Flipping the Classroom: Boosting Student Motivation in Probability and Statistics Education

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Abstract. This study aimed to investigate the impact of the flipped classroom approach on students' motivation and learning strategies in probability and statistics courses. The study included an experimental group that followed the flipped classroom approach and a control group that followed traditional teaching methods. The Motivated Strategies for Learning Questionnaire (MSLQ) was used to collect data on the students' motivation and learning strategies. The results showed that students in the experimental group were more motivated than those in the control group, with significant differences in six statements. Four statements were related to motivation, one to control belief measure, and three to self-efficiency. Two statements were related to learning strategies, specifically elaboration and rehearsal. The findings suggest that implementing the flipped classroom approach can increase students' motivation in probability and statistics courses, and further research is needed to explore its implications in other courses and settings.

Keywords: flipped classroom · learning motivation · learning strategic

1 Introduction

The Covid-19 pandemic in 2020 affected the learning process in higher education. The entire framework of mind and working components of the institution should be changed following the requirement of digital learning; then, only we can win the battle over the pandemic [1]. Learning usually carried out face-to-face directly changes to distance learning using media conferences. It makes the continued implementation of distance learning very dependent on the stability of the internet in real-time. The strength of the internet network is not always good. The consequence is distance learning is not running smoothly. Students need a more flexible distance learning method so that students can study without depending on the stability of the internet in real-time.

One of the learning methods that can be applied to distance learning is flipped classrooms. In principle, a flipped classroom is learning that is partly done online and partly face-to-face. Distance learning using the flipped classroom method allows students to study independently in online sessions and discuss through media conferences in face-to-face sessions. The purpose of flipped classrooms is to allocate more time to explore learning material independently. Furthermore, students must have the basic knowledge to

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discuss actively during face-to-face sessions. The majority of reviewed studies reported that the flipped model promotes improvements in student learning performance and encourages learning motivation and students' positive attitudes [2].

During the pandemic, most of the learning processes in schools and higher education applied the flipped classroom method, including the Probability and Statistics courses. In practice, lecturers provide learning videos, lecture notes, and other learning resources as independent study materials for students in online sessions. Furthermore, in the online, face-to-face session, students discuss the material studied with the lecturer as a facilitator. The study found that there are substantial short-term effects in math with flipped classroom learning than economics. Math instructors report higher rates of students paying attention, asking questions, and working in groups. Survey data also showed that the math classroom increased student engagement and student-teacher interactions more than the economics classrooms [3].

Based on the results of an interview with one of the lectures for the Probability and Statistics course, it was found that only 5 out of 50 students gave responses during the discussion session. It shows that more than 90% of students tend to be passive in the learning process of face-to-face online sessions. This student inactivity is thought to be because students do not have basic knowledge regarding the material they should get from independent study results. Independent study sessions that are not carried out optimally affect student learning motivation. Moreover, independent learning requires regulating and controlling oneself well to achieve an effective learning experience. Therefore students need to know what learning strategies are appropriate for them when studying independently. This study focuses on the effect of applying the flipped classroom method on student learning motivation and learning strategies, especially in the Probability and Statistics course.

2 Literature Review

2.1 Flipping Class

Bergman and Sams, chemistry teachers at Woodland Park High in Colorado, coined the word "flipped classroom" in 2006. Bergman and Sams created this model to give students more time for constructivist activities in the classroom because what is typically done in school is also done at home [4].

The flipped class method is built on two simple steps:

1. Remove the lecture from the group area. Pre-class film viewing and interaction are typical.
2. Use directed instruction-free class time to practice concepts, engaging tasks, and higher-order thinking [5].

In line with the explanation, the flipped classroom is an instructional approach reversing traditional classroom learning processes-what is made outside the classroom is now done in the school. Students are asked to master course content outside the classroom by watching digital videos designed by the teacher based on students' needs [6].

2.2 Motivation

Motivation is the process of starting and continuing activities that help us achieve our goals. In expectancy-value theory, motivation depends on how likely we are to succeed and how much we value the task [7]. To measure students' motivation, we use a questionnaire called the Motivated Strategies for Learning Questionnaire (MSLQ). It asks students to rate themselves on a scale from "not at all true of me" to "very true of me" on how much they are motivated to learn and how they approach learning in college courses [8].

2.3 Learning Strategic

Learning strategies are methods that learners will use to understand learning material more effortlessly, and in the end, the learning objectives can be mastered. In this study, we use MSLQ to identify students' learning strategies. The MSLQ has two components of learning strategies; cognitive and metacognitive strategies and resource management strategies [8].

Cognitive strategies help pupils master math. Rehearsal, organization, elaboration, and critical thinking are cognitive techniques. Rehearsal helps students remember knowledge, while organization helps them study. Critical thinking analyzes and evaluates information, while elaboration compares new information to previous knowledge [9].

Students plan, watch, and regulate learning using metacognitive strategies. Planning involves gathering information and setting goals, while monitoring involves analyzing learning and adjusting. Regulation includes avoiding distractions and persevering through difficult or boring jobs. Effective learning also requires time management, studying in a suitable setting, seeking help from peers or teachers, and regulating effort and perseverance [10].

2.4 Statistics Associated with Chi-Square Test

Research is generally conducted on a representative sample to draw generalizations for the population from which the sample was drawn [11]. A cross-tabulation describes two or more variables simultaneously. Statistical analysis is commonly used for assessing the statistical significance and strength of the association of cross-tabulated variables. The importance of observed association measured by chi-square statistics $\left(\chi^2\right)$. The null hypothesis, H_0 is that there is no association between the variables. Assume that a cross-tabulation has r rows and c columns and a random sample of n observations. Then expected frequency (f_e) for each cell can be calculated by using a simple formula [12]:

$$f_e = \frac{n_r \cdot n_c}{n} \tag{1}$$

where n_r is the total number in the row, n_c is the total number in the column, and n is the total sample size. Then the value of χ^2 is calculated as follows [12]:

$$\chi^2 = \sum_{all\ cells} \frac{(f_0 - f_e)}{f_e} \tag{2}$$

where f_0 is the actual frequency. A systematic association exists, and the probability of obtaining a chi-square value as large as or larger than one calculated from the cross-tabulation is estimated. An essential characteristic of chi-square statistics is the degree of freedom (df) associated with it. The number of degrees of freedom is equal to the product of a number of rows (r) less one and the number of columns (c) less one [13].

$$df = (r - 1) \times (c - 1) \tag{3}$$

The null hypothesis will be rejected only when the calculated value of χ^2 is greater than the critical value of the chi-square distribution with the appropriate degrees of freedom.

3 Methodology

The subject of this study were students who took Probability and Statistics. We used the MSLQ to collect the data with 44 statements. The MSQL consists of two major groups, namely motivation and strategic learning. The indicators of motivation that we used were intrinsic goals, extrinsic goals, task scores, control beliefs, self-efficacy for learning and performance, and test anxiety. The strategic learning indicators that we use are rehearsal, elaboration, organization, metacognitive self-regulation, and effort regulation [8]. For every statement, students can choose seven items, which are 1- very untrue of me, 2- untrue of me, 3- somewhat untrue of me, 4- neutral, 5- somewhat true of me, 6- true of me, 7- very true of me.

The experiment and the control class were determined by conducting a pre-test. The average and standard deviation of the pre-test are very similar. So we choose the experiment class randomly and the control class. The experiment class is Information System, and the control class is Informatics. The experiment class was given treatment with the flipped classroom. Before joining the class, students are given some materials like PowerPoint and video, then make the summary. On the other hand, control class traditionally. The lecture explained the materials and gave the homework.

4 Result and Discussion

The questionnaire results were distributed to 99 participating respondents; there were 51 respondents in the experimental class and 48 respondents in the control class. The statements are mapped based on groups, components, and indicators based on the Motivated Strategies for Learning Questionnaire Manual [8]. The number of each statement and validity test results are shown in Table 1.

All question is valid using a correlation test for validity. Chi-square was used as a contingency test to compare response patterns by class. Based on 44 statements in the questionnaire, only six statements were significantly related between the control and experimental class. Table 2 shows the six statistically significant statements.

We can see from Table 1 that the P-value is smaller than the significance level of 0,05. For example, in statement number 9, P- value 0,011. It means that statement number 9 is related between the control and experimental class, likewise statements number 10, 11,

Table 1. Validity Test Result

Group	Component	Indicator	Numb. of Statement	Validity
Learning Motivation	Value	Intrinsic Goal Orientation	2	Valid
		Extrinsic Goal Orientation	2	Valid
		Task Value	8	Valid
	Expectancy	Control Belief	1	Valid
		Self-Efficacy	5	Valid
	Affective Cognitive & Metacognitive	Test Anxiety	4	Valid
Learning Strategic		Rehearsal	5	Valid
		Elaboration	3	Valid
		Organization	4	Valid
		Metacognitive Self-Regulation	5	Valid
	Management	Effort Regulation	5	Valid
Total			44	Valid

Table 2. Statistically Significant statements

Statement	P-value	Associations
Q09. Compared with others in this class, I think I'm a good student	0.011	Significant
Q11. I am sure I can do an excellent job on the problems and tasks assigned for this class	0.003	Significant
Q16. My study skills are excellent compared with others in this class	0.000	Significant
Q18. Compared with other students in this class, I think I know a great deal about the subject	0.013	Significant
Q10. I often choose paper topics I will learn something from, even if they require more work	0.009	Significant
Q41. I am sure I can do an excellent job on the problems and tasks assigned for this class	0.019	Significant

16, 18, and 41. Statement number 9 is categorized as a control belief. Statements 11, 16, and 18 are classified as self-efficacy for learning. Where belief control and self-efficacy for learning are a component of motivation. Statement number 10 is elaboration, and number 41 is the rehearsal. Both of them are components of strategic learning.

Figures 1 and 2 show questionnaire results about six statements, which are 1- very untrue of me, 2- untrue of me, 3- somewhat untrue of me, 4- neutral, 5- somewhat true of me, 6- true of me, 7- very true of me. The result of all statements is that students in

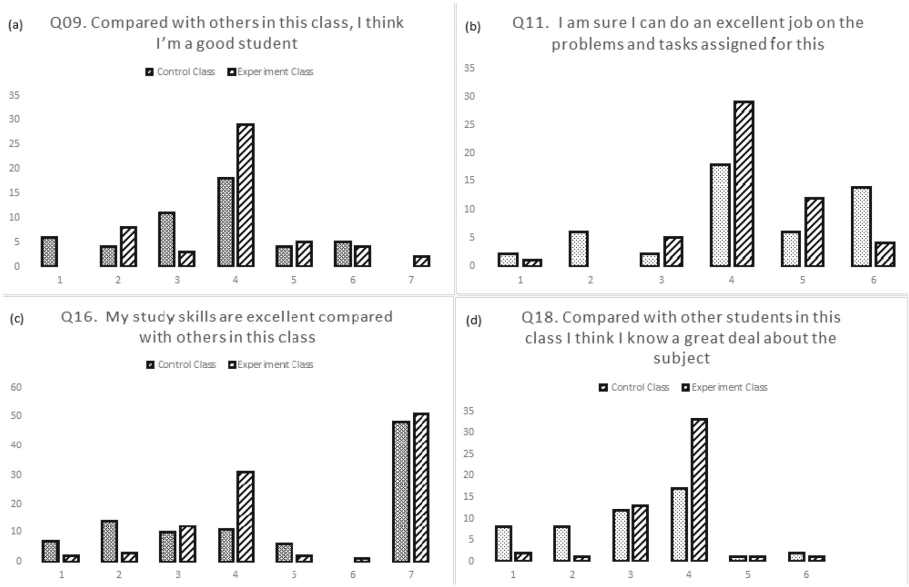

Fig. 1. Questionnaire Result about Motivation (a) Q09, (b) Q11, (c) Q16, (d) Q18

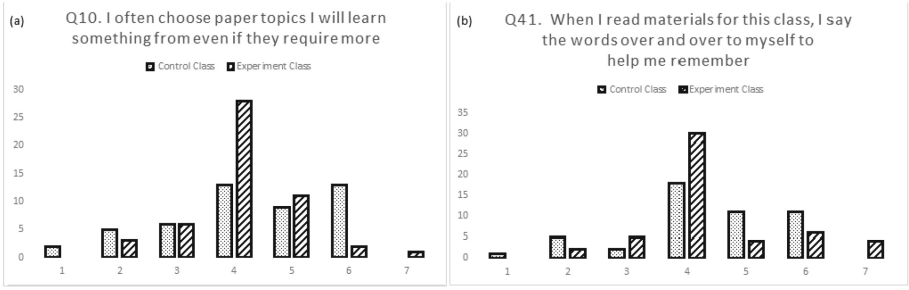

Fig. 2. Questionnaire Result about Learning Strategic (a) Q10, (b) Q41

the experimental class are more confident than those in the control class. They answer motivation statements higher than students in the control class for the statement about their ability in probability and statistics courses.

Figure 1 shows that the experimental class responds better than the control class. Students in the experimental class generally answer more than the control class on 4- neutral, 5- somewhat true of me, 6- true of me, and 7- very true of me. On the other hand, students in the control class generally answer more than the experimental class on answers 1- very incorrect from me, 2- not true from me, and 3- somewhat incorrect from me.

Figure 2 shows that students in the experimental class answered more than the control class in 4- neutral, 5- somewhat true of me in statement 10 (often chose paper and learn something require more). But total control students answer "6- true of me" more than

the experimental class in this statement. At statement 41, students in the experimental class only higher on neutral. This result indicates that students in flipped learning are less confident in learning strategies.

5 Conclusion

The learning of probability and statistics in a flipped classroom is conducted in the Information Systems class, and learning without flipped classroom is shown in the Informatics class. The MSQL questionnaire measured the effect of the flipped classroom on learning motivation and learning strategies. MSQL questionnaire consists of 44 statements to which 99 students from both classes have responded. Responses to students in the information system class to the MSQL statement are statistically significant in learning motivation. However, responses from students in the informatics class to the MSQL statement are statistically significant in learning strategy. Based on the result, flipped classrooms affect students in four statements of motivation. On the other hand, flipped classrooms no have a positive impact on two statements of learning strategies.

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