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The effect of virtual lab and gender toward students' creativity of physics in senior high school

The effect of virtual lab and gender toward students' creativity of physics in senior high school

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Abstract. Creativity is one of the success goals in the learning process. One of the efforts to develop and improve creativity is through computer-based learning. This study aims to investigate the effect of virtual laboratory on student creativity which consists of verbal, numerical and figural creativity in physics. The increase of students' average score was compared based on their gender. This quasi-experimental study used a pre-test and post-test control group design conducted at four different schools with 51 male and 51 female students. The data were obtained based on creativity tests (essay form) that have been validated by experts. The tests of creativity can improvement differences that were done by calculating the average difference of N-gain score. The results showed that the female student's scores have higher than male students. In the aspect of verbal creativity, male and female students have the equal score relatively. Whereas, in the aspect of numerical and figural creativity that the female students have higher scores than the male students.

1. Introduction

The advanced development of information and communication technology in this 21st century bring the significant effect on everyday life, especially education. One of the benefits of information and communication technology in education is computer-based learning media.Learning media was used to support the learning which covers to collect, to present, and to process experimental data [1]. Shyr[2] also revealed that the computer-based learning has grown in schools to replace traditional methods. In year, the virtual learning environment is widespread in high-level education, not only for presenting the subject matter but also for facilitating the communication in learning.

Physics as part of science education has a strong connection with the existence of learning media. Some concepts in physics, especially for the abstract concept, actually it cannot be separated from the touching of learning media. This is caused by the various abstract concepts that often difficult for teachers to visualize and deliver to students verbally. Moreover, most students also argue that while studying the abstract concepts of physics, they find the difficulty in terms of mastering the material, proofing the concept in real terms, and further regarding analyzing it in real life. This activity indirectly trains students' creativity to perform every step of scientific work. Unfortunately, many school laboratories have the limit experimental tools. This condition causes the experimental activity cannot be implemented optimally. As a result, the development of students creativity becomes poorly trained. Students need effective learning media that can support their activities for physics experiment

virtually. Students can still train and develop their creativity as when doing real experiments. Therefore, the presence of learning media is necessary for physics teaching.

One of the effective learning media is a virtual laboratory. The virtual laboratory can guide students to experiment as well as doing real experiments in general. The existence of virtual laboratories is also intended to gain students' experience for solving difficult problems and situations that they faced. The virtual laboratories in physics learning can increase the verbal and figural creativity higher than conventional learning [3], and encourage the increasing of problem-solving skills of students [4]. Gorghiu [5] stated that the virtual laboratory is very helpful to increase the interest, motivation and learning skills.

A virtual laboratory is also useful in providing opportunities for students to learn by doing, developing thinking skills, and problem-solving skills [6]. In another study, the use of project-based learning model that is supported by virtual media can improve students' creativity [7]. The use of virtual laboratory in college learning is also proven to improve generic science skills of physics teacher candidates [8], as well as improving the critical thinking disposition of pre-service physics teachers, especially on truth-seeking and open mindedness indicators [9].

Creativity is the student's ability to follow learning activity in order to discover and use the new ideas that are unusual but still logical and rational. According to Gunawan et al. [10], creativity is an essential component of global competition in the 21st century. Therefore, the innovation in the learning is needed to help students more creative, including with the use of computer technology. Horng et al. [11] revealed that one of the goals of creative instruction is to create a student-centered learning environment with multimedia-assisted that can encourage students to think creatively in imagining freely and understanding the relationship of concept with real life.

In physics learning, the gender of students has little effect on their creativity. Gender is a sociocultural and psychological dimension of male and female [12]. Philbin et al. [13] stated that male and female have different learning styles. Honigsfeld and Dunn [14] also revealed that male and female students have different learning styles in many ways. Furthermore, Stadler et al. [15] in their research on gender stated that male and female students have differences in the meaning of physics that can affect the learning outcomes. This is due to the learning of physics associated with the real context in accordance to students daily life. This conformity involves three aspects: (1) the linkage between the learning content and daily life, (2) the pattern of body language understanding, and (3) the touching events of feelings and emotions. Gunawan et al. [16] on their research in three different high schools also found that the use of virtual laboratory in physics learning can enhance the verbal and figural creativity of students, both male and female. Female students have higher verbal creativity than male students, while male students have higher figural creativity than female students.

This study aims to investigate the effect of the virtual laboratory on student creativity which includes verbal, numerical and figural creativity. The result of student creativity improvement then compared by gender. Several previous studies on gender have been widely discussed but few compare gender based on student creativity. Most research results on gender conclude that there are differences between male and female students. This difference becomes the primary task of teachers to understand better the character of each student's gender in accepting and understanding the learning.

2. Method

This research used quasi-experimental study with pre-test and post-test control group design conducted in four different senior high schools. The sampling technique was purposive sampling. There were 102 students involved in the study, consist of 51 female students and 51 male students. Students were selected based on initial capability data as well as the proportion of female and male student ratios in each school. The treatment provided was the use of a virtual laboratory to compare verbal, numerical, and figural creativity based on students' gender. The creativity test used in the form of a description test consists of verbal, numerical, and figural creativity tests that have been validated by experts.

The obtained data then analyzed with simple statistics to determine the average N-gain score and t-test. N-gain was used to avoid misinterpretation of increasing creativity of students, both male, and female. Meanwhile, the t-test was intended to calculate the significance of differences in the increase in creativity between male and female students. Before the t-test, the homogeneity and normality tests of the data were carried out.

Results and Discussion

This study was conducted to examine the effectiveness of a virtual laboratory in four different high schools. The differences in the physics creativity enhancementare further compared to gender; male and female. The virtual lab used in learning comes with features program that helps students to experiment according to the goals. The virtual laboratory was equipped with a control tool that allows students to think and be creative to determine one of several solutions in solving the given problem.

Students were given tests before and after learning physics with a virtual laboratory. The results of data analysis showed that there was the difference in creativity improvement based on the student's gender which reviewed from the pre-test and the post-test of student physics creativity. Pre-test of creativity was given before the use of virtual laboratories in learning, to know the initial creation of the students. The results of the homogeneity test showed that the data of male and female students were homogeneous. This shows that male and female students have the same prior knowledge. The normality test also indicated that the data were normally distributed.

Furthermore, students follow the learning with the use of virtual laboratories. The last of the lesson, students were given a final test of creativity to find out the result and the increase of student creativity. Observations were made during the lesson. Enhancement of the student creativity was known by using the N-gain test. Figure 1 below presents the resulting study about the mean scores difference on pretest, posttest, and N-gain score of the students by their gender.

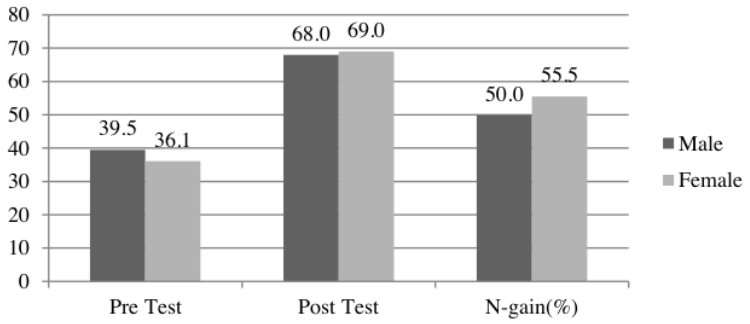

Figure 1. The difference in average score of creativity of students.

Figure 1 showed that the average score of the initial test of creativity for male students was 39.5 and for female students was 36.1. These pre-test scores were not significantly different. This may be due to students who did not understand the lesson well and only used their initial knowledge to solve the problem. After having treatment using a virtual laboratory in learning, students'creativity test results was increased. Based on Figure 1 mainly the post-test chart, it could be seen that the average score of the final test of creativity for male students was 68.0 and 69.0 for female students. The final test score showed that female students have higher creativity than male students, although not significantly different. It is assumed that male and female students have different abilities to collect information that they studied. Studying with a virtual laboratory could help students; for both male and female students to develop and accumulate their creativity. This result relates to Çelik et al. [17] that stated learning with virtual programs can enhance learners' understanding. According to Syyr [2], virtual laboratories have been able to help teachers adjust learning and enable students to develop their ideas and identify problems.

The increased creativity of male and female students was known based on the results of N-gain test. Based on Figure 1, it could be seen that the male student's score was 50.0% and the female student's score was 55.5%. The acquisition of N-gain scores of both groups students showed that the increased creativity included in the medium category. Male students had a lower creativity increase than female students but did not differ significantly. This statement was reinforced by the results of hypothesis testing with t-test that $t_{count} < t_{table}$ (1.25<1.99), so it could be concluded that there was no significant difference between the creativity of male students and the creativity of female students. The results of this study were in line with the research results of Suprapto et al.[18] that stated gender does not affect students' creative thinking ability. Afriana, et al. [19] in their research also found that the increase in science literacy in the male and female classes was not significant. In contrast to the results of this study, Bacharach et al. [20] reported that the gap in science achievement depends on the gender of the students. Asis& Nurdin [21] in their study also concluded that based on the terms of reference and mental rotation, the dominant male subject used spatial skills, while the dominant female subjects used logical reasoning.

The results of the students' creativity tests were divided into tests of verbal, numerical, and figural creativity. The results of the test compared to the increase based on students' gender. The differences enhancement in the verbal, numeric, and figural creativity of students based on their gender are shown in Figure 2.

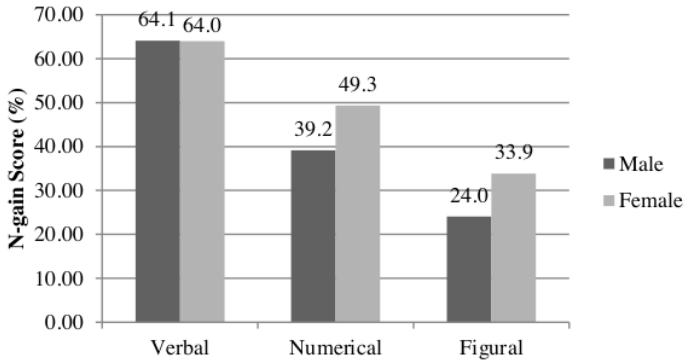

Figure 2. The differences in each aspect of students' creativity.

Figure 2 shows that there was differences between the creativity of male and female students in each aspect. In verbal creativity, male students get an increase at 64.1 while female students score slightly lower at 64.0. This increase is not significantly different which is reinforced by the results of the hypothesis testing with a t-test that $t_{count} < t_{table}$ (0.24<1.99).In numerical creativity, male students get an increase in the value of creativity 39.2 while female students score 49.3 higher which is not significantly different. This was indicated by the t-test result which is $t_{count} < t_{table}$ (1.73<1.99).Moreover, also in figural creativity, male students score 24.0 while female students score 33.9. Female students have a higher improvement score than male students, but not significantly different. Itis showed by the results of the t-test that is $t_{count} < t_{table}$ (1.67<1.99).

Based on Figure 2, it could be seen that in general the increase of female students' creativity was higher than male students, although the score of both increases was almost the same on the test of verbal creativity. Next, will be discussed one by one for the results of each type of creativity. First, the type of creativity that has the highest increase was verbal creativity, both for male and female students. This suggested that the use of virtual laboratories could help students, both male,and female, to think divergingly by combining ideas about a problem verbally. This enhancement was reflected in the fluency, flexibility, originality, and elaboration capabilities that demonstrated by the students. This result proved that male and female students have a good enough ability in forming ideas through

words, as well as directing the focus problem on mastering communication in writing. According to Dalgarno et al. [22], the virtual experiments have been able to improve students' skills in deductive reasoning, hypothesis formation, andeffective testing through experiments.From the gender aspect, Skaalvik & Skaalvik [23] mentioned that male students have a higher self-concept, performance expectancy, intrinsic motivation in mathematics than female students, whereas female students have the higher intrinsic motivation to learn the language than male students.

Numerical creativity got the second highest increasing after verbal creativity. Female students have a higher increase than male students, although not significantly different. It was assumed that female students have better abilities associated with numbers, structured thinking, mathematical logic, as well as more precision on basic mathematical calculations. Also, Voyer & Voyer [24] stated that female makes more effort than male in learning to use mathematical calculations. In his research, Fennema [25] concluded that male students tend to have higher mathematical abilities than female. Loori [26] also revealed that women in learning tend to use intrapersonal intelligence while men prefer to use logic and mathematical intelligence. Both male and female students alike experienced an increase in numerical creativity in the moderate category. This statement showed that the use of virtual labs could help students to associate new ideas in mathematical logic quite well. The results of this study were in line with the statement of Oidov et al. [6] who argued that with virtual activities, students could perform numerical measurements and evaluations of the process being explored, interpret data (information / facts), and write formulas and formulate the fundamental laws of physics.

The type of creativity that has the lowest increase was the figural creativity, for both male and female students. These results in line with Wu et al. [27] that concluded that student has significantly higher scores on real-world problems, and significantly lower in figural tasks, and on verbal assignment there was no different for the groups. Female students have a higher increase than male students, although not significantly different. The increase of figural creativity of female students was in the medium category, while the increase of figural creativity of male students was in a low category. This result suggested that the use of virtual laboratories, female students were able to use better abilities in divergent thinking to form ideas by combining patterns of shapes or images to solve a problem. Thisis supported by the research of Cheung & Lau [28] that suggested female students have better figural creativity, which includes figural fluency, figural flexibility, figural uniqueness, and figural unusualness.

4. Conclusion

The use of a virtual laboratory in physics learning could improve students' creativity, namely on verbal, numerical, and figural creativity. This increase could be seen from the score of N-gain of each student's creativity, both for male students and female students. The highest student creativity improvement was in verbal creativity, then numerical creativity and the lowest increasing was in figural creativity. In general, female students have a higher level of creativity than male students, although statistically, the ability difference did not differ significantly. In verbal creativity, the increase for male and female students was similar. In numerical and figural creativity, female students have a higher increase than male students.

As for suggestions that can be given for further research, mainly the use of virtual laboratories in learning needs to be preceded by explanation of the function of the program features as well as the opportunity for the students to try several times so that the students will more familiar before using it in the primary learning session. The use of virtual laboratories should be supported by an inquiry-based worksheet where the work steps can be independently adjusted by the students to achieve the learning objectives.This will further encourage the creativity and new ideas of students than if the worksheets have been prepared before by the teacher. The results of the study recommend for further research to find out in detail at which stage the students' creativity develops, both in male and female as well as comparisons at each cognitive level of students after the learning is done.

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