Student’s critical thinking skills in interactive demonstration learning with web based formative assessment

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Abstract. Besides conceptual understanding, students are required to have good critical thinking skills because critical thinking skills is one of the important goals in educational world. By having good critical thinking skills, students can solve problems especially in Physics easily. The aim of this research was to study student’s critical thinking skills after experienced interactive demonstration learning with web based formative assessment in static fluid. This research used quasi-experimental with one group pre-test post-test design. The subject of this research was students in grade XI of Natural Science class in MAN 1 Pamekasan. The result of this research showed that interactive demonstration learning with web formative assessment could increase student’s critical thinking skills in static fluid. Based on n-Gain score, the improvement of student’s critical thinking skills in static fluid included in the medium category. This happens on all three indicators of critical thinking skills that have been used, namely reasoning, argument analysis and problem solving.

1. Introduction

In this 21st century, technology has developed rapidly and has entered into every field of human life including in learning activities. One of the learning activities that use technology is in e-learning. There have been many studies related to e-learning and it has been applied in several schools. E-learning used to deliver some of the solutions that could increase knowledge and performance [1]. It also effective in improving students' critical thinking skills [2]. One of type e-learning is called web-based learning [3]. According to the studies web-based learning can increase interest and have a positive impact on students' attitudes in learning physics [4,5].

Critical thinking ability is one of the main goals of the world of education [6]. The ability to think critically can train students in terms of reasoning, reflecting, and making decisions [7]. If students have good critical thinking skills, it will have an impact on mastering good concepts [8]. Besides improving students' critical thinking skills can have a positive impact on the lives of students in society [9]. To maximize students' critical thinking skills, appropriate learning is needed.

Inquiry learning has a significant effect in improving students' critical thinking skills [10,11]. Interactive demonstration is one of inquiry learning that can help teachers to improve students' critical thinking skills [12]. This is because with the demonstration, students can directly compare the
conception they have with the actual events presented through the demonstration. Interactive demonstration learning has four main steps, namely predict, observe, discuss, and synthesis [13]. At the predict stage, the teacher gives a demonstration of the phenomenon without giving a detailed explanation. The teacher can instruct some students to do the demonstration in front of the class with the teacher. After that, the teacher tells students to write an explanation of why the phenomenon can occur on a piece of paper. Then the teacher does the same demonstration with the results. At this stage, students observe the demonstrations carried out by the teacher. Then students discuss the explanation of the phenomenon with their peers. Students also conduct experiments to increase students' understanding. Finally, students synthesize their knowledge by linking the results of experiments with phenomena demonstrated by the teacher. If students are still having difficulty connecting the two, teachers can provide explanations to help students. The teacher can also show demonstration videos or conduct other demonstrations to increase students' understanding.

So far, in terms of assessment, teachers tend to use summative assessment that located at the end of the lesson as a determinant of whether students understand the material or not. Summative assessment cannot provide immediate feedback to students [14]. Immediate feedback is very necessary for students so students can directly overcome their weaknesses. Therefore, in order to be able to monitor the development of student learning it can be done with formative assessment [15]. Key elements in formative assessment activities can help teachers monitor student progress and maximize students' understanding and students' critical thinking [16]. Formative assessment is difficult if there are many students in one class. One alternative is to include formative assessment into e-learning that is integrated with learning in the classroom can help students improve the quality of their learning [17,18]. With a web-based formative assessment that can be accessed anywhere as long as it has an internet connection [19], it is more effective and efficient to help student learning [20,21,22].

In this study, interactive demonstration learning was carried out accompanied by formative web-based assessment to determine students' critical thinking skills in static fluid. Some studies show that students still have difficulty understanding static fluid. One study showed that students assume fluid pressure at all points was the same [23]. Students also assume that the only factor that could make objects float or sink is the mass of objects [24].

2. Methods
The type of this study was a pre-experimental study by using one group pre-test post-test design. The subjects in this study were class XI IPA 1 MAN 1 Pamekasan consisting of 31 students. Following is the design of one group post-test pre-test design [25].

![Figure 1. One group pre-test post-test design](image)

**Note:**
- O₁ = Pre-test
- X = Treatment
- O₂ = Post-test

Before treatment is given, students are first given a pre-test to determine students' critical thinking skills in static fluid material. After that, the treatment was given in the form of interactive demonstration learning accompanied by web-based formative assessment. During the treatment, students can access the web that has been provided by the teacher. Before the first meeting, students are asked to access the web to answer a short quiz about static fluid on the web. After learning, students are also asked to visit the web and do a short quiz on the web. As well as for the next meeting, students access the web after
receiving learning to help students study at home. After giving treatment, it is continued with post-test giving to find out the results of treatment that has been given.

Data collection is done by giving a test in the form of an essay question consisting of three questions. The three questions contain indicators of critical thinking including reasoning, argument analysis, and problem solving. The empirical test results state that the three questions are valid and reliable so that they can be used as tests to determine students' critical thinking skills. Scoring techniques for each question are from 0-5.

The results of the pre-test and post-test scores were analyzed using a paired t test to determine students' critical thinking skills before and after experience learning that use interactive demonstration with web base formative assessment. If t_count < t_table, then H1 is accepted, H0 is rejected. Conversely, if t_count > t_table, then H0 is accepted and H1 is rejected. To find out how much improvement in students' critical thinking skills after getting treatment, is calculated by using n_gain. The results of n-gain can be interpreted in the following table 1 [26].

| Gain normalized | Criteria |
|-----------------|----------|
| G < 0.3         | Low      |
| 0.3 ≤ G < 7    | Medium   |
| G ≥ 0.7         | High     |

3. Results and Discussion

The following are the results of the paired t test from the students' pre-test and post-test scores. From the calculation of the t test using SPSS, obtained t_count = -9.23. Because of t_count is smaller than t_table (t_count< t_table), so it can be concluded H1 is accepted. This indicates that the provision of treatment in the form of learning with interactive demonstration with web base formative assessment helped students improve their critical thinking skills in static fluid. Table 2 below shows the average score obtained by students for each question and n-gain scores for each question.

| Question number | Pre-test (mean) | Min | Max | Post-test (mean) | Min | Max | N-gain |
|-----------------|-----------------|-----|-----|------------------|-----|-----|-------|
| 1               | 40              | 40  | 60  | 63.2             | 40  | 100 | 0.38  |
| 2               | 40              | 40  | 60  | 65.2             | 40  | 100 | 0.42  |
| 3               | 40              | 40  | 80  | 65.8             | 40  | 100 | 0.43  |

In question number 1, students were told to analyze about analyzing the final position of 5 different masses in the aquarium according to Archimedes’ Law. In this case the students’ ability to reason before treatment was still relatively low. This can be seen from the average results of the pre-test obtained by students which is 40. After learning is given, students' reasoning ability is appreciably increased with the acquisition of the post-test average of 63.2 and n-gain of 0.38. In question number 2 students are told to use their arguments to analyze the influence of the depth of the pool on the pressure produced on the ear when diving. The average pre-test shows the value obtained by students is 40 and the average post-test value of students is 65.2. The n-gain value obtained after learning is 0.42. For the last session, the question number 3 with the question indicator applies Pascal's Law equation in daily life. The pre-test value obtained by the average student is 40 and the post-test average is obtained at 65.8. For the n-gain value obtained at 0.43. Based on table 1, the acquisition of n-gain achieved by students for the three questions is in the medium category.

This following is an example of student’s answer sheets before and after intervention. The question used to find out the reasoning of students in analyzing the final position of five blocks with different masses in the water-filled aquarium according to Archimedes' Law. Here is the question and the answer.
Based on figure 2, it can be seen that students still have an understanding that objects sink or float depending on their mass. Whereas, not only does the mass affect objects float or sink, but there are other factors, namely the density of objects. Because students have false initial conception, students didn’t use their reasoning well. During pre-test students’ answer for this question almost the same as figure 2. After intervention using interactive demonstration with web base formative assessment, students’ reasoning ability improved. Here is the example of student’s answer for the same question as Figure 2.

Based on figure 3, student have been able to use reasoning to explain about floating, fully immersed, and sinking object. Student could already connect between the density of object and the position of objects. This indicates that the learning that has been done helps students improve their reasoning abilities. Reasoning ability is part of critical thinking skills, so if students' reasoning abilities increase, students' critical thinking skills also increase.
The acquisition of students' pretest scores shows that students' critical thinking skills before learning are low. When viewed from students' answers, students tend to answer each question briefly without a more detailed explanation. This is what causes the student's pretest score to be low. In addition, students also have not been able to apply the static fluid concept to answer the problem properly. After demonstration interactive learning accompanied by web based formative assessment is given, students' critical thinking skills are better than before. Students can answer questions in more detail and can apply the concept of static fluid to the problem well. In addition, web based formative assessment can help students to study independently at home. This shows that web based formative assessment can be used by teachers to monitor student learning so students can achieve better learning outcomes.

There are several previous studies that support the results of this study. Inquiry learning such as interactive demonstration can make students more active during learning and help students learn in each indicator that used. In addition, students' critical thinking ability, so it can be concluded learning that use interactive demonstration with web based formative assessment improved student's critical thinking in static fluid. The increase of students' critical thinking skills almost has same average in each indicator that used. The use of interactive demonstration learning with web-based formative assessment can make students more active during learning and help students learn at home.

4. Conclusion

From the results of the post-test given, most student have achieved their critical thinking ability, so it can be concluded learning that use interactive demonstration with web based formative assessment improved student’s critical thinking in static fluid. The increase of students' critical thinking skills almost has same average in each indicator that used. The use of interactive demonstration learning with web-based formative assessment can make students more active during learning and help students learn at home.

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