Assessment for learning through written feedback to develop 21st-century critical thinking skills on plantae learning

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Abstract. The development of 21st-century skills becomes essential life skills in supporting individuals to adapt well to 21st-century life. One of the 21st-century skills that need is critical thinking skills. The development of student skills can be done through learning and appropriate assessments. The application of assessment for learning is an effort that can be done to develop student skills. The feedback provided can help students to plan and improve their learning strategies. However, the application of assessments in the learning process is often not optimal. Therefore, it is necessary to research the application of assessment for learning to improve students' critical thinking skills. This study uses the quasi-experiment method with the pretest-posttest control group design. Assessment for learning through written feedback is applied to the experimental group, while the control group is given of conventional assessment. Indicators of critical thinking skills in this study were developed based on the Partnership for 21st Century Skills. The result showed that assessment for learning through written feedback can improve the critical thinking skill of students. This is indicated by the experimental group has higher critical thinking skill improvement than control groups in Pteridophyta and Bryophyta chapter.

1. Introduction
The development of science and technology has driven the world globally to experience the transition from the 20th century to the 21st century. 21st-century life creates challenges and opportunities for human life. Environmental issues about biodiversity damage are one of the important topics in human life in the 21st century. This is due to the dynamic growth of the world's population that moves rapidly. In 2050, it is estimated that the world's population will reach 9.2 billion people [1]. Increasing population in line with increases deforestation activities which aim to increase the availability of land intended to support human life. Over the past 25 years, 24% of the world's land area has experienced a decline in quality and productivity due to deforestation. In 2030 it is estimated that more than 20% of terrestrial habitats in developing countries will function as cultivated land [2]. If this occurs continuously, it will risk the loss of biodiversity decline. Indonesia is one of the developing countries that are rich in biodiversity. Changes in the function of land as a place to live have an impact on the increasing number of plant species in Indonesia categorized as rare plants [3]. Even though, plants have an important role in human life. Scientist argues that knowledge of plant science needs to be applied as an innovative solution that will be needed to meet the challenges and improve the prosperity of human life future [4].
To increase this awareness, it is necessary to develop critical thinking skills as one of the 21st-century skills. The development of 21st-century skills is important in supporting an individual to adapt well in 21st-century life. Critical thinking skill is an essential skill which is related to individual ability to solve problems and find the best alternative solutions to solve them. The development of critical thinking skills can create humans who can think effectively and systematically to find the best solution for every problem that occurs in life in the 21st century [5]. However, students' critical thinking skills in Indonesia haven’t developed optimally [6, 7]. International assessment in PISA (Program for International Student Assessment) result shows that the scores obtained by Indonesian students in the three competencies tested are still low [5]. This PISA result is by the indicators of students' critical thinking skills proposed by the Partnership for 21st Century Skill [2]. PISA uses an innovative literacy approach that is related to students' ability to apply their knowledge and skills in analyzing, arguing, communicating effectively, and solving problems [8]. In-plant learning, students' critical thinking skills are still low. Students' ability to evaluate information about medicinal plants is low. Students do not understand how to assess, classify, and compare the types of medicinal plants [9]. Therefore, learning practices are needed that can help improve student literacy towards plants which in turn leads to environmental preservation.

In this case, relevant learning practices are learning that can help students to develop the ability to think, master science and technology, and do joint problem solving to achieve mutual prosperity [10]. These learning activities need to be supported by a good assessment. However, the assessment in learning is still not optimal. Learning has not implemented an assessment instrument that can reveal students' critical thinking skills on each topic of learning. There are still many teachers who apply assessment tools that can only measure aspects of knowledge. Even though the assessment applied should be able to cover aspects of knowledge, skills, and attitudes [11, 12]. Assessment for learning can be used to contribute to learning practices. Assessment for learning focuses on the interests of students to improve the quality of their learning through the help of teachers. Feedback provided throughout the learning process helps students to monitor and assess the development of their learning. Research related to assessment for learning suggests that the application of assessment for learning can improve student learning outcomes [8, 13]. However, research related to the application of assessment for learning to develop students' critical thinking skills in plant learning is still very limited. Therefore, this research is important to identify the development of critical thinking skills of students who are given the application of assessment for learning through written feedback in plant learning.

2. Methods

The research uses a quasi-experiment with a control group pretest-posttest design. This design uses two groups [14]. Assessment for learning through written feedback is applied to the experimental group, while the control group is given of conventional assessment. The population of this study is critical thinking skills from all students of 10th grade in one of the Public High Schools in Sukabumi District. Sample in this study is critical thinking skill from three classes representing nine classes of 10th grade high schools majoring in science and taken through cluster random sampling techniques. Data retrieval is done through student worksheet as assessment for learning. 14 questions critical thinking skills test, student response questionnaires, and learning reflection journals. The question of critical thinking skills is developing based on the Partnership for 21st Century Skill, which consisted of 7 questions about Pteridophyta and 7 about Bryophyta subchapter.

Assessment for learning used is developed and applied to Plantae learning. Development is carried out on student worksheet, critical thinking skills test questions, rubrics, and written feedback. The stages of development begin with preparation, testing, and correction. Assessment for a learning tool that has been prepared is tested and the results of the trial will be used for correction. The development of assessment for learning tools aims to obtain a good assessment tool so that it can be used to measure and develop students' critical thinking skills in Plantae learning. Then, these results are applied in Plantae learning activities.
Learning activities begin with giving a pretest to find out the initial critical thinking skills students. After that, practicum based learning is done in the Pteridophyta and Bryophyta subchapter. Each student is given a worksheet that acts as an assessment for learning. Furthermore, students in groups carry out plant observation practicum activities and work on the worksheets that have been given. Worksheets that have been worked on are then given written feedback and returned to students for repairs. Students write reflection journals that contain things that students cannot understand in learning and the efforts that will be made by students to improve their learning. In this case, teachers and students work together to improve the learning process so that they can obtain optimal results. At the end of learning, students are given a posttest to find out the final critical thinking skills that students have after learning activities. The results of the research data were analyzed using statistics through SPSS software and N-gain test.

3. Results and Discussion

Results of the application of assessment for learning through written feedback on learning activities for Pteridophyta and Bryophyta subchapters were obtained through the pretest and posttest of the critical thinking skills test, and student worksheet. Statistical analysis was carried out in SPSS version in SPSS 21 to see whether there was a significant difference in critical thinking skills between the experimental and control group. The results were shown in Table 1.

| Subchapter | Mean | Group | Sig (α = 95%) |
|------------|------|-------|---------------|
| Pteridophyta |      |       |               |
| Pretest    | 13.73| 19.03 | 0.045         |
| Posttest   | 82.03| 76.77 | 0.087         |
| Bryophyta  |      |       |               |
| Pretest    | 20.50| 30.73 | 0.020         |
| Posttest   | 89.63| 82.53 | 0.000         |

According to Table 1, at Pteridophyta and Bryophyta subchapters, the pretest score of students in the control group is higher than the experimental group. After learning activities, the average posttest scores of experimental and control groups increased. However, a posttest score between the experimental and control group did not differ significantly at the Pteridophyta subchapter. At the Bryophyta subchapter, the posttest score of the experimental group is higher and significantly different from a control group (Figure 1).

![Figure 1. Comparison of N gain value for critical thinking skills](image)

Based on students’ pretest and posttest, N gain analysis is carried out to identify students' critical thinking skills improvement for each subchapter. Figure 1 shows a graph about comparison N gain
value of students in the experimental and control group at Pteridophyta and Bryophyta subchapter. According to Figure 1, the improvement of students’ critical thinking skills of experimental and control groups is in the high category. The improvement of students’ critical thinking skills of the experimental group is better than a control group for each subchapter. The category of improving critical thinking skills in both groups probably can occur because of the same learning and worksheet used in both groups. The difference between experimental and control groups is feedback given for students on learning and reflection journals that used to plan students’ strategies of learning to improve their learning in the next meeting.

The improvement of pretest and posttest scores also students’ N gain was supported by students’ worksheets. This worksheet provided at each subchapter on Plantae learning. Based on Table 2, a student in the experimental group achieved a higher score than a student in the control group for Pteridophyta and Bryophyta subchapter. This result shows that assessment for learning with written feedback which was given during the learning process could guide a student to revise their mistake in the worksheet they worked on and improve their strategy of learning.

Table 2. Recapitulation average value of student worksheet

| Subchapter   | Assessment for learning (Average) | Conventional Assessment (Average) |
|--------------|----------------------------------|----------------------------------|
| Pteridophyta | 81.25                            | 62.36                            |
| Bryophyta    | 90.83                            | 78.44                            |

Based on the result, students’ critical thinking skills in the experimental group are better than a control group. It can be stated that assessment for learning through written feedback applied in Plantae learning can help students to develop their critical thinking skills. Worksheets given to students as part of an assessment for learning are applied to become student learning tools that help students to study more thoroughly, be more active in seeking information, and train students to always actively participate in learning activities so that they can help students understand plant material. The position of task and rubric is a learning tool to develop student competencies. With task work, students can reflect, recognize their strengths and weaknesses, and be able to learn good learning strategies. In the context of assessment for learning, students learn to be self-regulated learners [13].

In Plantae learning activities, students are given written feedback on student assignments. The following is an example of written feedback given: “The answer to the question has been answered well. Refine the phenogram made based on the correct similarity matrix table”. Written feedback provided throughout learning motivates students to improve tasks so that they can improve students’ critical thinking skills. Based on the questionnaire, most students (81%) think that assessment for learning with written feedback provided can help students think critically and improve their learning. This is consistent with findings in other studies that state that written feedback provided by the teacher can help students improve the quality of the work, especially when focused on clarity and conceptual coherence [15].

Assessment for learning focuses on the students’ interests to improve the quality of their learning through the help of teachers [16]. In the experimental group, changes in the learning strategy of student and teacher as part of an assessment for learning can help the student to understand the subject better so it can improve their learning. Then, it can make the student aware of their mistake in Plantae learning and increase their critical thinking skills. Based on the results of the questionnaire, although 63% of students more easily change the way of learning independently, in fact, there are most of the students followed a change of teachers’ teaching strategy. In this case, students have an active role in determining the planning of their learning based on the results of the assessment. Based on the research data, students have not been able to understand the nature of assessment for learning properly. Most students still depend entirely on the teacher to be able to do learning. Students still find it difficult to change their way of learning independently. Students still assume that the change in
teacher learning is more important in improving the learning outcomes obtained. Most students also still think that the final result in the form of a large number of values is more important than the process of obtaining it.

In the Pteridophyta subchapter, students’ final critical thinking skills between the experimental and control group did not differ significantly. Based on student questionnaires and reflection journal, this can be caused by several factors. First, students are not familiar with the learning activities carried out so students are still trying to adjust to the learning. Most of the students in the experimental group wrote that they found it difficult to follow the steps in the learning process, especially in terms of making the phenogram. Second, based on the results of students’ worksheets, students feel difficulties in determining the characteristics of ferns which will be observed in learning activities so that they have difficulty in understanding the material about this subchapter. Third, students cannot focus and concentrate when learning in class. Most students feel that learning is less interesting and enjoyable so students are relatively unable to participate in learning activities properly. Meanwhile, in the Bryophyta subchapter, students’ critical thinking skills between assessment for learning with written feedback class and conventional assessment class have differed significantly. In the Bryophyta subchapter, there are changes to the learning strategies used. The existence of this change turns out to be directly proportional to changes in student learning attitudes. Most students become more focused and more enthusiastic about participating in the learning activities carried out. Besides, students assume that the Bryophyta material is less than the Pteridophyta material so students are easier to understand well.

In the Bryophyta subchapter, based on the results of students’ worksheets, some students have a problem in determining the character of the moss that used in making the phenogram. Some students write "live in a humid place" as one of character that used in making phenogram. The character used in making a phenogram must be morphological character and that character isn't a morphological character. Morphological character relating to physical form from the plant [16]. Thus, written feedback is given while the student writes a reflection journal and planning the change of learning strategy to improve their learning. At the next meeting, the teacher changes the learning strategy by asking students information with other groups about a character from a specimen that they have observed.

Assessment for learning with written feedback can help students improve the quality of their next assignment. In an assessment for learning, the feedback provided throughout learning makes students actively play a role in building this feedback. The feedback helps students to monitor and assess the learning development process [13]. However, in this case, the student can be planning their learning strategy independently, but the student didn't realize it. Most of the students have a dependency on the teacher bigger than themselves. The role of a teacher is dominant to determine the way of learning.

4. Conclusion
Assessment for learning through written feedback that is applied to Plantae learning, especially for Pteridophyta and Bryophyta subchapter can help to develop students' critical thinking skills. Worksheets as tasks and rubrics provided can help students develop their learning competencies. Worksheets as part of an assessment for learning can help students be more active in learning and can motivate students to improve the tasks previously done. Students feel comfortable with the written feedback given to help students to get optimal learning outcomes. Even so, other factors influence students' critical thinking skills. This study implies that the implementation of assessment for learning must pay more attention to the learning strategies used, the technique of giving written feedback, and the proportion of task assignments as part of an assessment for learning. Learning strategies, written feedback techniques, and tasks are things that support the implementation of assessment for learning in learning. The proportion of tasks assigned must pay attention to the ability of students to do it. Written feedback can be given in more detail, easier to understand, and provided with more varied techniques. Besides, innovation and variation in the use of learning strategies can help increase students' interest and interest in learning.
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