Study in statistics: motivation, independence, and learning achievement

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Abstract. Statistics are very important for students to master, but many experience difficulties. This study aims to determine the effectiveness of a combination of blended learning and problem-based learning in improving student motivation, independence, and statistical learning achievement. This research is a quasi-experimental study conducted on IAIN Ponorogo students. The instruments used for data collection were achievement tests, learning independence tests, and learning motivation questionnaires. The data collected was analyzed using MANOVA and continued with the Bonferroni Test. The result of the MANOVA test has obtained a significance of 0.000 so that it can be concluded that the combination of blended learning and problem-based learning was more effective in increasing student motivation, independence, and statistical learning achievement than blended learning and problem-based learning methods. Specifically, the combination method is more effective in increasing student learning motivation than blended learning and problem-based learning. In the aspect of increasing student learning independence, the combination method has the same effectiveness as problem-based learning. Both are more effective in increasing the independence of student learning than blended learning. Whereas in the aspect of learning achievement, the combination method is more effective in increasing student statistical learning achievement than blended learning and problem-based learning.

1. Introduction
Mathematics as a rapidly developing field of knowledge is continuously applied in various fields of work and education [1]. Statistics, is one part of an important subject for students including prospective teacher students. Students are not only required to understand the concept of statistics, but are also able to apply it to research. Students must understand the concepts of descriptive and inferential statistics properly and correctly. Low mastery of concepts, will have implications for the ability of students in their application. The fact is, many students avoid quantitative research because of their low understanding of statistics. The results of previous studies indicate that students' mastery of statistical concepts is still low. The existing problems need to immediately get a solution so that students can understand statistics properly and correctly.

The solution to improve students' understanding is to use contemporary learning. Learning following the characteristics of generation Z. One of the characteristics of generation Z is the use of information technology [2, 3]. Therefore, the learning developed must be following the characteristics of today's students.

One alternative to contemporary learning is by combining learning with blended learning and problem-based learning. Blended is defined as the combination of the best features of traditional
learning and online learning [4–7]. Thus, blended learning can be considered a sort of electronic learning or its extension; its main difference is the necessity of face-to-face communication of students with each other and with the instructor [7–9]. Blended learning is also very relevant for university use [10–12]. The application used for blended learning in this study is Google Classroom. Google classroom is a supporting application for the learning management system developed by Google. The advantages of this application compared to other applications are practical, easy to use, flexible, integrated email, and free [13]. While learning problem-based learning is a teaching method characterized by the existence of real problems as a context for students learning critical thinking and problem-solving skills, and gaining knowledge [14–16]. The strengths of this learning are that it is realistic with student life, concepts are following student needs, fosters student inquiry nature, concept retention becomes strong, and fosters problem-solving abilities [17].

Existing research so far has only focused on blended learning [5, 8, 11, 18, 19] or problem-based learning [20–22]. Therefore, this study attempts to fill in existing emptiness, namely the use of a combination of blended learning and problem-based learning as well as the impact on motivation, independence, and student achievement in statistical learning. The study was conducted involving three different classes and each received a different treatment. Therefore, the purpose of this study is to: 1) determine the effectiveness of a combination of blended learning and problem-based learning in increasing student motivation, independence, and statistical learning achievement; 2) find out which is more effective in increasing student motivation, blended learning, problem-based learning, or a combination of blended learning and problem-based learning; 3) find out which one is more effective in increasing student learning independence, blended learning, problem-based learning, or a combination of blended learning and problem-based learning; 4) find out which is more effective in improving student achievement in statistical learning, blended learning, problem-based learning, or a combination of blended learning and problem-based learning.

2. Methods
This type of research is a quasi-experimental design with a pretest-posttest equivalent comparison group design. The study population was students of the Tarbiyah Faculty and Teacher Training IAIN Ponorogo. As a sample, three classes were chosen randomly. One class was treated with a combination of blended learning and problem-based learning, one class was treated with only blended learning and one class was treated with only problem-based learning.

Before being treated, a manova test was carried out to ensure that all three classes had the same motivation, independence, and statistical learning achievement. The instruments used in this study were learning motivation questionnaires and learning independence questionnaire and statistical learning achievement test. Each instrument was developed concerning the grid and has been through expert judgment and trials to determine its validity and reliability. Only valid instrument items are used for data collection. Based on the results of the reliability test using Cronbach Alpha obtained r-value on the learning motivation instrument of 0.862 (reliable), learning independence of the instrument of 0.791 (reliable) and learning motivation of 0.916 (reliable).

Furthermore, the data that has been collected is analyzed descriptively and inferentially. Descriptive data analysis is used to describe the average, standard deviation, maximum and minimum scores of motivation, independence, and student statistical learning achievement. The inferential analysis is used to test research hypotheses using multivariate analysis of variance (MANOVA). Previously, a manova prerequisite test consisted of a multivariate normality test and a variance-covariance matrix homogeneity test. After a manova test, a post hoc test is performed using the Bonferroni test if the data is homogeneous and using the Games-Howell test if the data is not homogeneous. This further test aims to find out which treatment is more effective in increasing motivation, independence, and statistical learning achievement of students. Technically the data analysis was performed using SPSS 25 software.
3. Results and discussion

3.1. Results

The treatment of blended learning is done using Google Classroom as a management learning system. Lecture material, assignment collection, and exams are conducted online using Google Classroom. Figure 1, Figure 2, and Figure 3 are some pictures of the lecture process using Google Classroom as a learning system.

Figure 1. Blended learning process using Google Classroom

Figure 2. The process of giving assignments and lecture material

Figure 3. The process of gathering and evaluating assignments
Before and after learning using blended learning and also problem-based learning for one semester, a questionnaire was given to measure learning motivation and learning independence as well as tests to measure student achievement in statistical learning. Description of learning motivation data presented in Table 1, data on learning independence presented in Table 2, and learning achievement presented in Table 3.

**Table 1. Description of Student Learning Motivation Data**

| Description | Combination of Blended Learning and Problem Based Learning | Blended Learning | Problem Based Learning |
|-------------|----------------------------------------------------------|-----------------|------------------------|
|             | Pre Test | Post Test | Pre Test | Post Test | Pre Test | Post Test |
| Average     | 78,03    | 88,00     | 77,11    | 83,71     | 78,21    | 76,91     |
| Standard Deviation | 4,718 | 5,122 | 5,357 | 5,773 | 5,439 | 5,439 |
| N           | 35       | 35        | 35       | 35        | 33       | 33        |

**Table 2. Description of Student Learning Independence Data**

| Description | Combination of Blended Learning and Problem Based Learning | Blended Learning | Problem Based Learning |
|-------------|----------------------------------------------------------|-----------------|------------------------|
|             | Pre Test | Post Test | Pre Test | Post Test | Pre Test | Post Test |
| Average     | 78,03    | 86,46     | 77,11    | 77,91     | 76,91    | 85,36     |
| Standard Deviation | 4,119 | 4,300 | 4,159 | 4,388 | 4,146 | 6,152 |
| N           | 35       | 35        | 35       | 35        | 33       | 33        |

**Table 3. Description of Student Statistics Learning Achievement Data**

| Description | Combination of Blended Learning and Problem Based Learning | Blended Learning | Problem Based Learning |
|-------------|----------------------------------------------------------|-----------------|------------------------|
|             | Pre Test | Post Test | Pre Test | Post Test | Pre Test | Post Test |
| Average     | 59,91    | 92,11     | 59,26    | 83,83     | 58,97    | 82,67     |
| Standard Deviation | 4,566 | 5,395 | 3,416 | 4,805 | 4,217 | 4,113 |
| N           | 35       | 35        | 35       | 35        | 33       | 33        |

Table 1 above illustrates that students' initial learning motivation in the three classes is the same, both in the blended learning class, problem-based learning, and in the combination, class blended learning and problem-based learning. However, the results of the post-test showed that the average student motivation in the three classes was not the same. Meanwhile, in Table 2 above illustrates that the independence of early learning of students in the three classes is also relatively the same, both in blended learning classes, problem-based learning, as well as in-class combinations of blended learning
and problem-based learning. However, the results of the post-test showed that the average learning independence of students in the three classes was not all the same. Whereas in Table 3 above, it illustrates that the initial achievement of students in the three experimental classes is relatively the same, both in the blended learning class, problem-based learning, and in the combination class blended learning and problem based learning. However, the results of the post-test showed that the average statistical learning achievement of students in the three classes was different.

Furthermore, data analysis was carried out to determine the effectiveness of a combination of blended learning and problem based learning in increasing student motivation, independence, and statistical learning achievement. Before the Manova test is carried out, a prerequisite test which includes a multivariate normality test with the results presented in Table 4 and a variance-covariance matrix homogeneity test with the results presented in Table 5.

### Table 4. Multivariate Normality Test Results

|                      | $d_i^2$ Pre Test | $d_i^2$ Post Test |
|----------------------|------------------|-------------------|
| Combination of Blended Learning and Problem Based Learning | 50.32%           | 51.72%            |
| Blended Learning     | 55.09%           | 53.41%            |
| Problem Based Learning | 51.84%       | 52.27%            |

### Table 5. Box’s Test of Equality of Covariance Results

|                | Pre Test | Post Test |
|----------------|----------|-----------|
| Box’s M        | 16,361   | 11,318    |
| F              | 1,304    | 0,902     |
| Sig.           | 0,208    | 0,544     |

The results of data analysis as listed in table 4 show that the value $d_i^2$ is more than 50%, both in pre-test and post-test blended learning, pre-test and post-test problem-based learning [23,24], as well as pre-test and post-test combination of blended learning and problem-based learning. It can be concluded that all data, both pre-test and post-test are normally distributed multivariate. Furthermore, in table 5 shows that the value $\text{Sig.}$ is more than $\alpha$ that $H_0$ is accepted [23,24], so it can be concluded that the variance-covariance matrix in the pre-test and post-test is homogeneous.

The fulfillment of the two main assumptions of manova, can be a foothold to proceed on the manova test. The results of the manova test to determine the effectiveness of blended learning, problem-based learning, a combination of blended learning and problem based learning in increasing motivation, independence, and student achievement in statistical studies are presented in Table 6.

### Table 6. Manova Test Results Using Hotelling’s Trace

|                | Pre Test | Post Test |
|----------------|----------|-----------|
| Value          | 0.976    | 2.137     |
| $F$            | 0.405    | 34.548    |
| $\text{Sig.}$  | 0.875    | 0.000     |
Based on the above table, the pre-test results show that \textit{Sig.} the Hotelling’s Trace test value is more than $\alpha$ that $H_0$ is accepted [24, 25], so it can be concluded that the motivation, independence, and achievement of student statistics in blended learning classes, problem based learning, a combination of blended learning and problem based learning are equally good. While the post test results show that the value of $\text{Sig.}$ Hotelling’s Trace test is less than $\alpha$ that $H_0$ is rejected [24, 25], so it can be concluded that the effectiveness of blended learning, problem based learning, a combination of blended learning and problem based learning in increasing motivation, independence, and statistical learning achievement of students is not the same. Therefore, to see the effectiveness of each treatment, post manova further testing is needed. The results of further tests using the Bonferroni Test are presented in Table 7 below.

| Dependent Variable     | (I) Method          | (J) Method         | Mean Difference (I-J) | Std. Error | Sig. |
|------------------------|---------------------|--------------------|-----------------------|------------|------|
| Motivation to learn    | Combination Model   | Blended Learning   | 4.29                  | 1.303      | 0.004|
|                        |                     | Problem Based Learning | 11.09               | 1.323      | 0.000|
|                        | Blended Learning    | Problem Based Learning | 6.81               | 1.323      | 0.000|
| Learning independence  | Combination Model   | Blended Learning   | 8.54                  | 1.161      | 0.000|
|                        |                     | Problem Based Learning | 1.09               | 1.178      | 1.000|
|                        | Blended Learning    | Problem Based Learning | -7.45              | 1.178      | 0.000|
| Learning achievement   | Combination Model   | Blended Learning   | 8.29                  | 1.221      | 0.000|
|                        |                     | Problem Based Learning | 9.45               | 1.159      | 0.000|
|                        | Blended Learning    | Problem Based Learning | 1.16               | 1.083      | 0.534|

3.2. \textit{Discussion}

Based on the above data analysis, it appears that there are differences in the effectiveness of the blended learning model, problem based learning, and the combination of blended learning problem based learning in increasing motivation, independence, and student achievement in statistical learning. Specifically, it can be seen from the results of the analysis of the effectiveness test data as listed in Table 7 above. Therefore some conclusions can be formulated as follows. First, because the value of $\text{Sig.}$ comparative motivation between the combination of blended learning problem based learning and blended learning is less than $\alpha$ that $H_0$ is rejected [25], it can be concluded that there are differences in student motivation to learn using the blended learning method and the combination of blended learning problem based learning. Taking into account the difference between the two, it can be concluded that the learning motivation of students who learn to use the combination method of blended learning problem based learning is higher than blended learning. Likewise because the value of $\text{Sig.}$ comparative motivation between the combination of blended learning problem based learning
and problem based learning is less than \( \alpha \) that \( H_0 \) is rejected [25], it can be concluded that there are differences in learning motivation of students who learn to use the method of problem based learning and the combination of blended learning problem based learning. Taking into account the difference between the two, it can be concluded that the learning motivation of students who learn to use the combination method of blended learning problem based learning is higher than problem based learning. Furthermore, because the \( \text{Sig.} \) value of comparative motivation between blended learning and problem based learning is less than \( \alpha \) that \( H_0 \) is rejected [25], it can be concluded that there are differences in learning motivation of students who learn to use blended learning methods and problem based learning. Taking into account the difference between the two, it can be concluded that the learning motivation of students who learn to use blended learning methods is higher than problem based learning. These three conclusions are in line with various previous research results which state that blended learning can significantly increase student learning motivation [26–28].

Second, because the value of the \( \text{Sig.} \) comparative independence between the combination of blended learning problem based learning and blended learning is less than \( \alpha \) that \( H_0 \) is rejected [25], it can be concluded that there are differences in the learning independence of students who learn to use the blended learning method and the combination of blended learning problem based learning. Taking into account the difference between the two, it can be concluded that the learning independence of students who study using the combination method of blended learning problem based learning is higher than blended learning. Meanwhile, because the value of comparative independence between blended learning and problem based learning is less than \( \alpha \) that \( H_0 \) is rejected [25], it can be concluded that there are differences in the learning independence of students who learn to use the blended learning method and problem based learning. Taking into account the difference between the two, it can be concluded that the independence of learning of students who learn using problem based learning methods is higher than blended learning. However, because the value of comparative independence between the combination of blended learning problem based learning and problem based learning is more than \( \alpha \) that \( H_0 \) is accepted [25], it can be concluded that the learning independence of students who learn to use the method of problem based learning and the combination of blended learning problem based learning is equally. This conclusion is in accordance with other studies which concluded that problem based learning is effective in increasing learning independence [29,30].

Third, because the value of \( \text{Sig.} \) comparative achievement between the combination of blended learning problem based learning and blended learning is less than \( \alpha \) that \( H_0 \) is rejected [25], it can be concluded that there are differences in the learning achievements of students who learn to use the blended learning method and the combination of blended learning problem based learning. Taking into account the difference between the two, it can be concluded that the learning achievement of students who study using the combination method of blended learning problem based learning is higher than blended learning. Likewise, because the value of \( \text{Sig.} \) comparative achievement between the combination of blended learning problem based learning and problem based learning is less than \( \alpha \) that \( H_0 \) is rejected [25], it can be concluded that there are differences in student achievement in learning that learns using the method of problem based learning and the combination of blended learning problem based learning. Taking into account the difference between the two, it can be concluded that the learning achievement of students who learn to use the combination method of blended learning problem based learning is higher than problem based learning. These results are consistent with the results of other studies which concluded that blended learning is effective in increasing student achievement [10,12,31–33]. However, because the value of \( \text{Sig.} \) comparative achievement between blended learning and problem based learning is more than \( \alpha \) that \( H_0 \) is accepted [25], it can be concluded that the learning achievements of students who learn using the blended learning method and problem based learning are equally.
4. Conclusion
Based on the results of the data analysis and discussion above, the following conclusions can be formulated. First, there is a difference in effectiveness between blended learning, problem based learning, and the combination of blended learning and problem based learning in increasing student motivation, independence, and statistical learning achievement. Second, the combination of blended learning and problem based learning methods is more effective in increasing student learning motivation than blended learning and problem based learning. Likewise the blended learning method is more effective in increasing student motivation than problem based learning. Third, the combination method of blended learning and problem based learning has the same effectiveness as problem based learning in increasing student learning independence. Both are more effective in increasing the independence of student learning than blended learning. Fourth, the combination of blended learning and problem based learning methods is more effective in increasing student statistical learning achievement than blended learning and problem based learning. However, the blended learning method and problem based learning have the same effectiveness in increasing students' statistical learning achievement.

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