The effectiveness of the blended learning approach in algorithm and programming courses

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Abstract. The purpose of this research is to increase learning achievement by applying the Blended Learning Approach. The Algorithm and Programming course is a subject that requires more problem-solving practice. Learning is done by applying the Flipped Classroom. In face-to-face activities, students do cooperative learning. They discuss the solution of a given computational problem. Student motivation and engagement were measured using the MUSIC® Model of Academic Motivation. MUSIC® Model measures five components, namely Empowerment, Usefulness, Success, Interest, and Caring. Log activities are used to see the interaction between students and Moodle's Learning Management System (LMS). Log activities show student contributions to discussion forums, number of hits on LMS, number of learning object accesses, and days to access learning objects. Face-to-face learning with cooperative learning trains the ability to work together in groups. The study showed that the Usefulness component had the highest value, with an average of 80.11, while success had the lowest score with a value of 70.16. The learning experience of each student using LMS was different. Students who actively use LMS have better abilities when learning face-to-face.

Research shows there is a link between online learning activities and face-to-face learning on learning achievement.

1. Introduction
Learning must be done by following the characteristics of the learner. Nowadays, learners are Generation Z; a generation where technology is attached to life. Generation Z instructors must prepare software, hardware, or other digital technologies that support the learning process. Creative classroom setups will be required in the learning process [1]. A change in the learning approach from the traditional teaching approaches to the Blended Learning approaches must be made. Blended Learning approaches are an approach to education that combines online learning activities with traditional classroom methods. Online learning can be managed using a Learning Management System (LMS).

Flipped Classroom is a learning setting where learners can access material before the meeting is held. Flipped Classroom can be implemented using the Blended Learning approach. Material or self-assessment can be done through online learning. The Flipped Classroom approach can increase student engagement, resulting in better learning outcomes [2–4]. Besides, the Flipped Classroom helps
students better to be more involved during classroom activities [5,6]. Students in the Blended Learning setting have a better learning performance compared to fully online. Moreover, the Flipped Classroom has a positive impact on self-efficacy beliefs and intrinsic motivation [7].

Algorithms and Programming are introductory courses that computer science students must master. This course is given in the first semester. The difficulty influences the high dropout rate in Computer Science courses in understanding the concept of programming [8]. Therefore, we need an effective learning strategy for Algorithm and Programming courses. This study applies the Flipped Classroom approach to the Algorithm and Programming course at Universitas Udayana. Face-to-face learning is carried out with a problem-solving approach or case studies conducted with individuals and cooperative learning. Student responses to online learning differ due to different digital literacy skills. This happens because of the inequality of access and various quality of education in Indonesia [9]. Therefore, this study aims to design learning with the Flipped Classroom approach in Algorithm and Programming courses. Besides, the effectiveness of learning is measured by looking at the learning outcomes and academic motivation of learners in taking courses with a blended learning approach. Correlation analysis was carried out to see the relationship between online and face-to-face learning activities on learning outcomes and the correlation between online learning activities and student participation in face-to-face activities. Academic motivation is an observable process of action and verbalization, both through physical and mental activities, to achieve learning outcomes [10]. Academic motivation does not directly impact learners, but motivated learners are involved in activities that support the learning process. In this study, an analysis of the effectiveness of learning with a blended learning approach was observed from learners' behavior using a learning management system, student participation during cooperative learning in class, and academic learner motivation. The rest of this paper is organized as follows: Section 2 explains the method and setting of the study, section 3 shows the results of data analysis, discusses the result, and Section 4 concludes this study.

2. Method
This study uses a case study in the Algorithm and Programming Course, Universitas Udayana, Indonesia. The research population consisted of 50 first semester students in the Informatics study program. Learning is carried out using the Flipped Classroom method with the Blended Learning approach. Table 1 shows the stages of learning development with a blended learning approach.

### Table 1. Blended Learning-based Learning Development Stages in Algorithm and Programming Courses

| Stage 1: Instructional Design Development and Learning Management System Set-up |
|---|
| - Develop blended learning-based instructional designs that show strategies for learning and assessment activities to measure the achievement of learning outcomes. |
| - At this stage, prepare courses on the learning management system (Moodle). Preparation is done by making courses, providing course descriptions, and preparing enrollment methods. |
| - This stage makes arrangements related to access restriction of course material. So that students can access materials sequentially according to the learning plan. |

| Stage 2: Educational Material Development |
|---|
| - This stage develops learning objects in the form of text (slides and handouts), short videos (maximum 5 minutes) for several topics, and program code examples. |
| - Assessments are categorized in face-to-face and online mode. |
| - Each learning topic is completed with a self-assessment in the form of a quiz (eg, multiple-choice or true-false). |
| - Formative assessment is used to assess the level of student participation in lectures. |
| - Summative assessment is carried out by solving computational problems that are given face-to-face or online. |

| Stage 3: In-class/out-of-class Activities |
|---|
| - In-class activities are carried out to provide a general explanation of the course of the learning. Some of the in-class activities carried out are group discussions, small group activities, problem-solving / case studies, and students' presentations. |
| - Out-of-class activities are performed using an LMS. Some learning settings are carried out, such as videos, readings, quizzes, discussion, homework, reflection, and online modules. |
Stage 4: Students Feedback
- This study collected feedback from students regarding algorithms and programming's learning experience with a blended learning approach. The online questionnaire was used to reflect with a one-minute paper, and the students' motivation was measured according to the MUSIC® Model.

Algorithm and programming courses are divided into two parts, algorithm topics presented in the first eight meetings and programming topics in the next eight sessions. On the topic of algorithms, the learning strategy is carried out by independent learning, which is carried out outside the classroom through LMS. Most of the learning objects in this topic are in the form of text and simulations. In-class activities conducted discussions and presentations on the results of their cooperative learning. The lecturer provides an assessment of the level of student activity, referring to the assessment rubric. Unlike the first topic, learning objects on programming topics provide more video tutorials related to programming. Several programming guide modules are given according to the topic. In in-class activities, lecturers provide computational / algorithm problems, and students create programs to solve them.

This study measures the effectiveness of learning in three ways, namely: 1) making direct observations on in-class activities to measure the level of student participation/activity in the learning process, 2) Using the log activity provided by LMS Moodle. Researchers used the activity log to see activity data in online forums, the number of hits, the number of days accessing online courses, the number of resources views, 3) taking data on the value of self-assessment quizzes on the LMS and the score of assignments either online or face-to-face. 4) Using feedback to get students' academic motivation in taking blended learning classes in algorithm and programming subjects referring to the MUSIC® Model [10,11]. MUSIC® Model of Motivation is used to diagnose motivational strengths and weaknesses of instruction [11]. MUSIC® Model measures five main components, including empowerment, usefulness, success, interest, and caring. These five main components are measured using 26 questions. The response options for each question are as follows: 1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Somewhat Agree, 5 = Agree, 6 = Strongly Agree. The average scale score is calculated by averaging the item values for each component. The scale score value is then converted into a scale of 100.

3. Result and Discussion

3.1. Student learning outcomes
The grades of student learning outcomes are analyzed at the end of the semester. Table 2 shows student learning outcomes whose data retrieved from log activities, direct observation (F2F participation), and assessment scores. Summative assessment is carried out in two forms of quizzes and assignments through the Moodle LMS. The table shows that student participation in participating in online forums is still not good; this also occurs when the number of hits made to courses has a high variation.

| Table 2. Student Log Activity |
|------------------------------|
| Minimum | Maximum | Mean  | Std. Deviation |
| Online Forum | 0 | 179 | 31.20 | 39.482 |
| Hits | 169 | 636 | 332.18 | 120.497 |
| Days | 27 | 91 | 45.00 | 12.705 |
| Resources View | 20 | 111 | 36.60 | 19.102 |
| Participation F2F | 2 | 23 | 8.04 | 4.558 |
| AvgQuiz | 55.00 | 92.97 | 83.8255 | 6.54150 |
| AvgAssignment | 25.83 | 77.89 | 51.0643 | 13.13499 |

Some students seem comfortable with online discussions; this can be seen from the number of online forums. On the other hand, some other learners still lack self-confidence, so they did not participate in the learning process. Face-to-face learning shows that learners' participation in discussions is not significantly different from online learning. Teachers must motivate learners so they
can participate in both online forums and face-to-face learning. Assessment in the form of a quiz is carried out on each learning topic. The average quiz score appears to have been above 80, with a standard deviation of 6.5. This grade indicates that the average student has reached the expected learning outcome. However, the assignment activity has an unsatisfactory score. Both forms of assessment mean that learning outcomes in the realm of knowledge have been achieved. Meanwhile, learning outcomes in the realm of application and analysis have not been maximally achieved in blended learning. Assessment is a task carried out collaboratively intending to see the depth of the learner's understanding and technical programming skills.

This study shows a correlation between the final score and the seven activity scores described earlier in Table 1. The final score is categorical data; the final score is passed if the student's score is greater than or equal to 65. The number of students who passed is 41 out of 50 students. Table 3 shows the correlation analysis results using the Pearson Correlation Coefficient (PCC) method. Based on the table, student graduation has the highest correlation with learner participation in face-to-face activities and assessments in assignments. The number of activeness in online forums and the number of days accessing the online course have a high enough correlation. The smallest correlation is shown in the number of hits. This value means that the number of hits on the online course has a low correlation with learners' passing on the online course. In face-to-face chasing settings, student participation correlates with activities on the online course. This correlation value is shown in the Participation F2F correlation, which has a large correlation (greater than 0.50) with online activities such as the number of access days, the number of hits, and the number of activities on online forums.

Table 3. Correlation Analysis of Blended Learning Learning Activities on Learning Outcomes

|          | Result | Forum | Hits | Days | Resources View | Participation F2F | AvgQuiz | AvgAssignment |
|----------|--------|-------|------|------|----------------|-------------------|---------|---------------|
| Result   | 1.00   | 0.37  | 0.14 | 0.35 | 0.23           | 0.43              | 0.25    | 0.52          |
| Forum    | 0.37   | 1.00  | 0.51 | 0.57 | 0.25           | 0.50              | 0.28    | 0.42          |
| Hits     | 0.14   | 0.51  | 1.00 | 0.79 | 0.29           | 0.61              | 0.20    | 0.23          |
| Days     | 0.35   | 0.57  | 0.79 | 1.00 | 0.44           | 0.65              | 0.34    | 0.40          |
| Resources View | 0.23   | 0.25  | 0.29 | 0.44 | 1.00           | 0.28              | 0.09    | 0.15          |
| Participation F2F | 0.43   | 0.50  | 0.61 | 0.65 | 0.28           | 1.00              | 0.30    | 0.46          |
| AvgQuiz  | 0.25   | 0.28  | 0.20 | 0.34 | 0.09           | 0.30              | 1.00    | 0.46          |
| AvgAssignment | 0.52   | 0.42  | 0.23 | 0.40 | 0.15           | 0.46              | 0.46    | 1.00          |

3.2. Learner academic motivation

This study uses the MUSIC® Model of Academic Motivation to measure learners' motivation in participating in blended learning in Algorithm and Programming courses. Table 4 shows the average score of the 26 MUSIC Model questions. Based on the results of learners' feedback, the highest component score is Usefulness of 80.11 (Figure 1). In comparison, the Success component gets the lowest score of 70.16. This feedback results mean that students have understood the benefits of these courses on their academic journey. However, they feel pessimistic about getting good grades. Another component that needs attention is Caring. Teacher interaction with learners must be done well, especially in online learning.

Table 4. Mean Score MUSIC® Model of Academic Motivation

| NO  | QUESTIONS                                      | MEAN SCORE |
|-----|-----------------------------------------------|------------|
| M1  | I have the opportunity to decide for myself how to meet the course goals | 75.27      |
| M2  | I have the freedom to complete the coursework my own way. | 72.58      |
| M3  | I have options in how to achieve the goals of the course. | 73.12      |
| M4  | I have control over how I learn the course content | 73.66      |
| M5  | I have flexibility in what I am allowed to do in this course. | 72.58      |
The results of student feedback using the MUSIC® Model can be used to reflect the learning process. Figure 1 shows the music model component that gets the lowest average score is Success. In Table 4, it can be seen that one of the causes of the score in this component is small because learners have a lack of confidence in learning outcomes. This is consistent with the assignment values shown in Table 2, which have a smaller average value than other assessment values. Whereas in the correlation analysis shown in Table 3, the assignment strongly correlates with the final result. Therefore, this learning experience reflects that teachers must prepare better assignment strategies. This can be done by giving assignments considering the diversity of potential learners. So that learners can be more motivated and enthusiastic in following the learning process.

The next observation is the Caring component. There are many studies related to the effect of student involvement on the achievement of learning outcomes [2,10,12–14]. Teachers have an essential role in influencing student engagement. Based on the feedback results in Table 4, it can be seen that communication between teachers and learners is not going well. This is thought to affect learners in both online and face-to-face forums. The teacher must have a good interaction plan, even if the learning is done online. Being actively involved in forums, making discussion questions, seeing learners as different individuals, and responding to any learning activities can increase student engagement.
4. Conclusion
Blended learning provides an attractive learning setting for students. The algorithm and programming course's passing rate that applies the Blended Learning approach to the observed class is 82%. Students have different online learning experiences; some can follow online learning well. Others still need to be motivated to be more active. Correlation analysis shows the effect of online learning activities on graduation rates. Correlation analysis shows that collaborative task activities most influence passing rates. Next is participation in face-to-face activities and participation in online forum discussions. Other than that, correlation analysis shows a large correlation (greater than 0.50) between students' ability to participate in face-to-face learning and online learning activities that have been carried out. Although correlation analysis cannot determine a causal relationship, the results of this analysis can be used as a reference for developing a blended learning classroom learning plan strategy. The measurement of academic motivation shows that the average component score is above 70, with each score as follows: Usefulness (80.11), Interest (75.36), Empowerment (73.44), Caring (71.51), and Success (70.16).

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