# Improving Course Learning Outcomes Object-Oriented Programming through Blended Learning

Maspaeni, Suyitno Muslim, and Nurdin Ibrahim

***Abstract*—Object-Oriented Programming (OOP) is one of computer students' competencies to have. However, students in computers at the University of Technology Mataram have always had more than 50% of their students have grades below B in the last three years. Based on the analysis, literature review, and existing problems, research was carried out by developing a blended learning model by adopting a blended learning lab rotation to improve student learning outcomes in OOP courses. The learning model is supported by learning materials with facilities in the form of learning modules (equipped with practice questions, pre-tests, and post-tests), video tutorials, facilities for discussion and collaboration, and material in presentation slides. The research method used is Research and Development (R&D) by implementing an existing model that combines two learning development models, namely the Borg & Gall Model and the Dick & Carey Model, whose overall steps are called the Step of System Approach Model of Educational Research and Development. The feasibility test was carried out through expert validity tests. The application of this blended lab-rotation-based learning model effectively improved student learning outcomes in OOP courses. This is shown through the product effectiveness test, where the average value of the post-test reached 80.40, with the number of students declared complete in achieving the minimum standard set at 85%. The increase in student learning outcomes in this OOP course is quite significant, reaching 50% of the pre-test average value, only 57.20, with the number of students declared complete by 35%.**

***Index Terms*—Learning outcomes, object-oriented programming, blended learning, lab-rotation.**

## I. Introduction

Association for Computing Machinery *(*ACM*)* is an association that has always been a reference for higher education providers in the field of computer study programs in formulating and compiling their curriculum. Based on the curriculum developed by the ACM, Object-Oriented Programming (OOP) is one of the competencies that must be possessed by computer students [1]. One of the universities that organize computer studies programs and prepares its curriculum by adopting the curriculum formulated by ACM is the Faculty of Information and Communication Technology (FICT) University of Technology Mataram (UTM), with 5 study programs in the field of computers.

However, from observations made at FICT UTM, the learning outcomes of FICT UTM students in the OOP course in the last three years by applying the full face-to-face learning model before the covid-19 pandemic and implementing complete online learning during covid-19, student learning outcomes in the subject OOP lectures look not optimal. This can be seen from the fact that most students have scores below B, which indicates that problems need to be solved. According to Slameto (2010:54), one of the external factors that influence learning outcomes is the learning environment (school/campus), such as teaching methods, learning resources/learning materials, and others [2]. When viewed from one of the external factors, the implementation of face-to-face learning implemented by OOP Lecturers so far has been running quite well.

From the results of preliminary research that has been carried out, as many as 81.8% of students stated that Lecturers always provide and explain Semester Learning Plans (SLP) before lectures, 76.7% said that lecturers are always ready to provide learning materials (76.7%), 72.6% stated that lecturers have the ability and mastery learning materials well, 73.3% stated that the lecturers provided feedback on student assignments well. As many as 78.1% said that the lecturers had discipline in teaching. Meanwhile, judging from the learning resources or learning materials provided, as many as 82.6% stated that the lecturers provided learning materials in e-books derived from downloads on the internet and presentation slides made by the lecturers. However, as many as 81.8% of students stated that the learning materials used were provided less appropriate and not by the needs or not by the Semester Learning Plan (SLP), 95.1% of students want learning materials or materials available in the form of offline (modules) and online (LMS/web), 81.8% students feel that the time available for learning in class is not enough and 97.1% of students want the delivery of material in the form of video tutorials.

By looking at the situation and conditions as well as the learning outcomes of OOP courses at FICT UTM, an effort is needed to improve student learning outcomes such as by optimizing the use of information and communication technology which has many positive influences on the progress of the world of education, such as implementing learning with e-learning models, innovative classroom technology, virtual classroom, blended learning, and others [3]. The use of increasingly advanced information and communication technology is increasingly being used in the world of education, especially when the Covid-19 pandemic hits the world, despite the various challenges that exist, such as some countries experiencing infrastructure problems such as the availability and quality of the internet, online learning materials that have not been developed yet. Many institutions do not yet have a Learning Management System (LMS). Students are not familiar with online exams and others [4].

Manuscript received January 15, 2022; revised March 12, 2022.

The authors are with Universitas Negeri Jakarta, Indonesia (e-mail: Maspaeni_7117157705@mhs.unj.ac.id, suyitno@unj.ac.id, nurdin1349@yahoo.com).

doi: 10.18178/ijiet.2022.12.8.1674

The application of complete online learning by utilizing information and communication technology also does not guarantee student learning outcomes for the better. For this reason, it is necessary to combine face-to-face and online learning models with their respective advantages because there is a positive correlation between face-to-face learning and virtual or online learning, where students can benefit from face-to-face and contemporary learning models by integrating learning elements virtual or online into face-to-face classroom delivery [5].

According to several studies and becoming a trend of 21st-century learning models today, a learning model that can improve student learning outcomes is a blended learning model supported by information and communication technology and composite learning materials that are appropriate and according to student needs.

Blended learning itself, according to Eastman, is a learning strategy that combines face-to-face learning with individual learning, directed students, and computer-based learning programs [6]. Another opinion states that the concept of blended learning is more synonymous with understanding the integration of independent learning (independent online learning and independent offline learning using print modules) with face-to-face learning [7]. Blended learning is also defined by Elaine Allen (2007), which is said to be blended learning if the delivery of material between 30% to 79% of the material is delivered online, if it is more than or equal to 80%, then the learning is called online learning [8].

Several studies that state that the application of blended learning can improve learning outcomes include those carried out by Wichadee (2017), namely blended learning can improve oral skills, student learning motivation, positive attitudes towards the use of technology (Edmodo), and better student academic performance [9]. The application of *blended learning* can create a sense of satisfaction in learning due to changes in the learning system and exciting and challenging assignments [10]. Blended learning can develop students' independent learning skills and occupy a central position in professionalizing [11] education [11]. Blended learning shows higher performance compared to conventional understanding [12]. Blended learning can make learning implementation more effective and student outcomes better [13], and the blended learning Flipped Classroom Model can improve student academic achievement better than traditional learning [14].

From several previous studies, the applied blended learning model does not explain the sequence of steps (syntax), reaction principle, social system, and support system in carrying out the learning process, which is the main component in the learning model [15]. Likewise, the application of blended learning models is still general, without using more specific blended learning models such as lab-rotation, flipped, and others [16]. The support system in previous studies focused more on support systems for online and independent online learning, such as online learning materials (LMS and the like), without paying attention to the support systems for face-to-face and independent offline learning (Modules). The implementation of learning is said to be blended if 30% to 79% inter-learning is carried out online [8]. In previous studies, it was unclear what percentage ratio or composition of the number of meetings between face-to-face, online, and independent learning. From these existing studies, it appears that there has been no research on the development of a lab-rotation blended learning model with a support system that meets the needs and has been tested for validity, feasibility, and effectiveness.

By paying attention to student learning outcomes in the last three years which look not optimal, the desire of students to be able to learn to use learning materials that can be studied anytime and anywhere, more flexible study time, the delivery of material in the form of video tutorials and others, then by paying attention to OOP courses that require laboratory space for practicum and adapt to changing educational trends that take advantage of current technological advances, it is necessary to conduct research that can be innovative solutions to the problems that have been described. For this reason, this study aims to develop a learning model for OOP courses based on blended learning lab rotation to improve student learning outcomes at FICT UTM.

The development of the blended learning lab-rotation-based learning model is by the characteristics of the OOP course, which requires a computer laboratory for learning. By applying a blended-based learning model, which is a combination of face-to-face learning and independent learning (self-directed online learning and independent offline learning), it will be able to provide convenience and flexibility for students to study, discuss and collaborate, ease in doing and collecting assignments, ease in managing grades by lecturers such as the value of attendance, activity, assignments, quizzes or other assessments that can be carried out transparently, and can facilitate students or lecturers in the learning process.

## II. Methodology

The method used in this research is Research and Development (R&D) by implementing an existing model by combining two learning development models, namely the Borg and Gall model and the Dick & Carey model.

According to Borg and Gall, "Educational R&D is an industry-based development model in which the findings of the research are used to design new products and procedures, which then are systematically field-tested, evaluated, and refined until they meet specified criteria of effectiveness, quality. or similar standards", and The product used does not only refer to material objects, such as textbooks, learning videos, and the like but can also be in the form of procedures and processes, such as learning methods or methods for organizing learning [17]. Meanwhile, the Dick & Carey model is one of the systems approach models whose application is adjusted to the steps that must be taken sequentially [18].

In the development or design steps of Dick & Carey's learning, ten steps must be followed sequentially, from identifying instructional goals to the design and conducting summative evaluation step. However, in the Dick & Carey step, there was no data collection step at the beginning of the study, so the research step was added to the research and information collecting step, which was adopted from the Borg & Gall step and became the first step in this research.

Thus, the whole step in this research is referred to as The Step of the System Approach Model of Educational Research and Development, as shown in Fig. 1.

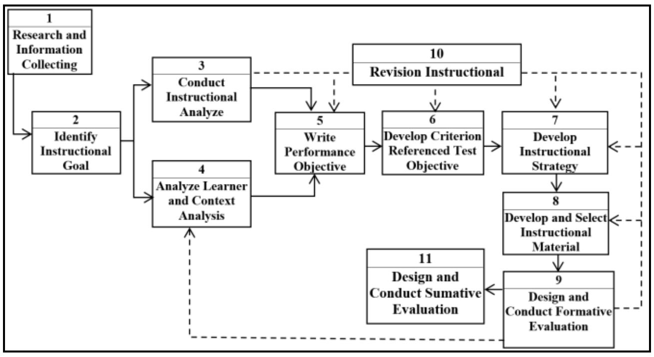


Fig. 1. Research and development steps done.

The research was carried out in sequential steps according to Fig. 1, starting from the steps: 1) Research and Information Collecting, namely by observing the process of implementing OOP course learning and conducting literature studies to review and prepare for research formulations; 2) identify learning objectives according to the results of observations in the first stage and conduct discussions or Group Discussion Forums (GDF) with the parties needed to formulate learning objectives and to identify skills and knowledge that must be possessed, competencies that must be mastered, and so on. 3) carry out learning analysis activities to determine the form of the model, the form of the strategy, the form of the tasks, and so on. In this analysis activity, GDF was carried out with stakeholders, course lecturers, students, alumni and heads of study programs to map competencies and materials that must be studied to achieve the desired learning objectives, 4) analyze the level of knowledge and skills that students must possess, 5) determine performance goals or Specific Instructional Objectives (SIO) which are the basis for compiling test grids, 6) compile an assessment instrument model or test criteria reference for evaluating the learning process in order to determine the extent to which the desired competency achievement is met, 7) perform development of learning strategies in the form of preparation of SLP by taking into account the order of the content of the material, descriptions of activities or student learning experiences and determining material storage strategies using a blended learning lab-rotation model supported by information and communication technology as well as learning materials lessons that have various facilities, 8) develop blended learning materials with facilities in the form of learning modules (equipped with practice questions, pre-test and post-tests), video tutorials, facilities for discussing and collaborating as well as material in the form of presentation slides to support the application of the learning model. Blended learning lab-rotation so that learning objectives can be achieved, 9) conduct formative evaluations to ensure the design and learning materials developed are practical and suitable for use through one-to-one validation evaluations involving experts who have expertise in the field of materials, instructional design, graphic and media design, and language. In addition, validation evaluation is also carried out by conducting *one-to-one* and small group evaluations with students who have taken OOP courses and conducting validation and effectiveness trials through field trials involving students who have never taken OOP courses, 10) making revisions or improvements learning activities.

## III. Results and Discussions

### A. Learning Theory

Learning is defined as a change in one's abilities, attitudes, beliefs, knowledge, and skills [19]. In this definition of learning, there are transparent processes and outcomes involved. The foundational pillars of learning need to be emphasized and elaborated individually because learning is at the core of integrating any educational technology. The purpose of education is to develop understanding and competence, and the purpose of learning is to encourage learning that conveys understanding and reinforces competence.

Traditional assumptions in instructional design theory are about things that need to be learned that can significantly affect the best and optimal learning design (support to achieve the desired results). In the analysis phase of learning planning, it is natural for a designer to collect the types of thoughts that can be learned. According to Gane (1985) in Michael Spector (2012), there are five kinds of things that can be learned, namely: a) verbal information (e.g., facts); b) intellectual skills (e.g., using rules to solve problems); c) cognitive strategies (e.g., selecting a process for dealing with problem situations); d) motor skills (e.g., riding a bicycle); and e) attitudes (e.g., dislike math ) [20].

Of the five things that can be learned in learning, the five will affect learning outcomes, the more information or knowledge that can be absorbed in learning. More changes will occur in the knowledge, skills and attitudes possessed. To be able to absorb or receive learning outcomes from the learning process, Dale's Cone of Experience in Davis B, Summers M. (2015), says that the mastery and memory of learners who learn by listening is 20%, viewing pictures and videos is 30%, seeing and listening (videos, pictures, etc.) by 50%, by what is said and written (simulation from direct/real experience) by 70% and by what is done while doing the task (through direct experience or real experience) by 90% [21].

According to Winkel, learning is a mental or psychic activity that occurs in an environment with active interactions. In addition, learning is required or produces changes directly or indirectly in the person who does it. There will be changes in the management of understanding on any side [22].

### B. Blended Learning System

To improve student learning outcomes optimally in the OOP course, the application of the blended learning model is made by determining the blended learning model that is by the characteristics of the OOP course. These courses require a laboratory as the leading learning center, so the appropriate learning model is the blended learning model. learning lab rotation is a learning model in which students learn according to the learning schedule that the lecturer has made. In the learning rotation, the principal place of learning is in the computer laboratory, where students can study independently or online by studying materials that have been prepared by the lecturer or study enrichment materials that can be accessed through the Learning Management System (LMS), in addition to studying. Independently and online, students can also increase their mastery of the material by attending lectures through face-to-face learning conducted with lecturers [23].

The form of an illustration of the implementation of the blended learning lab-rotation learning model is as shown in Fig. 2.

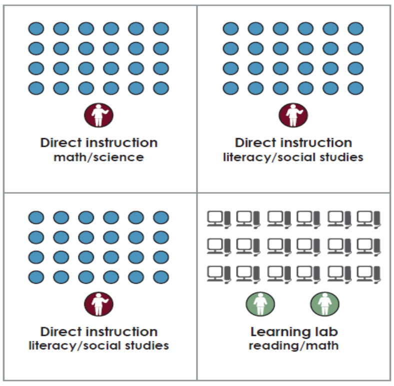


Fig. 2. Lab-rotation model [20].

Based on Fig. 2, the application of the blended lab-rotation learning model, such as for the OOP course, can be done by carrying out the learning process starting from face-to-face learning, where the lecturer explains the scope of the material to be delivered, learning objectives, task plans, and material explanations. On the other hand, students listen to what is said by the lecturer. Students who already understand can move to spend one part of specific material to the computer laboratory to study online or independently according to their learning speed to practice what they have learned understood before. Meanwhile, other students can still study with the lecturer to strengthen what they have learned in the laboratory and ask what they find difficult or cannot be solved in the computer laboratory.

Students can move to computer labs for self-study or independently at their own pace or learning style. Students who need additional support from the lecturer's explanation of the material can receive more special attention by forming small groups for more detailed and straightforward explanations.

Students can work flexibly at their own pace in computer labs, spending as much time as they need to understand the material. During face-to-face learning, the lecturer provides support or enrichment activities as needed. Lecturers can also group students into groups to do different things based on where they are and what level of mastery they have demonstrated. Students who show progress in learning are ready to be rotated to the computer laboratory to complete independent exercises. Students who need additional assistance work immediately with the lecturer in small groups. This model allows lecturers to intervene quickly if students need additional support, such as additional material explanations.

### C. *Model Design*

#### 1) *Conceptual model*

Based on the learning theory proposed by Keller, Gagné, Bloom, Merrill, Clark, and Gery in Carman [24], there are five essential elements in blended learning, as shown in Fig. 3.


Fig. 3. Elements in blended learning.

Based on Fig. 3, it can be explained as follows:

1) **Live events** or direct learning activities, or face-to-face learning. These learning activities are led by educators/instructors where all students participate simultaneously, such as in a classroom or a live virtual classroom.
2) **Self-Paced Learning**, where learning activities run independently and asynchronously, will add significant value to the blended learning equation.
3) **Collaborating**, students can communicate with others by using e-mail, discussion forums, or online chats.
4) **Assessment** this assessment needs to be done to determine the initial abilities of students, both for direct learning or independent learning. So Also an assessment needs to be done during the learning process to find out or measure the level of student absorption or measure the transfer of learning to the material received
5) **Reference Material,** wherewith this performance support can increase retention and transfer of learning, including PDA downloads, printable references, summaries, and job help.

Meanwhile, according to Ibrahim (2015), blended learning is synonymous with understanding the integration of independent learning (independent online learning and independent offline learning with print modules) with face-to-face learning [7]. Based on the two theories, the conceptual model of blended learning developed is shown in Fig. 4.

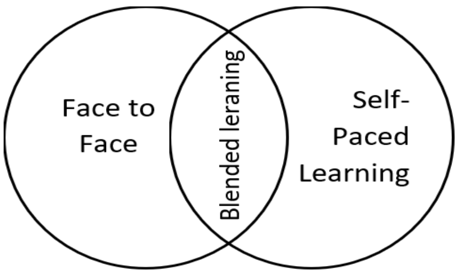


Fig. 4. Conceptual model of blended learning.

Based on Fig. 4, the concept of the blended learning model developed for this OOP course is a learning model that requires a support system in the form of information and communication technology and learning materials for face-to-face learning, learning materials for online learning, and learning materials for independent learning.

Suppose you look at the five essential elements in blended learning proposed by Keller, Gagné, Bloom, Merrill, Clark, and Gery in Carman above. In that case, the conceptual model for blended learning lab rotation will be developed more specifically, as shown in Fig. 5.

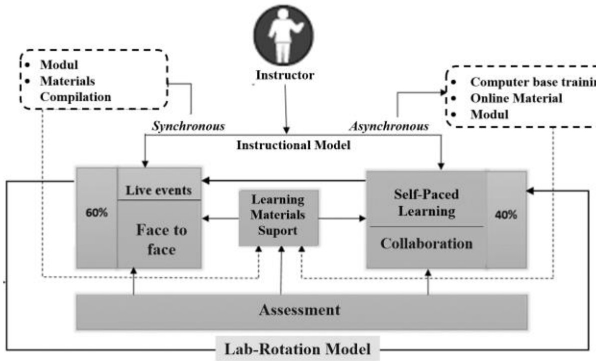


Fig. 5. The conceptual model of blended learning lab-rotation.

From Fig. 5, it can be explained that the blended learning lab-rotation learning model that is applied is to combine the face-to-face learning model *with* a composition of the learning process as much as 60% and the independent learning model (online independent and offline independently) with the composition of the learning process 40 % which is carried out in rotation according to a mutually agreed schedule. Types of learning activities carried out face-to-face (**live events**) and **self-paced learning** and support for learning materials (**reference material**) that support blended learning. Students' enthusiasm for learning in face-to-face learning *(*live events) and independent learning experiences will undoubtedly increase the opportunities for **collaborative** learning to become more meaningful. To determine the initial ability level of students or to measure the level of absorption or transfer of learning material, an **assessment** is carried out before the learning process takes place or while the learning process is running.

*2) Procedural model*

In developing a model such as developing a learning model, at least the model must have four main elements, namely:

1) **Syntax** is a sequence of learning steps that refer to the phases or stages that the lecturer must carry out if using specific learning.
2) **Principles** of *Reaction* are activities that describe how lecturers should see and treat their students, including how lecturers should respond to students. This principle provides instructions on how lecturers should use the game's rules that apply to each model.
3) **The Social System** is the pattern of Lecturer relationships with Students during the learning process (situation or atmosphere and norms that apply in the use of specific learning models)
4) **Support System** is all the facilities, materials, and tools needed to support the implementation of the learning process optimally.

The application of a model in learning must be able to have an impact or learning effect for students, such as the achievement of learning objectives *(instructional effects)* and the creation of a more lively learning environment (living in) by students (nurturant effect) [15].

Based on the learning theory and conceptual model described, the procedure that must be carried out so that student learning outcomes in OOP courses can be improved is to apply a learning model based on lab-rotational blended learning with a syntax consisting of 6 phases, namely:

**Phase I:** Problem orientation. In this phase, the lecturer opens the lecture by giving Pre-Test questions (Formative Tests) to students available at the LMS to determine the student's initial abilities. Furthermore, the lecturer conducts discussions with students to find solutions to problems that might hinder learning.

**Phase II:** Develop lesson plans and organize students. In this phase, the lecturer forms study groups (organizing learners) by paying attention to the results of the pre-test and the problems experienced by students such as ownership of practicum equipment (laptops), the ability to buy internet quota, distance from home, availability of group study areas or locations and so on. Other. Furthermore, the lecturer prepares a lesson plan by providing offline and online learning materials and determines the learning model that will be used by taking into account the results of discussions with students when learning is carried out face-to-face, online, or independently. Meanwhile, students are ready to study individually or with their study groups through face-to-face, online or independent learning.

**Phase III:** Demonstrating skills or guiding learning. In this phase, the lecturer explains the learning material according to the Module, demonstrates the skills correctly according to the logic and algorithm of making the program plans, and provides guidance or training to students according to the planned or learning objectives. Meanwhile, students observe, follow and continue to try to explore their ability to study either in groups or individually and ask questions if they do not understand

**Phase IV:** Monitoring Students and the progress of learning implementation. In this phase, the lecturer monitors the progress of the implementation of learning by occasionally asking students questions at random, giving assignments or exercises to determine the level of mastery of the material, or by looking at the results of student performance or work directly or via online (zoom meeting), and lecturers provide input if any.

**Phase V:** Testing learning outcomes and assignments. In this phase, the lecturer gives Post-Test questions (formative tests) or assignments to students to find out the progress of their learning outcomes.

**Phase VI:** Evaluating the learning experience. In this phase, Lecturers evaluate learning outcomes based on exercises, assignments, post-tests, which are then given feedback or follow-up to improve the next exercise, assignment, or project. Meanwhile, students receive the results of the lecturer's evaluation to be used as a reference or enthusiasm in doing the next task or project to be better and ask if there is something they want to ask or there is something inappropriate or doubtful about the results of the evaluation from the lecturer.

Thus, the procedure for applying the OOP course learning model based on blended learning lab-rotation at FICT UTM is carried out based on syntax with 6 phases or stages, namely starting from the problem orientation stage, preparing lesson plans and organizing learners, demonstrating skills or guiding learning, monitoring learners. And the progress of learning implementation, testing learning outcomes, and assignments to the stage of evaluating the learning experience. In carrying out the learning process, lecturers must motivate and encourage students to improve their independent learning, be active in discussions, ask questions, do assignments, and others. In addition, Lecturers are also facilitators, partners, or mediators in learning; Lecturers must monitor student learning progress while providing direction or input if needed, paying attention, monitoring and guidance to learners both individually and in groups, responding to questions from learners, providing opportunities for learners to construct their knowledge through learning activities and do not dominate in learning, lecturers must also provide feedback, responses, comments or input on each task or project given to students to increase their learning motivation. The learners' reactions in the developed model are called the reaction principle. The reactions shown by these students will undoubtedly create a social system or a good relationship between students and students. To support the smooth implementation of the learning process according to syntax, the principle of reaction, and the social system to run optimally, it is necessary to have a support system such as the provision of support in the form of learning materials both offline and online as well as information and communication technology devices to facilitate the delivery of learning materials by lecturers, access to learning materials student online, assigning assignments, collecting assignments by students, facilitating discussions, collaborative learning, and others.

*3) Physical model*

By referring to the conceptual and procedural model of the blended-based OOP course learning model that was developed, the physical model of the developed model is designed. The physical model of the developed model is in the form of a learning model for OOP courses which has 1) 6 phases/stages in carrying out the learning process (**syntax**), 2) a description of the lecturer's reaction to student activities with a student-centered learning process (the lecturer does not dominate in learning), lecturers as partners, facilitators, motivators or mediators (**reaction principle**), 3) a description of the relationship between lecturers and students who are good, humanist and friendly (**social system**), 4) support for learning materials and information and communication technology with facilities in the form of learning modules (equipped with practice questions, pre-test, and post-test), video tutorials, facilities for discussion and collaboration as well as material in the form of presentation slides (**support system**).

## *D. Formative Evaluation of Support Systems*

*1) Formative evaluation instrument*

The support system in developing this blended lab-rotation learning model is offline learning materials (Modules) and online learning materials (LMS), which are evaluated through formative evaluation using instruments that have been validated by instrument experts (validators). The validated tools are instructional design experts, materials experts, design and media experts, language experts, one-to-one evaluations with students, small group evaluations, and field trial evaluations. The instruments used in this formative evaluation all use a Likert scale 1-5 questionnaire with the instrument indicators referring to Dick & Carey's book "The Systematic Design of Instruction - Eighth Edition," with hands including Clarity of Instruction, Impact on Learner, Feasibility of instructions and others [25].

*2) Results of the support system formative evaluation*

*a) Support system feasibility test evaluation*

Support System in the form of learning materials that have been developed, then given to experts (material experts, instructional design experts, media and design experts, and language experts), three students (one-to-one), nine students (small group), and 20 students (field trial) for formative evaluation to test the feasibility of the product based on the instrument that the validator has validated. Some comments and suggestions for improvement from experts for the feasibility of this learning material area are shown in Table I.

TABLE I: COMMENTS AND SUGGESTIONS FROM EXPERTS

| Expert | Revision |
|---|---|
| Material Expert | a) The type of example given should be added with a special example related to the combination of all existing materials.<br>b) Please correct all doodles and comments, revised using. |
| Instructional Design Expert | a) The arrangement of learning materials should be made per book for each competency so that every time students want to learn, they just need to take one book according to the material to be studied. Later, the books will be packaged into one module *box*.<br>b) Revision of the Competency Map and Special Instructions<br>c) Learning materials are made according to module standards, namely using module standards, and the standard module is the Open University Module and printed using B5. |
| Media and Graphics Expert | a) The cover module is less attractive, less contemporary and the design doesn't look original.<br>b) In the LMS, as independent learning material, it is incomplete, please complete it. |
| Linguist | Please correct all doodles and comments, using correct Indonesian. |

The average value of the feasibility test results from learning materials as a support system in developing the blended lab-rotation-based OOP course learning model after revision according to expert advice is as shown in Table II.

TABLE II: THE AVERAGE VALUE OF THE FEASIBILITY TEST RESULTS

| Indicator | Average Formative Evaluation Results* | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| Clarity of Instruction | 4.67 | 4.63 | 4.48 | 4.33 | 4.33 | 4.59 | 4.60 |
| Impact on Learner | 4.53 | 4.5 8 | 4,6 8 | 4.67 | 4.67 | 4.5 9 | 4.7 8 |
| Feasibility of Instruction | 4.54 | 4.3 8 | 4.29 | - | 4.33 | 4.44 | 4.56 |
| Centered on Instructional Goals | 4.5 0 | 5,00 | - | - | 4.00 _ | 5.00 | 4.75 |
| Technical | - | 4.4 0 | 4.5 0 | - | 4.67 | 4.5 0 | 4.47 |
| **Average evaluation results** | 4.56 | 4.60 | 4.49 | 4.50 | 4.40 | 4.62 | 4.63 |

*1:Materials expert, 2:Instructional design expert, 3:Media and Design expert, 4:Language Expert, 5:one-to-one, 6:Small group, 7:field trial

Based on Table II, the results of the feasibility test on the support system for the learning model based on the blended learning lab-rotation in the form of learning materials for OOP courses carried out by material experts according to indicators resulted in an average score of 4.56, by instructional design experts with an average score of results. Evaluation of 4.60, by media and design experts 4.49, by language experts 4.50, through a one-to-one assessment with three students of 4.40, by nine students (Small group) of 4.62 and based on the evaluation results of the evaluation field trial of 4.63.

To determine the learning materials developed have excellent quality, good or otherwise, it is carried out based on assessment criteria using evaluation standards [26], as shown in Table III.

TABLE III: ASSESSMENT CRITERIA FOR THE AVERAGE SCORE

| Number | Average score | Classification |
|---|---|---|
| 1 | >4.2 | very good |
| 2 | >3.4 – 4 | good |
| 3 | >2.6 – 3.4 | enough |
| 4 | >1.8 – 2.6 | not enough |
| 4 | <1.8 | very less |

Based on the assessment criteria using evaluation standards using the average score assessment criteria in Table II, it can be recapitulated the results of the feasibility test of OOP learning materials as a supporter of the blended lab-rotation-based learning model as shown in Table IV.

TABLE IV: RECAPITULATION OF THE RESULTS OF THE FEASIBILITY TEST

| Formative Evaluation by | The average value | Explanation |
|---|---|---|
| Material Expert | 4.56 | very good |
| Instructional Design Expert | 4.60 | very good |
| Design and Media Expert | 4.49 | very good |
| Linguist | 4.50 | very good |
| One-to-one | 4.40 | very good |
| Small-Group | 4.62 | very good |
| Field Trial | 4.63 | very good |

Based on the feasibility test results in Table IV, it can be said that the support system developed in the form of learning materials for OOP courses is considered very good or feasible to use.

*b) Support system effectiveness test*

To test the effectiveness of the support system for the blended learning lab-rotation learning model in the form of learning materials for the developed OOP course, a field trial was conducted by processing the results of the pre-test and post-test scores obtained by students, where before learning activities on a particular topic began, Students are given pre-test questions to find out whether students have studied the learning materials that have been given or not. At the same time, the post-test questions are provided after students complete the learning activities of the topics that have been studied. The students' pre-test and post-test results are shown in Table V.

TABLE V: STUDENT PRE-TEST AND POST-TEST SCORES

| Respondent | Pre-tes t | Pre-test Results | Post-tes t | Post-test Results |
|---|---|---|---|---|
| Student-1 | 83 | Complete | 87 | Complete |
| Student-2 | 81 | Complete | 86 | Complete |
| Student-3 | 37 | Not Complete | 86 | Complete |
| Student-4 | 47 | Not Complete | 83 | Complete |
| Student-5 | 84 | Complete | 83 | Complete |
| Student-6 | 82 | Complete | 95 | Complete |
| Student-7 | 81 | Complete | 93 | Complete |
| Student-8 | 60 | Not Complete | 84 | Complete |
| Student-9 | 46 | Not Complete | 75 | Not Complete |
| Student-10 | 37 | Not Complete | 81 | Complete |
| Student-11 | 48 | Not Complete | 85 | Complete |
| Student-12 | 87 | Complete | 85 | Complete |
| Student-13 | 45 | Not Complete | 80 | Complete |
| Student-14 | 80 | Complete | 85 | Complete |
| Student-15 | 45 | Not Complete | 80 | Complete |
| Student-16 | 35 | Not Complete | 50 | Not Complete |
| Student-17 | 45 | Not Complete | 80 | Complete |
| Student-18 | 46 | Not Complete | 50 | Not Complete |
| Student-19 | 40 | Not Complete | 80 | Complete |
| Student-20 | 35 | Not Complete | 80 | Complete |
| Average | 57,20 | | 80,40 | |
| Value Increase | | 23.20 | | |

From the *pre-test* and *post-test* results in Table V, it can be seen that the average value of the *pre-test* is 57.20, with the number of students who are declared complete by 35%. Student scores increased by 23.20 points after the post-test with an average post-test score of 80.40, and students who were declared complete were 85%, or an increase of 50% from the results of the previous pre-test. Students announced full have reached the minimum standard set, namely the value>=80. A significance test for the difference in mean pre-test and post-test was conducted using a t-test through the SPSS application to determine whether there is a significant difference in the increase between the pre-test and post-test. From the results of the t-test (statistical test) with N = 20, the pre-test t-count value of 13.956 and post-test of 39.545 is greater than the t-table 2.05596 with a significance value <alpa (0.000 <0.05), this can mean that there is a significant difference in student learning outcomes before and after using the developed OOP learning materials.

By looking at the results of this effectiveness test, it can be said that the application of the blended learning lab-rotation learning model developed for the OOP course has been proven to be effective in improving student learning outcomes at FICT UTM.

## IV. CONCLUSION

The application of the blended learning lab-rotation learning model in OOP courses with a support system in the form of learning materials that have been tested for feasibility and effectiveness has proven effective in improving student learning outcomes. With online learning in blended learning, the learning process can be done anytime and anywhere without being limited by space and time. The method of discussion and collaborative learning becomes more optimal. In addition, lecturers also find it easier to monitor learning activities and provide direct feedback on student performance results. Research on the development of a blended learning lab-rotation model with a support system tested for validity, feasibility and effectiveness have not been carried out by other researchers, as well as the support system that focuses more on using LMS applications without the support of offline learning materials (Modules) as face-to-face learning support or self-study offline. The results of this study are more appropriate to be applied to courses that require a laboratory as the primary learning place for practice to test or use a particular theory. For this reason, it is hoped that future research can be developed into other blended learning models, which can be applied to all subjects.

## Conflict of Interest

The authors declare no conflict of interest.

## Author Contributions

Maspaeni develops the main idea of the research, conducts the research, analyzes the data, and composes the manuscript. Meanwhile, Suyitno Muslim contributed to developing learning models both conceptually and procedurally, and Nurdin Ibrahim contributed to implementing blended learning and its supporting learning materials. The three authors have approved the final version of this manuscript for publication

## Acknowledgment

The author would like to thank the Rector of the Mataram University of Technology for funding this research project. and also his fellow lecturers from the Faculty of Information and Communication Technology have helped a lot in facilitating the implementation of this research.

## References

[1] ACM, *Computing Curricula 2020 - CC2020*, New York: Association for Computing Machinery (ACM), 2020.
[2] Slameto, *Belajar dan Faktor-Faktor Yang Mempengaruhi*, Jakarta: Rineka Cipta, 2010.
[3] M. S. S. Z. Rahman, T. Rijanto, and I. Basuki, "The implementation of blended learning model on motivation and students' learning achievement," *IJEVS-International J. Educ. Vocat. Stud.*, vol. 2, no. 9, pp. 767–775, 2020, DOI: https://doi.org/10.29103/ijevs.v2i9.2694.
[4] M. Hassan, "Online teaching challenges during COVID-19 pandemic," *Int. J. Inf. Educ. Technol.*, vol. 11, no. 1, pp. 41–46, 2020, DOI: 10.18178/ijiet.2021.11.1.1487.
[5] N. Li, J. Wang, X. Zhang, and R. Sherwood, "Investigation of face-to-face class attendance, virtual learning engagement and academic performance in a blended learning environment," *Int. J. Inf. Educ. Technol.*, vol. 11, no. 3, pp. 112–118, 2021, DOI: 10.18178/ijiet.2021.11.3.1498.
[6] P. Eastman, *Blended Learning*, Washington, 2015.
[7] H. N. Ibrahim, "Penerapan pembelajaran blended learning pada SMP terbuka kandanghaur-indramayu," Jakarta, 2015.
[8] R. G. E. Allen *et al.*, *Blending in the Extent and Promise of Blended Education in the United States*, USA: Printed in the United States of America, 2007.
[9] S. Wichadee, "A development of the blended learning model using Edmodo for maximizing students' oral proficiency and motivation," *Int. J. Emerg. Technol. Learn.*, vol. 12, no. 2, pp. 137–154, 2017, DOI: 10.3991/ijet. v12i02.6324.
[10] W. Banyen, C. Viriyavejakul, and T. Ratanaolarn, "A blended learning model for learning achievement enhancement of Thai undergraduate students," *Int. J. Emerg. Technol. Learn.*, vol. 11, no. 4, p. 48, 2016, DOI: 10.3991/ijet.v11i04.5325.
[11] M. Hajji, R. D. Bouzaidi, H. Douzi, and E. H. Khouya, "New blended learning strategy based on flipped-learning for vocational work-linked training," *J. Educ. Pract.*, vol. 7, no. 36, pp. 126–130, 2016.
[12] Y.-W. Lin, "The effect of blended learning in mathematics course," *EURASIA J. Math. Sci. Technol. Educ.*, vol. 13, no. 3, pp. 741–770, 2017, doi: 10.12973/eurasia.2017.00641a.
[13] A. Harris and M. Jones, "Blended learning: Flipped, flopped or forgotten," *Blended Flip. Learn. Case Stud. Malaysian High. Educ. Institutions*, vol. 65, no. 2, pp. 311–315, 2014.
[14] J. R. Sablan and M. Prudente, "Traditional and flipped learning: Which enhances students' academic performance better?" *Int. J. Inf. Educ. Technol.*, vol. 12, no. 1, pp. 54–59, 2022, DOI: 10.18178/ijiet.2022.12.1.1586.
[15] E. C. B. Joyce and M. Weil, *Models of Teaching*, Eighth. USA: Pearson Education, 2009.
[16] M. B. Horn and H. Staker, "Models of blended learning, blended: Using disruptive innovation to improve school," 2014.
[17] M. D. Gall, J. P. Gall, and W. R. Borg, *Education Research*, Eighth. USA: Pearson, 2007.
[18] W. Dick, L. Carey, and J. O. Carey, *The Systematic Design of Instruction*, Five. USA: Pearson, 2015.
[19] M. Spector, *Foundations of Educational Technology*, NewYork: Routledge, Taylor & Francis Group, 2012.
[20] H. Staker and M. B. Horn, "Models of blended learning," *Blended Using Disruptive Innov. to Improv. Sch.*, pp. 6–9, 2014.
[21] S. M. Davis, "Applying Dale's cone of experience to increase learning and retention: A study of student learning in a foundational leadership course," *Science Proceedings*, 2015.
[22] W. S. Winkel, *Psikologi Pengajaran*, Yogyakarta: Media Abad, 2007.
[23] K. D. D. Pembelajaran, *Panduan Penyusunan Kurikulum Pendidikan Tinggi di Era Industri 4.0*, III. Jakarta: Direktorat Jenderal Pembelajaran dan Kemahasiswaan Kementerian Riset Teknologi dan Pendidikan Tinggi, 2019.
[24] J. M. Carman, "Blended learning design: Five key ingredients," *Philology Matters*, no. March 2005, pp. 164–174.
[25] L. C. W. Dick and J. O. Carey, "The systematic design of instruction — Eighth Edition," United States of America: Pearson Education, 2015.
[26] E. P. Widoyoko, *Evaluasi Program Pembelajaran : Panduang Praktis bagi Pendidik dan calon pendidik (X)*, Yogyakarta: Pustaka Pelajar, 2019.



**Maspaeni** was born in Benteng, on December 31, 1979, and has a master's degree in computer science in 2011. In 2016, he continued his doctoral education at the State University of Jakarta in the field of Educational Technology. His main interest is technology.

**Suyitno Muslim** is a man who was born on August 27, 1959. Currently, he is still actively teaching at the postgraduate program at the Jakarta State University. He completed his bachelor's, master's, and doctoral degrees in educational technology at the Jakarta State University. He remains consistent with his field of knowledge.

**Nurdin Ibrahim** was born in Bima, on July 22, 1949. He has completed his education starting from the education level of S1, S2, and S3 in the field of educational technology at the State University of Jakarta. He is always consistent with the area of science that he is involved in, namely educational technology.