. However, conceptually it turns out there are misconceptions about it. This is a problem that teachers need to solve. In expressing their arguments, students must also be strengthened by strengthening the concept of being guided by their teacher. This aims to ensure that when conveying your thoughts or arguments, you don't just dare to write your arguments. However, the strength of evidence is needed to follow existing concepts. According to Priyantini et al. (2021) also revealed that students rarely connect arguments with evidence and rarely use data to support evidence when answering a question.

In filling in the second cycle of learning Students Worksheet, of the 7 groups formed, each group made progress not only in conveying claims in their arguments but in answering questions. Students can convey supporting evidence for the claim expressed in their answers. The following is an excerpt of the Students Worksheet completed by students shown in Figure 5.



(a)



Notes: Claim Warrant Backing

Figure 5. Results of student worksheet answer in cycle II

If we refer to the results of filling in the Student Worksheet, it turns out that 4 groups, Figure 5 (a) – (d), have written answers with arguments consisting of Claim, Warrant, and Baking. So, there are students who can write arguments at level 3. Then, the other 3 groups, Figure 5 (e) – (g), show the Student Worksheet answers only consisting of Claim and Warrant (components of argumentation ability at level 2). Based on the answers of all groups, warrant, and baking are quite suitable and possible linking data and claims. Judging from the results of filling out the Student Worksheet, it is in line with the results of the post-test which allows students to experience changes in students' abilities, where there are students with argumentation abilities at level 3.

Something is interesting about the posttest answers, namely that it turns out that the evidence written by students to connect claims with existing data needs to be paid close attention to by the teacher. Because it turns out there are several statements that are not conceptually appropriate. So, teachers still need to provide guidance services that are balanced between cognitive, psychomotor, and attitude aspects. A student needs to be directed to be able to have argumentative skills that must be accountable. Not only do they have the courage to convey their scientific arguments, but students also need to be equipped with relevant and reliable evidence to support their arguments. So that students do not convey arguments without clear evidence and haphazardly. Teachers must also be able to guide students in conveying responsible arguments, to equip them for life in society.

CONCLUSION

Based on the findings and discussion that have been presented, the conclusion obtained is that there has been an improvement in students' argumentation abilities in classroom action research in these two learning cycles. At the first cycle meeting, only students' argumentation abilities were found at level one and level two. Then, in the second cycle, students were found with argumentation skills at level three. It is hoped that the results of this research can be used as a basis for evaluation for teachers to improve the learning process to make it even better. For other researchers, this research can be continued to obtain even more optimal results in measuring higher levels of argumentation ability.

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Authors' Note

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