Improving students’ critical thinking skills through natural science learning website

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Abstract. This study aims to determine the improvement of students’ critical thinking skills through a natural science learning website. The subject of the pre-experimental study is 64 junior high school students of grade 7th that is divided into two classes (32 students in the class D, Grade 7th, as experiment class and 32 students in class B, Grade 7th, as a control class). This study is placed at the 4th Pakem State Junior High School – Yogyakarta. Sampling technique that is used in this study is purposive sampling. The data was collected by using pre-test and post-test. The data was analysed by using paired t-test and N-gain score to see the effectiveness of the natural science learning websites to increase the students’ critical thinking skills. The results which are showed by using the natural science learning website has a significant effect on students’ critical thinking skills with the value of significant (α) 0.00 < 0.05 while the N-gain score is 0.87 that is included in the medium category. It can be concluded that natural science learning websites can increase students’ critical thinking skills.

1. Introduction

In the 21st century, technology has developed rapidly and that can be seen from the increasing varied technological innovations. The development of Science and Technology in the 21st Century provides new challenges in the field of education. Through education, students are expected to master the abilities needed in the 21st century (21st ’s century skills). Reliable human resources (HR) are needed as the main pillars supporting the development of the country and the nation to deal with them. Quality of human resources can be formed through education. In case of which, the government makes various efforts to improve the quality of education. The learning process in education should be directed to develop knowledge and skill as the main key that can help students [1].

Based on interviews and observations at the 4th Pakem State Junior High School – Yogyakarta, it is known that the school is provided with internet and computer network. The availability of networks and computers are utilized during national computer-based learning and examinations. Not all learning process uses internet and computer network facilities which are available at schools and one of them is in the science class. The application of technology in learning process is limited to presentations in the classroom and the use of laboratory equipments (co: microscopes) in the laboratory. The learning process in the 2013 curriculum places ICT (Internet and Communication Technologies) subjects as learning tools in all subjects or integrated into all subjects as it is also in line with Republic Indonesia’s Minister of Education and Culture (Mendikbud RI)’s presentation which states that teachers are expected to be an information literate, a media literate, and an ICT literate.

Based on a research conducted by Trilling and Fadel, several abilities in terms of oral and written communication, critical thinking and problem solving, work ethics and professionalism, work in teams
and collaborate, work in different groups, technology usage, and project management and leadership are less possessed by high school graduates, diplomas, and higher education students. Thus, the competencies and abilities that a person must possess to face the demands of the 21st century are seriously convoluted. There are seven types of life skills that are needed in the 21st Century uttered by Wagner. Those are having imagination and curiosity, being able to access and analyze information, being able to communicate effectively both orally and in written, having initiative and entrepreneurial spirit, being a dexterity and adaptability person, having skill in collaboration and leadership, and having skill in terms of critical thinking and problem solving.

Trilling and Fadel's research [2] states that high school and tertiary students who have graduated are not quite good in case of: collaboration and work in groups, written and oral communication, critical thinking and problem solving, professionalism and ethics in work, do work in diverse clusters, utilize technology in work, and work management and lead a project. To deal with 21st century demands, personal competence and skills are very complex. Related to the statements written above, Wagner breaks down the type of skills should be owned by someone to face 21st century. Those are critical thinking and problem solving, collaborating and having leadership in work, agile and able to adapt, the spirit of entrepreneurship and initiative, can communicate well in oral and written, able to analyze information properly, and imagine and have curiosity in a matter.

21st Century learning requires students to have four proficiencies, including collaboration, communication, critical thinking, and creativity. This was stated by the Partnership as Millennium Skills. Among those several skills, critical thinking is one of the most important life skills in the 21st century [4]. The social life of an individual, especially at work, requires critical thinking skills [5]. Critical thinking is also an important learning achievement for students of higher education [6]. Critical thinking generates new thinking because it uses higher cognitive abilities in processing information [7] that is through asking questions, thinking about making decisions, and solving problems [8]. Problem solving through critical thinking should use new methods. Various skills in the process of critical thinking are needed for problem solving, including problem analysis, inductive or deductive reasoning, making arguments, evaluating, making decisions, and communicating [9].

Critical thinking skills encompass skills in accessing, analyzing, synthesizing material that has been learned and mastered [10]. Critical thinking is a form of complex thinking activities by linking the activities of analyzing ideas more specifically, differentiating, identifying, assessing, and developing more perfectly. In measuring critical thinking skills, Ennis [11] proposes five indicators. Those are (1) analysis, assessing skills from various data and experiences; (2) Evaluation, the ability to assess information and the results of one's thoughts; (3) Conclusions, the ability to identify information in making conclusions; (4) deductive reasoning, individual skills are assessed from general ideas or premises to certain conclusions; (5) inductive reasoning, individual ability is measured from the premise or application of knowledge or experience to general conclusions.

Based on the interviews, there is a result can be concluded; critical thinking skills does not develop optimally in learning of VII grade students of 4th Pakem State Junior High School – Yogyakarta. Web-based learning is designed and developed by combining various types, which have a flexible nature so that it can be used whenever and wherever students are located because it can be accessed online. Thus, the various elements of education information technology which has been touched drives an idea about the web of learning up in the air.

2. Methodology
This study used pre-experiment with one group pre-test – post-test design. The experimental group used natural science learning websites about life organization system. The research design is presented in Table 1.

| No | Group   | Pre-Test | Treatment | Post-Test |
|----|---------|----------|-----------|-----------|
| 1  | Experiment | Y_{1,1} | X         | Y_{1,2}   |
| 2  | Control   | Y_{2,1} | -         | Y_{2,2}   |

(modification from Sugiyono[12])
Information:
Y1,1 = critical thinking skills and initial collaboration of experimental class students.
Y1,2 = critical thinking skills and final collaboration of experimental class students.
Y2,1 = Critical thinking skills and initial cooperation of control class students.
Y2,2 = Critical thinking skills and final cooperation of control class students.
X = Learning Science by using the web

This research was conducted at 4th Pakem State Junior High School, Special Region of Yogyakarta Province. The population in this study were all of the 7th grade students as many as 160 students, while the research subjects were 7th grade with 64 students, which is divided into 2 classes, namely experiments class consist of 32 students in class D grade 7th and control class consist of 32 students in the class B grade 7th. The sampling was selected by using purposive sampling. The instruments in this study consisted of the 2013 curriculum syllabus, lesson plans, and pretest-posttest question. The data were analyzed by using a descriptive statistical analysis and inferential statistical analysis. The inferential statistical tests paired sample t-tests are used to test hypotheses. The criteria for Ha were accepted and Ho rejected was sig (2-tailed) < 0.05. Besides, the data were analysed using the N-gain score to determine the level of critical thinking skills. The normalized gain score can be seen a category of increasing critical thinking skills and student collaboration using the science learning website. The categories of normalized gain score are presented in table 2 below [13].

| Normalized Gain Score | Level   |
|-----------------------|---------|
| g > 0.71              | High    |
| 0.3 < g < 0.70        | Medium  |
| g < 0.30              | Low     |

3. Result and Discussion

Based on the prerequisite test data that has been done, the data is normally distributed and homogeneous, then the hypothesis test can then be performed using a parametric statistical test and independent sample t-test. The results of the analysis can be seen in table 3.

| Information         | Sig (2-tailed) |
|---------------------|----------------|
| H0 rejected         | 0.000          |

Independent Sample T-Test statistical test results in table 3, the value of sig (2-tailed) t test for students’ critical thinking skills is 0.000. Because sig (2-tailed) <0.05 is 0.000 <0.05 then H0 is rejected. Thus, it can be concluded that there are significant differences in students' critical thinking skills between the experimental class and the control class.

| Value               | Control | Experiment |
|---------------------|---------|------------|
|                     | Before  | After      |
|                     |          |            |
| Low value           | 2,5     | 5,6        |
| High value          | 4,8     | 8          |
| Gain Score Value    | 0,52    | 0,87       |
| Gain Score Category | Medium  | High       |

The results of the analysis in table 4 can be seen that the value of the gain score of students’ critical thinking skills in the control class is 0.52 which belongs to the medium category. While the average
gain score of students' critical thinking skills in the experimental class was 0.87 and included in the high category.

Based on Figure 1, the control class pre-test score is higher than the experimental class pre-test score, while the experimental class post-test score has a higher score than the control class. This score shows that there is an increasing in terms of students' critical thinking skills after using a natural science learning website. Many benefits can be learned through the use of e-learning, two of which are mainly to increase the effectiveness and flexibility of learning. According to Suarsana, [14] the online learning environment allows students to explore information from various sources quickly and easily. This will encourage students to learn and to be critical and selective in choosing existing information in accordance with the problems given. The development of critical thinking skills is needed so that students can easily understand the concepts, can understand and solve the problems, and in different situations are able to apply concepts that have been learned [15].

Figure 1. Comparison Diagram of Average Critical Thinking Skills

The development of students' critical thinking skills is carried out using internet writing programs. The development of thinking skills with internet-based learning can be carried out in various ways. One of them, students are asked to look for information about topics given to search engines by using the critical thinking skills they have. Critical thinking skills when internet-based learning is facilitated by:

1. Students are given questions
2. Students, in their own words, formulates the answer of the question.
3. Students are motivated to participate in discussions using assessment criteria
4. Students are stimulated to submit examples according to the concepts being studied
5. Students are given another example in the application of concepts and theories according to the material being studied
6. Students are asked to inquire about the material being studied with other students and teachers
7. Students write down questions that require research or reading independently
8. Relevant journals are needed according to the learning material [16]

Based on the learning website that is developed, researchers have provided facilities that can improve students' critical thinking skills. The facility contains cell observation activities that can guide students to find out the parts of the cell and their functions. In addition to observation activities, students' critical thinking skills are known from the value of the pre-test and post-test that has been done. In learning process, students are given the concepts to be studied, given observation activities,
making models, working on discussion problems that students will be able to find and conclude the material learned in their own words.

4. Conclusion
From the results of this study, (1) the results of inferential statistical analysis of the independent sample t-test, showed a significance value of 0.000 <0.05, meaning that the increase in students' critical thinking skills in the experimental class with controls was significantly different, (2) shows the results of N-Gain is 0.52 which is included in the category of increasing the critical thinking skills of control class students and N-Gain is 0.87 in the high category increasing the critical thinking skills of experimental class students. It can be concluded that natural science learning websites are effective to be used to improve students' critical thinking skills.

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