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DEVELOPING LEARNING MATERIALS OBJECT-ORIENTED PROGRAMMING COURSE BLENDED BASED IN THE COVID-19 PANDEMIC PERIOD

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Abstract*: One of the competencies that computer students need to have in creating applications using the concept of Object-Oriented Programming (OOP). The ability to make this application can be measured based on student learning outcomes from OOP courses. By looking at the final scores of all computer students at the Faculty of Information and Communication Technology (FICT) University of Technology Mataram (UTM) in the last three years, most of them scored below B, indicating that more than 50% of the students do not have the ability or not so understand about making applications with the OOP concept. Based on a good analysis of student needs, problems were found. Through various studies, research was conducted to develop learning materials to improve student learning outcomes of FICT UTM during the covid-19 pandemic. This research was conducted using the Research and Development (R&D) method by combining the steps developed by Borg & Gall, Dick & Carey, Rowntree, and Allan Jolliffe. Applying learning materials for OOP courses developed effectively could increase student learning outcomes by 50%. The effectiveness of this learning outcome was measured based on the results of testing the effectiveness of the product through the post-test with the result that 85% of students were declared complete in achieving the expected minimum competency standard with an average score of 80.40 when compared to the score through the pre-test which averaged 57.20 with the number of students who were declared complete by 35%.*

Keywords*: Learning Materials, Object-Oriented Programming, Learning Outcomes.*

Introduction

Association for Computing Machinery (ACM) is an international association that has always been a reference for universities or study programs in computers in compiling curricula. Object-Oriented Programming (OOP) is one way or paradigm of making computer programs with

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object concepts. In the Curricula developed by ACM, there is always OOP content in the curriculum of each Study Program (ACM, 2020), so students must have the ability to understand and make applications using the OOP concept.

One computer study program organizer that compiles its curriculum based on the ACM Curricula is the Faculty of Information and Communication Technology (FICT) Universitas Technology Mataram (UTM) with 5 study programs. The learning outcomes of FICT UTM students in OOP courses in the last three years whose scores were below B were 74 (54%) of 136 students in the 2018/2019 academic year, 88 (59%) of 150 students, and the 2020/2021 academic year and 185 (78%) of the 238 students in the 2020/2021 academic year (Source: Section Academic FICT UTM).

By looking at student learning outcomes in the last three years, more than 50% of FICT UTM students scored below B. Student learning outcomes decreased significantly when the learning process was carried out fully online in the 2020/2021 academic year, namely the Covid-19 pandemic period with a total of students who scored below Breached 78%, meaning that students who managed to achieve completeness in learning OOP during the covid-19 pandemic were 22% (52 out of 238) students. This situation and condition need to find the right solution and improve FICT UTM students' ability to make applications with the OOP concept even in conditions hit by Covid-19 by optimizing information and communication technology (ICT). The development of information and communication technology today has brought many positive influences on education, where many learning activities can be carried out because of the benefits of technology. It is this increasingly advanced use of ICT that 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 are not ready, many The institution does not yet have a Learning Management System (LMS), students are not familiar with online exams and others (Hassan, M., 2021).

In the world of education, learning models that usually apply face-to-face learning models shift towards learning models that apply information and communication technology such as e-learning models, smart classroom technology, virtual classrooms, blended learning, and others (Rahman, Z., Rijanto, T., Basuki, I., & Sumbawati, M. S., 2020). FICT UTM can utilize this development of information and communication technology in supporting the smooth learning process during a pandemic or after the Covid-19 pandemic ends, namely technology that can make it easier for students to learn with appropriate learning materials and by learning objectives and easy to learn, understand. and accessed anywhere and anytime.

With the convenience of students to access and study learning materials anywhere and anytime, of course, it can be done by developing blended learning materials, namely learning materials available offline in the form of modules and online learning materials in the form of providing website-based learning materials or Learning Management System (LMS). The development of blended learning materials can improve students' mastery and memory to be more effective. After all, they can utilize learning resources from lecturers who are usually passive by listening to lecturers' explanations and can be more active because they can take advantage of various learning resources. To learn such as through modules, websites, or LMS, and others.

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According to Slameto (2010), one of the factors that can affect student learning outcomes is the learning resources, or learning materials used (Slameto, 2010). Based on the initial research conducted, the learning materials provided by the lecturers to students are learning materials in the form of e-books downloaded from the internet and presentation slides made by the supporting lecturers by the Semester Learning Plan (SLP) using various sources that are sometimes not clear. The provision of e-book learning materials and presentation slides by lecturers in charge of OOP courses was recognized by 82.6% of students. However, the e-book given by the lecturer has different material content from the material that should be taught or is not by the SLP. In addition, students also want learning materials that are available offline and online, with the number of students who want it is as much as 95.1%. The availability of offline and online learning materials or blended learning materials is expected to increase students' competence in computer programming at the global level (Jusuf, H., Ibrahim, N., & Atwi Suparman, A., 2019). Several other studies have stated that blended learning materials in learning activities have a positive response, make students actively participate in all learning activities, and effectively improve learning outcomes (Prayekti, P., 2020). Blended learning materials can be a practical solution in learning activities (Kristanto, A., Mustaji, M., & Mariono, A., 2017) and effectively improve student performance because students can read the e-book version of learning materials during class time. Students become more focused and active in their learning activities (Sari, U. R., 2020).

Based on the descriptions and considerations above, this research aims to develop learning materials for object-oriented programming courses based on blended lab rotation to support learning implementation during the Covid-19 pandemic to improve student learning outcomes at FICT UTM. From several research results that have been described previously, it is not clear that the blended learning materials applied are not yet clearly divided, which learning materials are delivered face-to-face and which are delivered online or independently because according to Allen and Seaman (2013) in Michael B. Horn and Heather Staker, said that blended learning occurs when there are face-to-face learning components and online or independent learning between 30% to 79% (Means, B., Toyama, Y., Murphy, R., & Baki, M., 2013). In previous studies, the composition of the application of blended learning has not been seen. Likewise, the types of blended used have not been seen, such as the Rotation, Flex, Self-Blend Model, and Enriched Virtual models, because the application of blended learning models is mostly implemented with these four models (Staker, H., & Horn, M. B., 2012).

Methodology

The research method used in developing teaching materials for OOP courses based on blended learning lab-rotation during the Covid-19 pandemic is the Research and Development (R&D) method by combining the steps developed by Gall, M. D., Gall, J. P., & Borg, W. R. (2007), Dick, W., Carey, L., & Carey, J. O. (2015), Rowntree, D. (1993) and Jolliffe, A., Ritter, J., & Stevens, D. (2001). The steps are generally called the Step of System Approach Model of Educational Research and Development. The initial step in this study adopted the Borg & Gall step, namely research and information collecting, Step of System Approach Model of Educational Research and Development which adopted the Dick & Carey step as a general step in developing learning materials, the Rowntree model step as a step in developing module learning materials and the Allan Jollifee model step as a website/online-based learning material development step. The research steps are shown in Figure 1.

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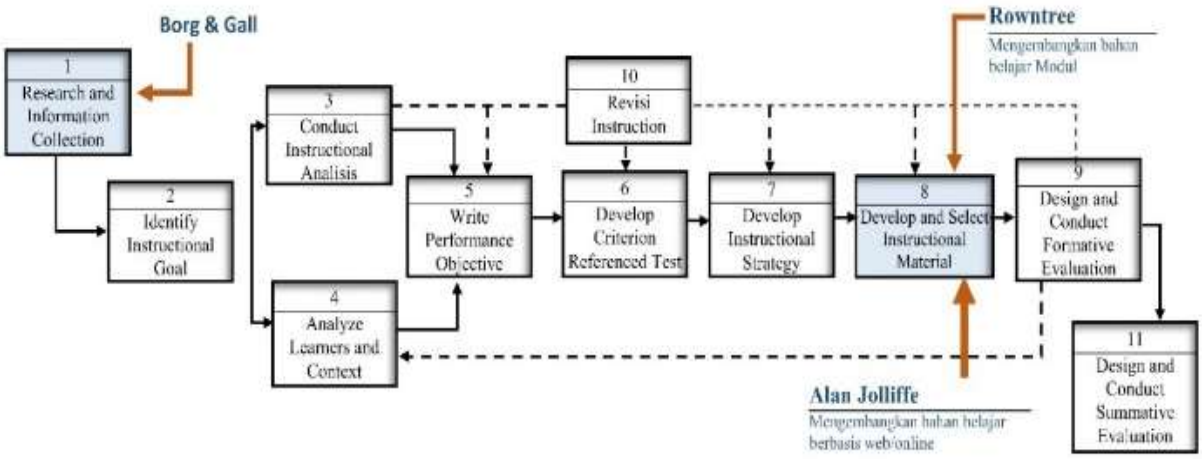

Figure 1: Step of System Approach Model of Educational Research and Development

Based on Figure 1, the development of blended lab-rotation-based learning materials to support learning during the Covid-19 pandemic is carried out with the following steps: 1) Research and information collecting. In this step, preliminary research and observations are conducted carried out regarding the process of implementing learning for courses. OOP by asking for help from the academic section, regarding the grades of students who have taken OOP courses in the last three years, knowing about the description of the implementation of OOP learning that has been carried out so far, conducting interviews with the head of the study program, supporting lecturers regarding the Semester Learning Plan (SLP), syllabus, learning implementation, and conducting literature studies to review and make preparations in research formulation, 2) Identification of instructional goals, at this step, a discussion was held with the head of the study program and the OOP course lecturer to formulate the General Learning Objectives (GLO), the results of the discussion were then brought to a discussion group forum (DGF) by inviting students, alumni, teaching lecturers, the head of the study program and practitioners to identify the skills and knowledge that must be possessed, the competencies that must be mastered, what prerequisite courses must be taken before taking the OOP course and determine the Specific Instructional Objectives (SIO) of learning to measure learning achievement, 3) Conduct instructional analysis , at this step, conducted DGF To use mapping the competencies and materials to be studied to achieve the desired learning objectives. This DGF was conducted by inviting users, course instructors, students, alumni, and the head of the Study Program, 4) Analyzing learners and contexts. In this step, an analysis was carried out on the knowledge and skills that students must possess. This analysis is carried out by looking at and paying attention to student data such as their educational background, entrance selection scores, school/national exam scores at high school/equivalent, etc. 5) Write performance objectives. In this step, GDFs are conducted to determine goals. the performance or Specific Instructional Objectives (SIO) form the basis for constructing the test grid. In making ICT, it must contain elements of the learning environment such as Audience, Behavior, Condition, and Degree, so that this element will be a guide in making tests and can develop tests that can measure the indicators of success or behavior contained therein, 6) Develop criterion-referenced test, in this step, a model assessment instrument is developed for evaluating the learning process to determine the extent to which the planned competency achievements are met. In this study, each learning activity was designed for pre-test, post-test, practice questions, and evaluation questions in the test format. The final stage is to make grids and questions that are used to measure student learning outcomes, 7) Develop instructional strategies, at this stage, the development of learning strategies is carried out in the form of preparing Semester Learning Plans (SLP) by paying

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attention to the order of the content of the material, descriptions of activities or student learning experience and determine how the material is stored. It's delivery activities, 8) Develop and select instructional material. At this step, the development of relevant learning materials or materials consists of several teaching materials used by students during the learning program so that learning objectives can be achieved. In this study, the stages in developing learning materials were adopting the steps for developing learning materials developed by Rowntree to develop module learning materials (for face-to-face and independent learning materials) and steps for developing learning materials developed by Alan Jolliffe for developing learning materials. website-based (for online and independent learning materials), 9) Design and conduct formative evaluation; this step is carried out by designing and conducting formative evaluations to ensure designs and materials. The learning developed is effective and feasible to use. Formative evaluation is carried out in stages through evaluation, validation, and evaluation of effectiveness. This validation evaluation is conducted by conducting a one-to-one evaluation involving experts/experts and resource persons, who have expertise in materials, instructional design, graphic and media design, and language. In addition, this validation evaluation is also carried out by conducting one-to-one and small group evaluations with students who have taken OOP courses and conducting field trials with students who have never taken OOP courses. While the Evaluation of Effectiveness is done by doing field trials, 10) Revise instruction. In this step, learning activities are revised based on the formative evaluation. The result of this activity is blended learning materials for OOP courses through a series of stages described previously.

Results and Discussions

Application of Learning Materials

The learning materials developed are blended-based OOP courses in offline learning materials (print modules) and online learning materials (LMS). This learning material is equipped with pre-test, post-test, exercises, video tutorials, discussion and collaboration forums, and presentation slides. Its implementation is done by applying the blended learning lab-rotation learning model in which the learning model is rotated with the main learning room in the computer laboratory. Students learn online and independently by studying learning materials available in modules or presented in LMS. In addition, students can also improve their understanding by attending lectures in class with lecturers (Dick, W., Carey, L., & Carey, J. O., 2015).

The application of OOP learning materials using the blended lab-rotation learning model during the covid-19 pandemic at FICT UTM is adapted to the characteristics of OOP courses that require laboratory space for practicum. The illustration of its implementation is as shown in Figure 2.

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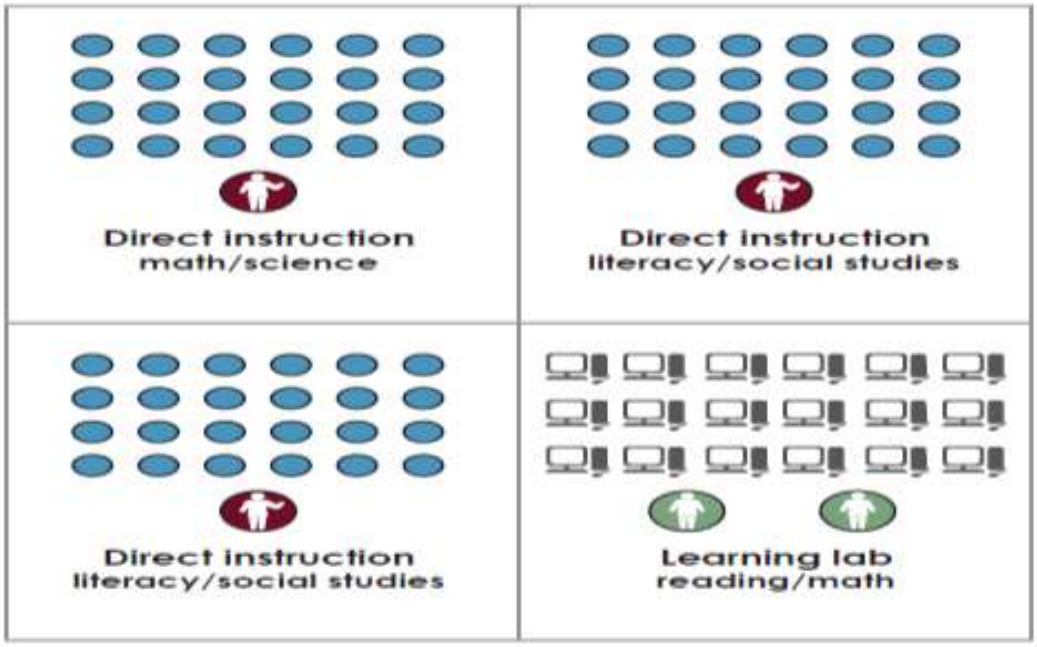

Figure 2. Lab-Rotation Model (Staker, H., & Horn, M. B., 2012).

Based on Figure 2. The application of OOP learning materials using the blended learning lab-rotation model by learning from face-to-face learning online (zoom). At this initial meeting, the lecturer explained the scope of the material to be delivered, learning objectives, task plans, and others, then entered the material explanation. Students who already understand can move to spend one part of certain material to the computer laboratory to study online or independently at the students' own pace to practice what has been learned and understood before. Meanwhile, other students can study to reinforce what they have learned in the thorium lab or ask what is considered difficult or has not been completed in the computer laboratory. Students who need additional support for material explanations can get more special attention by forming small groups for more detailed and straightforward explanations from the lecturer. Students who demonstrate proficiency are ready to be rotated to the oratory lab to complete the exercises independently. Students who need additional assistance work directly with students in small groups. The form of application of blended-based OOP learning materials in the Covid-19 pandemic era at FICT UTM according to the topic of discussion is shown in table 1.

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Table 1: OOP Learning Topics

Modules and Topics	IT	Evaluation Type	Learning models	Media and Technology
Module 1: Principles of Object-Oriented Programming (Meeting 1)	1. Able to explain the basics of Object-Oriented Programming well 2. Able to explain the elements of Java Programming and able to provide and use the required supporting applications properly	Pre-test Exercises Formative Evaluation Post-Test	Live Event via zoom for 100 minutes (2x50”x1) self-paced learning 100 minutes (2x50”x1)	Videos Conference via Zoom and LMS
Module 2: Programming with Classes, Objects, and Interfaces (Meetings 2-3)	1. Able to create classes and explain their components well 2. Able to create objects and explain the steps of making them well	Pre-test Exercises Formative Evaluation Post-Test	Live Event via zoom for 100 minutes (2x50” x 1) self-paced learning in the laboratory for 200 minutes (2x100”x1)	Videos Conference via Zoom, LMS and Modules
Module 3: Control Structure Meetings (4-8)	1. Able to explain and apply good use of selection statements in the program 2. Able to explain and apply good use of repetition statements in the program 3. Able to explain and apply proper use of Exceptions and try..catch in programs	Pre-test Exercises Formative Evaluation Post-Test	Live Event via zoom for 100 minutes (2x50”x3) self-paced learning in the laboratory for 400 minutes (2x100”x2)	Videos Conference via Zoom, LMS and Modules

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Module 4: Creating CRUD Applications using OOP Principles (Meetings 9-15)	1. Able to create GUI programs that are connected to databases based on the OOP concept well 2. Able to create reports and integrate them with GUI programs well.	Pre-test Exercises Formative Evaluation Post-Test	Live Event via zoom for 100 minutes (2x50”x4) self-paced learning in the laboratory for 600 minutes (2x100”x3)	Videos Conference via Zoom, LMS and Modules

Formative Evaluation of Learning Materials

Formative Evaluation Instrument

Learning materials developed are evaluated through formative evaluation using instruments that have been validated by instrument experts (validators). The validated instruments 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 conducting this formative evaluation use a Likert scale questionnaire 1-5 with the instrument indicators referring to the book The Systematic Design of Instruction – Eighth Edition, with indicators including Clarity of Instruction, Impact on Learner, Feasibility of instruction and others (Walter Dick, L. C., & Carey, J. O., 2015).

Results of Formative Evaluation of Learning Materials

a) Evaluation of the Feasibility Test of Learning Materials

Learning materials that have been developed are 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. Students (field trial) to do a formative evaluation to test the feasibility of the product based on an instrument that the validator has validated.

The average value of the feasibility test results from the blended-based OOP learning materials developed is shown in table 2.

Table 2: 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	4,58	4,68	4,67	4,67	4,59	4,78
Feasibility of Instruction	4,54	4,38	4,29	-	4,33	4,44	4,56
Centered on Instructional Goals	4,50	5,00	-	-	4,00	5,00	4,75
Technical	-	4,40	4,50	-	4,67	4,50	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

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Based on table 2, the feasibility test results on blended-based OOP course materials to support learning during the covid-19 pandemic carried out by material experts according to indicators resulted in an average score of 4.56 by instructional design experts with an average value of evaluation results. By 4.60, by media and design experts by 4.49, by language experts by 4.50, through a one-to-one evaluation with three students by 4.40, by nine students (Small group) by 4.62, and based on the evaluation results of the evaluation field trial of 4.63.

To determine the learning materials developed have very good quality, good or otherwise, it is carried out based on assessment criteria using evaluation standards Widoyoko, E. P. (2019), such as table 3.

Table 3: 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 3, the feasibility test results for blended-based OOP learning materials can be recapitulated according to table 4.

Table 4: 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 4, it can be said that the learning materials developed are considered very good or feasible to use.

b) Test the Effectiveness of Learning Materials

Before learning activities on a particular topic begin, 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 given after students complete the learning activities of the topics that have been studied. Field trials were conducted and compared or processed the pre-test and post-test scores to test the effectiveness of the developed learning materials. The students' pre-test and post-test results are shown in Table 5.

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Table 5: Student pre-test and post-test scores

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

Based on the results of the *pre-test* and *post-test results* in table 5, it can be seen that the average *pre-test score* 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 declared complete have reached the minimum standard set, namely the value>=80. To determine whether there is a significant difference in the increase between the pre-test and post-test, a test of the significance of the difference between the average pre-test and post-test was conducted using a t-test through the SPSS application. 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 < alpha (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.

With the results of this study, it can be said that the blended-based OOP course learning materials that were developed to support the implementation of learning during the Covid-19 pandemic at FICT UTM have proven to be effective in improving student learning outcomes.

Conclusion

The development of blended learning-based OOP learning materials using the lab-rotation learning model has improved student outcomes in OOP courses. This developed learning material can make it easier for students to study anywhere and anytime. It is available in offline (module), and online (LMS) forms without any space and time limits for learning. The discussion and collaborative learning process become more optimal. The application of

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blended-based OOP learning materials that have been developed has been proven to improve student learning outcomes so that they can be used as a reference or reference for other courses at FICT UTM or other universities to improve student learning outcomes in other subjects.

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