Effects of the Flipped Classroom on Learning Outcomes, Students' Motivation and Learning Strategies

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1. Introduction

Flipped classroom is not a new learning method. According to Akçayır, the first study on flipped classrooms was conducted and published in 2000 showed that most students and teachers had positive opinions of the flipped model [1]. Emergence of a pandemic has made the flipped classroom method becoming more popular. The reason is a flipped classroom can partly do online and partly face-to-face that suitable with pandemic situation. Effectively, students can study independently by...
theirself before join in online class. During flipped classroom sessions by online method students participate in media conferences during face-to-face sessions.

The flipped classroom approach was used in the majority of classrooms in higher education. In this case, flipped classrooms also used in probability and statistics. However, there was many problems during the implementation, such as the readiness of lecturers to provide appropriate materials for online sessions, because in the early of implementation, the lecturers also learned how to prepare learning videos properly. Besides that, the students also maybe not common with learning independently. It was exacerbated by not stable internet connection. In the end, lecturers and students try to adapt with new learning process. Finally, the student learning outcomes showed unsatisfactory results.

The final grades of Probability and Statistics courses on Table 1 shows that the percentage of students who scored D and E in learning using the flipped classroom (odd semester 2020/2021) method increased by 11.5%. This shows that student grades have decreased with the implementation of the flipped classroom method. Although, David, et.al found that there was a small positive effect on learning outcomes with flipped classroom [1].

| Table 1. Percentage of Grades Probability and Statistics Course |
|-----------------|-----------------|-----------------|
| Grades          | Odd Semester 2019/2020 | Odd Semester 2020/2021 |
| A               | 0.6%             | 2.1%             |
| AB              | 10.8%            | 5.1%             |
| B               | 24.7%            | 18.2%            |
| BC              | 30.7%            | 27.1%            |
| D               | 22.3%            | 21.6%            |
| E               | 9.0%             | 21.2%            |

Furthermore, the independent learning which is main part of flipped classroom requires regulating and controlling oneself well to achieve an effective learning experience. For example, while online session is running, students have flexible time to explore the materials. Normally, lecturer will give task in pre-class for guiding students in independent learning, so that students can practice managing their self-regulate and self-control, also finding the way to achieve learning objective. Therefore, learning process with flipped classroom is expected to influence learning motivation and learning strategies students. This study aims to know the effect of flipped classroom on the learning outcomes and learning motivation and strategies.

2. Method

The subjects of this study were students taking the Probability and Statistics course in Odd Semester academic year 2022/2023. Sources of data used in this study are questionnaires filled out by students related to learning motivation and learning strategies; and score of learning outcomes for Probability and Statistics courses. In research, there is an experimental class and a control class. By conducting a pre-test, the experiment and the control class were selected. The pre-test has a fairly similar average and standard deviation. Therefore, we select the control class and the experiment class at random. Informatics serves as the control class, whereas Information System serves as the experiment class.

The experimental class was treated with the application of a flipped classroom and a control class carried out as usual, the material is given during the lecture. Before being given treatment with the implementation of the flipped classroom, given a pretest first in order to persuade researchers that students in the control class and experimental class had equivalent abilities. Following treatment in both the experimental and control groups, a post-test was administered to get information on learning...
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outcomes, and questionnaires were sent out to gather information on learning motivation and learning strategies. Data which was then processed using the R Studio programs.

2.1. Statistical Parametric Test

In order to make conclusions about the population as a whole, research is typically done on a representative sample. Parametric tests are the most powerful test for testing the significance of the trustworthiness of the computed sample statistics. Hypothesis testing tests whether a parameter differs from a value or other parameters. The parametric test is based on the assumption that data is normally distributed. A method to test the normality of data is Kolmogorov-Smirnov (KS) test. The KS statistics are based on the maximum differences between the empirical distribution function (EDF) [2].

The mean is the value of the center of the data. Tests that involve two means with unknown variance from two unrelated populations are called independent t-tests. Before carrying out the independent t-test, a ratio test of two variances needs to determine whether the variances are considered the same or different. The statistic for testing variances two populations same versus different is [3]:

\[
F = \frac{s_1^2}{s_2^2}
\]

where \(n_1\) and \(n_2\) are sample size, \(s_1^2\) and \(s_2^2\) are variances from the two samples respectively. If the null hypothesis is true and the two populations are approximately normally distributed, so \(F\) is follows \(F\)-distribution with degrees of freedom are \(v_1 = n_1 - 1\) and \(v_2 = n_2 - 1\).

The difference between two means test with a hypothesis \(H_0\), mean a population equal to another population versus \(H_1\) is the mean of a population different from other populations. There are two hypothesis testing: t-test independent sample equal variance and unequal variance.

2.2. Mann Withney U-Test

The Mann-Whitney U test is a nonparametric test that can be used on two-sample unpaired data. Calculating value differences isn't feasible with unpaired data, though. Instead, we rank all of the original sample values after pooling them. Tests of hypotheses are:

\(H_0\): the two populations have identical distributions

\(H_1\): the two populations have different medians, but otherwise are identical

The first step in computing the statistical test is to combine the two samples (the test and control data) which have sizes of \(n_t\) and \(n_c\), respectively into a single, sizable sample. In the large samples, we arrange the data values \(1, \ldots, n_c + n_t\) and then calculate the sums of the ranks from each individual sample. \(R_t\) is the sum of the ranks of the test sample and \(R_c\) is the sum of the ranks of the control sample. Then, \(U_t\) and \(U_c\) are calculated using the following formula [4]:

\[
U_t = n_t n_c + 0.5 n_t (n_t + 1) - R_t
\]

\[
U_c = n_t n_c + 0.5 n_c (n_c + 1) - R_c
\]

Afterwards, a critical value from a table is compared with the less than value of \(U_t\) or \(U_c\). In the event that the computed value falls below the crucial threshold, the null hypothesis is rejected.
3. Results and Discussion

3.1. Impact Flipped Classroom to Learning Outcome

Post-test used to evaluate the difference learning outcomes between experiment class- with flipped classroom and control class. Table 1 shows the descriptive statistics of the experiment and control class post-test scores.

Table 2.

<table>
<thead>
<tr>
<th>Number</th>
<th>Class</th>
<th>N</th>
<th>Mean</th>
<th>Std.Dev</th>
<th>Std.Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>48</td>
<td>38.131</td>
<td>19.459</td>
<td>2.809</td>
</tr>
<tr>
<td>2</td>
<td>Experiment</td>
<td>51</td>
<td>34.640</td>
<td>13.165</td>
<td>1.843</td>
</tr>
</tbody>
</table>

Based on descriptive statistics, the average post-test scores for the control class is higher than the experiment class. However, the variance in scores between students was also higher. This shows that the post-test scores for the control class are more diverse than the experiment class. Result of normality test raw data of post-test in Figure 1 is not normally distribution with P-value $3.055 \times 10^{-5}$. So, transformation using square root is necessary. After transformation, the Kolmogorov-Smirnov (KS) test is shown data distributed normally with P-value 0.142.

Fig. 1. Output R for Normality Test

After that, F for test two variance is running. The result is variance post-test control class is different with experiment class. P-value for F test is 0.016. Then Welch two sample t test is shown that mean post-test control class same as experiment class show at Figure 2. P-value of 0.704 for t test indicates accept $H_0$.

Fig. 2. Output R for F and t Test
Testing the hypothesis on the results of the post-test showed that students in the control and experimental classes were not significantly different in achieving the posttest scores given. The average posttest score of students in the control class was indeed higher, although not significant, but the variance in scores between students was also higher and statistically significant. This result told that there was no effect of flipped classroom in the learning outcomes students. It was supported by Rita that found that the largest challenge in implementing flipped classrooms is getting students to change their mindset because they are accustomed to playing a passive role in traditional classrooms [5]. The passive mind-set of student can make the independent learning not optimal. So the lecturer should change their mind-set.

Besides that, flipped classroom requires careful planning. Lecturers guide students with materials prepared and communication media in the independent learning. There were two things that influenced the implementation of flipped classroom, first is the caliber of the instructional scenario (i.e., make them engaging and not too long), and the second is the availability of more interaction/communication capabilities (which are reportedly not widely used at the moment) to assist students in getting assistance or feedback when working on assignments or homework outside of class [6]. Another addition, Sya’adah found several challenges while implementing flipped classrooms, such as the use of technology, and some students feel unfamiliar with this method [7]. To overcome this problem, the teacher should engage well and communicate with the students. Therefore, to effectively implement the flipped learning model, it is important to reinforce the technical infrastructure, particularly the high-speed internet, and to motivate and encourage students to use the online resources such as videos, animations, simulations, interactive activities, and course materials to study outside of the classroom [8]. The lecturer should be able to provide online resources to make flipped classroom doing well.

Thus, although the learning outcomes in with or without flipped classroom is same, but in the face-to-face sessions, the flipped classroom class is more active than traditional class. It happened because of the experiment class, through the use of digital movies that have been created by the teacher in response to the needs of the students, students are expected to master course material outside of the classroom [5]. Therefore, students can master the content according to students’ learning style, time available, and pace. In this way, students will be better prepared to take part in the learning phase in the classroom, which of course uses more challenging learning activities. Face-to-face interaction in class is used more effectively to guide students to apply the knowledge they have mastered before entering the class.

3.2. Impact Flipped Classroom to Learning Motivation and Strategies

Result of questionnaire Motivated Strategies for Learning Questionnaire (MSLQ) used to evaluate the difference learning motivation and strategies between experiment class- with flipped classroom and control class. Table 2 shows a summary of the results of the Mann-Whitney test output of the R software between the experimental and control classes of the total MSLQ statements for each indicator.

<table>
<thead>
<tr>
<th>Group</th>
<th>Component</th>
<th>Indicator</th>
<th>Mann-Whitney U</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Intrinsic Goal Orientation</td>
<td>1163</td>
<td>0.663</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extrinsic Goal Orientation</td>
<td>1126</td>
<td>0.484</td>
</tr>
<tr>
<td>Learning Motivatio n</td>
<td>Expectancy</td>
<td>Task Value</td>
<td>1060.5</td>
<td>0.252</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control Belief</td>
<td>984.5</td>
<td>0.075</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self-Efficacy</td>
<td>911</td>
<td>0.028a</td>
</tr>
<tr>
<td></td>
<td>Affective</td>
<td>Test Anxiety</td>
<td>1384.5</td>
<td>0.261</td>
</tr>
<tr>
<td></td>
<td>Cognitive &amp; Metacognitiv e</td>
<td>Rehearsal</td>
<td>1473</td>
<td>0.079</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elaboration</td>
<td>1343.5</td>
<td>0.396</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organization</td>
<td>1338</td>
<td>0.254</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metacognitive Self-Regulation</td>
<td>1619</td>
<td>0.005a</td>
</tr>
</tbody>
</table>
Based on the Mann Withney test, only the Self-Efficacy indicator from learning motivation and Metacognitive Self-Regulation from learning strategies are significantly different.

4. Conclusion

Based on the average post test score of probability and statistic course showed that there was no effect significantly on learning outcomes with and without flip classroom method. However, the flip classroom method gives effect to learning motivation and strategies, especially in Self-Efficacy indicator from learning motivation and Metacognitive Self-Regulation from learning strategies.

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References


