Gender Influence on Students Creativity in Physics Learning with Virtual Laboratory

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Gender Influence on Students Creativity in Physics Learning with Virtual Laboratory

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Abstract. Creativity is one of the skills that must be developed in students through learning in high school. Every student has different creative potential. These differences can be influenced by ways of thinking, experience, how to determine the point of view and other factors. This study is to determine the increase in creativity based on students' gender differences in physics learning with virtual laboratory. This quasi-experimental study was conducted in two groups in two different schools in Mataram. Students are given learning treatment with a virtual laboratory. The sample selection uses purposive sampling consisting of 33 male and 33 female students. The results show an increase exhibited by all students in terms of verbal, figural, numerical and procedural creativity. Increased student creativity is measured using the N-gain test. The results were higher in male students compared to the female group, both based on all aspects of creativity as well as all indicators of creativity.

1. Introduction

Basically, science covers aspects of processes, products, and attitudes. Physics is one part of science that studies the symptoms and natural phenomena around. One of the goals of physics learning is to train students' thinking skills. Students who study physics must be helped to develop creative thinking skills and problem-solving skills in life. The teacher's role is basically important in helping students in the three aspects of science mentioned above. However, learning physics in high school is still teacher-centered. Student activities are generally limited to listening to lectures, recording material, and doing practice exercises in the textbook. Traditional teaching methods provide little opportunity for students to explore their abilities. So that causes the level of creativity of students during learning becomes very low.

Problems arise when the teacher in explaining physics material, where most physics lessons consist of abstract material. One of the difficulties in learning physics experienced by students is understanding various abstract concepts. In addition to the use of models and learning methods that are student-centered, supporting media are also needed so that learning materials can be conveyed properly and appropriately. In this case, the laboratory is a very important component to explain certain material

concepts. Learning in a physics laboratory makes students more active by seeing, observing and doing things. Many researchers have proven that learning in the laboratory increases students' interest and abilities in physics.

Science has developed into various independent branches. Physics learning consists of knowledge, concepts, and ideas that have essential roles in technological development. Learning technology that developed when dominated by physics applications. Utilization of technological developments in physics learning, one of which is the use of a virtual laboratory. A virtual laboratory can help teachers to visualize abstract concepts to students. In addition, the virtual laboratory can also facilitate students in understanding and building better concepts [1]. Mutlu & Sesen [2] revealed that the virtual laboratory could improve students' science process skills. A study by Tuysuz [3] found that the use of virtual laboratories had a positive impact on improving student achievement.

The use of virtual laboratories in various learning models has been shown to increase students' creativity in physics learning [1]. Creativity is an ability that can be developed. Every individual has a different level of creativity. In learning, creativity arises spontaneously through interaction between teacher and students and between students and other students [4]. One way to create a learning environment that allows students to imagine freely during learning is with the help of interactive multimedia. Interactive multimedia can connect learning material with everyday life and provide questions that encourage students to think creatively [5]. Creativity involves deep curiosity in one's self and an active imagination [6].

Students who have high creativity can facilitate them in solving a problem. Rawat et al. [7] revealed that someone's creativity is those who can create ideas from a fact to form a new concept. Meanwhile, creativity can be trained and developed through computer-based learning to discover various aspects of student learning experiences [8, 9].

The purpose of this study is to compare the increase in student creativity by gender. Improvement is measured after students take part in learning activities with a virtual laboratory. This research is important to obtain empirical evidence related to finding differences in increasing creativity between male and female students. Creativity measured in this study is on verbal, figural, numerical, and procedural aspects based on indicators of creativity [10]. Research related to measuring the comparison of creativity between male and female students through physics learning with a virtual laboratory is still rare. Only a few works of literature report differences in learning outcomes between male and female students. Gunawan et al. [11] claim that there is a gender-based influence on students' verbal and figural creativity. Many factors influence the difference in increasing student creativity, which includes the environmental and psychological factors of each student. A study by Bacharach et al. [12] shows a gap in student achievement across gender.

2. Method

This quasi-experimental study involved two classes in two different high schools in Mataram. Subjects were selected using a purposive sampling technique with 33 male and 33 female students. Not all students in both classes are taken as subjects. The selected students were adjusted based on their initial abilities to avoid differences in the number of the two groups. Each student is given a preliminary and final test. After the teacher gives the initial test, each class is given effective treatment with the help of a virtual laboratory. Then given the final test to determine the improvement of student creativity. To measure creativity given essay questions which include verbal, Figural, numerical and procedural creativity tests and include indicators of fluency, flexibility, originality, and elaboration. The score of N-gain calculation findings determines increased creativity. Calculations are based on formulas, as follows [13]:

$$\text{N-gain} = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \text{x } 100\% \quad (1)$$

Hake [16] divide category for N-gain: > 70% (high), 30% ≤ 70% (medium) and <30% (low). S_{pre} is the average initial test scores, S_{post} is final tests, and S_{max} is maximum tests.

3. Result and Discussion

Student creativity was analyzed based on verbal, figural, numerical, and procedural aspects that are adjusted to the indicators of creativity. Data comparing the increase in creativity of male and female students is obtained through the provision of initial and final tests. The learning process uses a virtual laboratory. Figure 1 shows the difference in increasing creativity between male and female students in school A and School B.

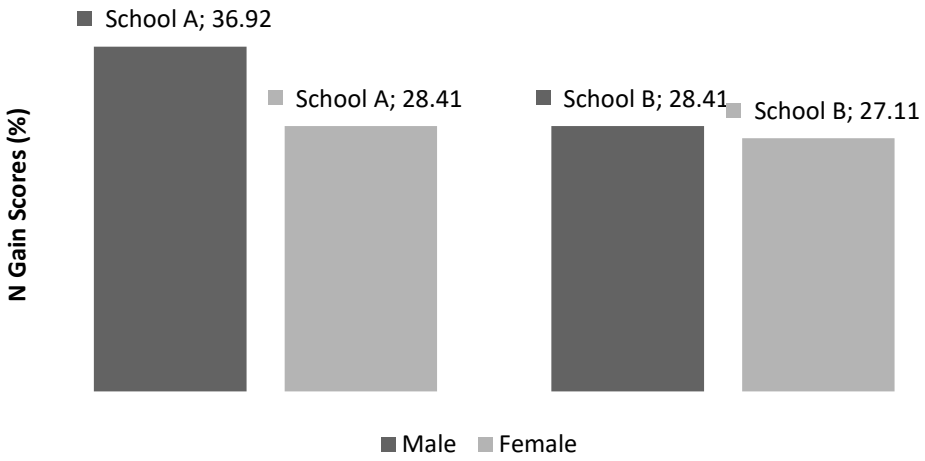

Figure 1. Comparison of Increasing Creativity of Male and Female Students in Two Different Schools

It was seen that overall, in the two schools, the highest increase occurred in male students with an average of 32.66% and female students of 27.76%. This result indicates that males have higher creativity than female students. However, the difference is not very significant. In contrast to Wang's [14] research which has proved that the creativity of females is higher than that of male students. This increase in creativity is inseparable from the role of the virtual laboratory used in the learning process. The acquisition of high student creativity results from positive media such as interactive e-books, animation media, and virtual labs [15, 16, 17]. The ability to think creatively can improve the quality of student learning with the help of virtual labs [18].

In addition to calculating the average, a comparative analysis is also carried out based on aspects of verbal, figural, numerical, and procedural creativity. The results of comparisons obtained from the two schools are presented in Table 1.

Table 1. Comparison of Every Aspect of Male and Female Student Creativity

Aspect of Creativity	N Gain (%)			
	School A		School B	
	Male	Female	Male	Female
Verbal	51	50	31	40
Figural	71	55	69	59

Numerical	53	38	25	24
Procedural	85	72	79	77

Increasing the percentage of average N-gain for each aspect of creativity in Table 1 shows that male students in schools A and B obtain higher results than females for all aspects of creativity. There is the highest increase in procedural aspects. Male students have a better ability to create and illustrate abstract concepts related to the subject matter. The verbal creativity aspect of male students was higher than female students. Some students managed to provide as many explanations as possible related to the material, although they still provide general explanations. This is contrary to the findings of Matud et al. [19] that the verbal creativity of females was higher than male students.

Students have a better ability to give new ideas related to images after learning with a virtual laboratory. Computer simulation helps students observe abstract scientific phenomena [20]. This can be seen in the increase in figural creativity in the high category for male and the medium category for female students. This result is supported by the research of Matud et al. [19] that males students have higher scores on physiological aspects. In contrast to the findings of Gunawan et al. [1] that the use of virtual laboratories limits the ability of students to complete images so that figural creativity is less developed. The findings indicate that habits and drawing exercises influence the improvement of students' figural creativity. Students who get constant learning related to images or graphics can trigger a memory that is quite high [21].

The numerical creativity of school B students is in a low category. This shows that students are less able to provide answers to questions about mathematical equations. Students who have an excellent mathematical understanding are not only able to memorize formulas but can solve questions that require the ability to associate various kinds of concepts.

A comparison of increased creativity between male and female students was also analyzed based on indicators of creativity. The comparison results are shown in Table 2.

Table 2. Comparison of Each Male and Female Student Creativity Indicator

Indicator of Creativity	N Gain (%)			
	School A		School B	
	Male	Female	Male	Female
Fluency	54	51	29	25
Flexibility	48	35	28	43
Originality	71	55	75	63
Elaboration	85	72	79	77

The results of the study showed that students for both schools gained higher creativity in the indicators of originality and elaboration. Researcher's findings that male students in detail are better able to detail a problem and create new ideas. Rodzalan & Saat [23] states that male has a better ability to think and solve problems than female students.

An interesting finding from this study is that students can explain the material with diverse delivery. It can be seen from the results of the analysis on fluency and flexibility indicators with an increase in the medium category for school A and a low category in school B, but students can provide answers from different perspectives. The increase among males is not much different from female students. Gunawan et al. [17, 22] stated that the important thing about the indicators of fluency and flexibility is that students can provide as many new ideas or solutions that are relevant to the problem given.

Based on the data obtained from the two schools, it shows that students have been able to master all aspects and indicators of creativity during the learning process with a virtual laboratory. Male has better creativity than female students, which is observed from the initial and final abilities included in the high, medium and low categories. The virtual laboratory used in this study is a simulation, animation and image for practicum. Male students who have better abilities in operating computers are able to solve problems using ideas expressed in image patterns [23]. Male have different thinking styles with female students and use different delivery methods. Overall they have been able to describe the problem in detail and precisely. This study proves that the application of virtual laboratories in both schools can increase verbal, figural, numerical and procedural creativity in all indicators of creativity.

4. Conclusion

The application of physics learning with virtual laboratory effectively enhances verbal, figural, numerical, and procedural creativity based on creativity indicators, both for male and female students. Male get a higher N-gain increase than female students for all aspects and indicators of creativity in both schools. The research will have the following implications. First, it has been implicitly proven that gender differences affect creativity developed through physics learning with virtual laboratories. Second, the virtual laboratory effectively increases the creativity of students in high school physics learning. Third, the results of the study show differences in the improvement of each aspect based on indicators of creativity in different genders. Fourth, these findings will encourage teachers to develop creativity and train students to think creatively.

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