The differences in physics learning outcomes based on gender after using blended problem-based learning model

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Abstract. Previous studies found that using e-learning to support Problem Based Learning can increase students’ learning outcomes. The increase of students’ learning outcomes has not been yet examined according to gender difference which can indicate the suitability of a learning model used by male and female students to enhance their learning outcomes. This study aims to examine the differences in physics learning outcomes at a public senior high school in Depok according to gender difference after using Blended Problem Based Learning model. This is an ex de facto study. The target population of this study was students of a public senior high school in Depok and the sample was grade ten students at a public senior high school in Depok. Samples were taken by purposive sampling. Data were collected from students’ learning outcomes grouped by gender difference, then analyzed using a two-tail test with the t-test formula. The results showed that there are no significant difference between male students’ learning outcomes and female students’ learning outcomes after using the Blended Problem Based Learning model at a public senior high school in Depok.

1. Introduction

Every learning process, both formal and informal, will result in learning outcomes. Purwanto [1] said that the outcomes could be changes in cognitive, affective, or psychomotor aspects. In Indonesia, for example, after students have completed the learning process for three years at high school level, the students’ learning outcomes is assessed through National Examination. Students’ average results of National Examinations throughout Indonesia for physics subject have decreased. The education assessment center of the Ministry of Education and Culture reported the results of Indonesian National Exams on their website www.pusplendid.kemdikbud.go.id, for physics subject in 2015 was 68.06 and in 2019 was 46.35. This is a big question and challenge for teachers, lecturers and the entire academic community to improve and develop a better education in Indonesia.

Along with the development of technology in the Industrial Age 4.0, online learning becomes a necessity for every student in Indonesia to be relevant with the 2013 curriculum. Waryanto and Setyaningrum [2] said that ICT in the 2013 curriculum is very important considering its rapid development; so, ICT is used to implement learning content or school material. However, Means, et al [3] said mixed learning has greater impact than online learning or face-to-face learning. So, the learning needs to be mixed between face-to-face learning and distance learning, specifically as
Blended Learning. This is in line with the opinion of Graham [4] which mentioned: “the blended learning system combines face-to-face instruction with computer-mediated instruction”.

Besides to involve ICT in learning, Abidin [5] said that the 2013 curriculum is also oriented at learning that can produce human resources who master high level comprehension skills, critical thinking skills, and the ability to collaborate and communicate. Problem Based Learning is a learning model that is in line with the objectives of the 2013 curriculum. This is as stated by Lajoie, et al. [6] in their study which showed that the superiority of this learning model is to improve content knowledge, critical thinking skills, and the ability to collaborate and communicate. According to the study, Problem Based Learning model and Blended Learning is suitable to be integrated to achieve the objectives of the 2013 curriculum. This is similar to Herlianas’ [7] research stating that the Blended Problem – Based Learning has greater impact in students’ learning outcomes than the Direct Instruction based Blended Learning. So, using Problem Based Learning can be combined between face-to-face and distance learning called the Blended Problem - Based Learning model. This refers to a research conducted by Triyanto, Susilo, and Rochman [8] stating that this learning model shows satisfying positive student activity and a good response from students to this learning model.

The idea is also supported by Liu et al. [9] in their research which reveal that students’ scientific knowledge and attitude toward science increase after they are involved in problem-based learning, not only for gifted students and students in general but also for students who have abilities below the average in terms of economic social and education. Apart from the social economic and education side, Min Liu proved that from a gender perspective there are no significant differences in scientific knowledge and scientific attitudes between male and female students. This is supported by Ajai and Imoko [10] revealing that there are no significant differences in achievement and the retention of learning mathematics using a problem-based learning model between male and female students. However, several other studies declared a significant difference. Pol, Harshkamp, and Suhre [11] stated that there is a significant gender effect on knowledge-based post test scores, where male students are higher than female students after using the PBL program computer. Sulistiyoningsih, Kartono, and Mulyono [12] purposed that problem-solving abilities and environmental awareness of female students are found higher than male students after using Blendid Problem - Based Learning models with environmental contexts.

Thus, it is necessary to analyze the learning model that is suitable for male and female students to improve students’ physics learning outcomes in high schools. Therefore, the authors are interested in investigating the differences of Students’ learning outcomes on physics subject according to gender difference after using Blended Problem Based Leaning model at a public senior high school in Depok.

2. Method
This is an ex post facto study. This research was conducted at a public senior high school in Depok in second semester in 2014/2015. The study was conducted from March to May in 2015. The population was students of a public senior high school in Depok and the sample was students of grade ten in a public senior high school in Depok. Samples were taken by purposive sampling that there were 46 students who have the qualification to learn with e-learning. Based on the results of sampling, there were two groups divided according to gender differences. The study was conducted in 8 sessions and divided into 2 groups: male and female groups. Both of the groups received the same treatment that is the Blended Problem Based Learning model. After receiving the treatment, the groups were given a post-test to assess their physics learning outcomes and examine the differences achieved by the two genders.

The data in this study were obtained from students’ physics learning outcomes on the subject of temperature, heat and optical devices. The instrument used in the data collection was tests of students’ learning outcomes in the cognitive domain in the form of multiple choices compiled by the authors where the test indicators referred to Anderson and Karthwohl's taxonomic theory [13]. Moreover, aspects measured from C1 to C6 abilities also referred to Anderson and Karthwohl’s taxonomy. There were 60 question instruments used to assess students’ physics learning outcomes are. Then the instruments were validated in the form of multiple-choice tests using the biserial point correlation equation and 40 valid questions were obtained. To find out the reliability of this instrument, the researchers used the KR-20 formula and with r11 0.91955, it was confirmed that the instruments were strongly reliable.
After the data was collected, statistical calculations were performed to test the differences in physics learning outcomes of male and female students using the Blended Problem Based learning model.

3. Result and Discussion

The results of this study are students’ final test scores on temperature, heat and optics topics which were taught to two groups who received the same treatments that is the Blended Problem Based Learning model. According to the two groups divided into gender difference, it was found that the average value of the female group (74.02) is found higher than the average value of the male group (68.80). Furthermore, the students’ learning outcomes after using a Blended Problem Based Learning model differentiated by gender are shown in detail in graph 1 below:

Graph 1. Students’ learning outcomes using blended-problem based learning model

The difference in the average value of students’ learning outcomes in this study shows that female students were better in solving physics problems in the cognitive domain compared to male students. This is in line with Sulistiyoningsih, Kartono, and Mulyono’s [12] finding suggesting that female students are better in problem-solving abilities and environmental awareness compared to male students after using Blended Problem – Based Learning models with environmental contexts.

Before testing the hypothesis, first is conducting test of data analysis requirement test which includes testing normality and homogeneity of population variance. Data normality test was carried out using Liliefors test used in each treatment group using a significance level α = 0.05. The finding indicated that the \( L_{\text{count}} \) value for all groups is smaller than the \( L_{\text{table}} \) value. Thus, it can be concluded that the data of physics learning outcomes from all data groups came from populations that were normally distributed. In addition, the homogeneity test uses the F test. The results and the significance test of the variance of the two data groups shows that the F count is smaller than F table at the significance level \( \alpha = 0.05 \). Therefore, it can be concluded that the two groups show homogeneous variances. The hypothesis test in this study was conducted by a two-tail test using the t-test separated formula. The results and hypothesis test of the two groups of data indicated that the t count was smaller than the t table at the significance level \( \alpha = 0.05 \). Thus, Ho is accepted and Ha is rejected. This revealed that there is no significant difference between the learning outcomes of male and female students after using the Blended Problem Based Learning model. Result of hypothesis test is shown in table 1:
This is similar to Ajai, and Imokos’ (2015) finding showing that there are no significant differences in achievement and the retention of learning mathematics using a problem based learning model between male and female students. Similar opinion is also expressed by Zakiri, Pujiastuti, and Asih, [14] that students' mathematical communication skills using the problem based learning and probing prompting model do not indicate a significant difference between male and female students. Therefore, the learning model that combines face-to-face learning and distance learning with the problem based learning model is suitable for use by both genders.

4. Conclusion
It can be concluded that there is no difference in the learning outcomes of high school students according to gender difference after using the Blended Problem Based Learning model. This suggests that this learning model is suitable for use by male and female students in learning physics in high school.

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Table 1. Result of hypothesis test using a two-tail test

|            | Male     | Female   |
|------------|----------|----------|
| Mean       | 68.8043478 | 74.0217391 |
| Variance   | 330.607708 | 211.215415 |
| Observations | 23       | 23       |
| Pooled Variance | 270.911561 |          |
| Hypothesized Mean Difference | 0 |          |
| Df         | 44       |          |
| t Stat     | -1.0749507 |          |
| P(T<=t) two-tail | 0.28825629 |          |
| t Critical two-tail | 2.01536757 |          |
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