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Project Based Learning Model in Computer Programming Courses at Mathematics Student

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Abstract

Project-based learning is carried out for computer programming courses. In this lesson, students are expected to have skills in recognizing, constructing, and creating programs from a problem using a programming language. This is a research and development (R&D) that consist of team based project scheme stage, development stage, implementation stage, and final or evaluation stage. When making a computer program on a problem, students must be able to identify the required input, process, and output. Then the information is constructed in an algorithm which is then made into a computer program. Its implementation there are schemes that have been implemented, namely: the preparation stage, and the project work activity process, which includes; forming groups, case studies, gathering information on project-based activities, and producing documentation and portfolios of project implementation and evaluation. This research also produces products in the form of graduate learning outcomes (CPL), Syllabus and Lecture Contracts, Semester Learning Plans (RPS), Student Project Task Plans (RTM) or Student Project Worksheets (LKM), Learning Outcomes Assessment Sheets (LPHB) in accordance with project-based learning model (Project Based Learning). The results of the evaluation through a questionnaire obtained that student perceptions of computer programming courses were very high.

Keywords*: Computer Programming, Project Based Learning*

1. Introduction

Universitas Jambi has a vision that is to become a World Class Entrepreneurship University based in Agroindustry and Environment. One of the efforts of the Mathematics Study Program is to develop a curriculum that formulates Graduate Learning Outcomes is then revealed in the learning outcomes course. Computer Programming is one of the compulsory subjects in the Study Program Mathematics. Students are expected to have skills in recognizing, constructing, and creating a computer program from a problem using One of the programming languages to use is MatLab. Learning innovations that will be carried out are project-based so that technology and knowledge taught and developed can keep up with the latest and novelty. On project-based learning innovation for this computer programs course, integration is carried out in solving problems using computer programs that can be initiated with the case method, Then students can be involved in the completion of project problems by creating computer program syntax.

The learning model of project-based learning (PBL) is a learning model that involves the project in the process of learning activities. This project-based learning is also an alternative learning in the implementation of online teaching during the Covid-19 pandemic in engineering chemistry learning (Salazar-Peña et al., 2023). The learning project model that has been designed provides challenges for students to be responsible for learning; the need for positive interdependence, individual accountability, social skills, and equal participation, then when presenting projects can encourage communication and leadership for students (Santos et al., 2023). The project model here conveys a way of teaching that provides opportunities for students to use units of life that exist in the environment to be made as learning materials (Agustin et al., 2016). Project-based learning can also be used to increase students' engineering design knowledge and skills in engineering design skills (Gomez-del et al., 2022). Project-based learning also allows the

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development of prototypes in collaboration with unregistered designs. Implementation of the entrepreneurship strategy opens active learning in the form of projects to motivate students to interact with clients (Moure Abelenda et al., 2023). This PBL learning model puts forward the process of innovative learning activities, emphasizing deep learning contextual in activities. The emphasis of this learning lies on the core principles and concepts of scientific subjects, which is followed by problem-solving constructed with students' knowledge of the courses conducted (Wena, 2012).

Project-based learning provides a positive experience for students in applying their knowledge in practicing problems according to design in the industry, the delivery of learning is not higher than conventional learning, but assessments are more objective, and the impact of learning goes beyond more theoretical assignments (Steffen et al., 2022). (Lu, 2023) also said that project-based learning is suitable for students at universities in increasing their skills in quantitative analysis and sports statistics; it was found that there were many interactions that occurred between students during learning.

The Computer Programming course is a subject that requires students to be able to practice the Computer Programming language in forming a programming script in one case. During the implementation of this lecture, students will be given theoretical material on computer programming; then, students must be able to practice in 3 cases with programming languages. Therefore, students must be able to understand computer programming language concepts comprehensively and also must-have skills in making a script and program.

The criteria for the computer programming course are felt to be implemented properly by applying the PBL learning method during the lecture period. Students become focused on completing this course project with the guidance of a team of supporting lecturers. Circumstances that are enforced like this require students to come up with skillful and critical. PjBL learning can be done in several steps, including; determining the project, preparing the project, preparing the schedule, monitoring, preparation of results, and experience evaluation (Hosnan, 2014)

The PBL method that will be implemented has several positive and negative sides implementation. According to (Wena, 2012), the advantage of PBL is that it can motivate students to work hard, able to work together, able to manage projects, able analyze problem solutions. The drawbacks of this learning method among them; are a lot of funds and time needed, facilities and learning equipment which should be sufficient, but not suitable for students who easily give up. There is the analysis regarding the advantages and disadvantages of this learning method should be a concern for the team of lecturers supporting Computer Programming courses so that learning outcomes are achieved. This course is achieved by applying it to project-based learning.

2. Method

1. Design of Learning Implementation Activities

Implementation of learning research grant activities in the programming computer courses is done using the team-based project scheme. Set up a schematic was developed using research and development (R&D) methods (Sukmadinata, 2010):

a) Team-Based Project Scheme Stage

The Team-Based Project scheme is a scheme whose implementation is carried out with the participation of a team of lecturers and students in understanding the programming language. Then the implementation of this course is supported by a team of three lecturers who have expertise in the field of statistical and mathematical studies and have the ability to teach computer programming courses. On learning the team divided into three parts of learning, namely the deepening part of basic concepts of computer programming, the basics of programming languages with practice; the second part, the syntax and algorithm of a program with its practice; and part the third, programming in the form of a guide and practice. Each lecturer will contribute to one part of the learning.

The team-based project scheme is carried out with various stages of activities. As for the stages, team-based project scheme activities consist of the following:

a) Preparation Stage

This is the standard stage of introductory learning, where information and schedules are created. Students try to understand each other by introducing themselves and gathering expectations in the whole activity project.

b) Team-Based Project Process

This is the main stage of a team-based learning project and consists of a number of activities related to individual readiness and team or group readiness and important steps in carrying out a project. This stage includes (a) group formation (which is really ready), (b) case study and three project selections, (c) gathering information on project-based activities, and (d) production of documentation and project implementation portfolio.

c) Evaluation Stage

At this stage, it shows activity in conducting an assessment of students. Feedback helps lecturers interpret the mastery of students on projects they have worked on. Implementation of this team-based project scheme on project-based learning (PBL) has several processing steps, including; 1) determining basic questions, 2) designing project plans, 3) preparing schedules, 4) monitoring students and project progress, 5) test results, and 6) evaluating experiences. Steps for the implementation of PBL learning can be explained in the Table 1.

Table 1: Steps for implementing PjBL Learning

No	Step
1	Provide problems or challenges posed to students
2	Facilitate students to design processes to determine solutions for the problems or challenges submitted;
3	Facilitate students to make decisions about a framework Work;
4	Facilitate students collaboratively to be responsible in accessing and managing information to solve problems;
5	Facilitate students periodically to reflect on activities that have been carried out;
6	Carry out continuous evaluation processes;
7	Conduct a qualitative evaluation of the final product of learning activities; And
8	Learning is very tolerant of mistakes and changes.

b) Development Stage

Computer Programming courses conducted using the R&D method will produce a product in the form of graduate learning outcomes, Syllabus and contracts lectures, semester learning plans, student project task plans or student project worksheets, learning outcomes assessment sheets according to the model project-based learning (Project Based Learning) or blueprint exam questions as well reviewed assessment rubric) (Sukmadinata, 2010).

This research and development model is the model used for developing products that will be produced in this research. According to (Sugiyono, 2014), the development model consists of procedural models, conceptual models, and theoretical models. The procedural model is a model that presents the steps involved that must be done to produce the product. The conceptual model is the model in its nature analysis that provides the necessary product components and interconnects components. In contrast, the theoretical model is a model that presents relationship state changes at each event. Then this project-based research was developed with the procedural model method.

The development method with the procedural model has several stages of implementation, that are, the preliminary stage, the instrument-making stage, and the evaluation stage. If applied to the computer programming course in this study, the implementation of activities can be explained as follows:

1) Preparation Stage
   Preparation of learning instruments in the form of CPL, Syllabus, RPS, RTM, LKM, LPHB, and exam questions.
2) Preparation of teaching materials for Computer Programming courses.
3) Determination of a team of experts/validators.

c) Implementation Stage

This stage will be carried out by making teaching materials for computer programming courses with validation from the validator team and approval by the authorities so that these teaching materials can be used for the process of working on student projects.

d) Final/Evaluation Stage

This stage is carried out to evaluate the learning process. It is already done. The activities carried out include:

1) Give a questionnaire to students which contains the assessment of the process of project-based learning in Computer Programming courses.
2) Perform data analysis on the results of the questionnaire above and interpret the results of data analysis.

Evaluation is carried out to find out whether the output quality produced has been reaching the appropriate standard. Evaluation of learning instruments in the form of; CPL, Syllabus, RPS, RTM, LKM, LPHB, and exam questions. The assessment is carried out by the team validation and also carried out on students.

After the activity is finished, students will fill out a questionnaire to find out their perceptions of students in computer programming lectures which were conducted for one semester. The data used in research on the development of learning in computer programming courses use qualitative and quantitative data. Qualitative data were obtained from the validation team, namely the material expert team, on teaching materials in the form of questionnaires that contains suggestions for better teaching materials. In contrast, quantitative data were obtained from students' perceptions of the learning process of computer programming.

a. Data Collection Instruments

The research data collection instrument used a questionnaire. This learning research uses data collection in 2 ways, namely structured questionnaires and open questionnaires.

1. Structured Questionnaire Method

According to (Sukmadinata, 2010), a structured questionnaire is a question that has been prepared in a structured way to assess the object being measured. Next, the questionnaire was submitted to the material expert team that contained questions regarding the research topic. Then the team will choose the answer option 'yes' or 'no' in each sub-question. If it has not or does not meet the standards, suggestions, and input from the team will be given expertise. Furthermore, the suggestions and input are in the form of qualitative data, which will be used to update the teaching materials made. The preparation of research instruments is done by making a

grid. This grid is laid out based on the criteria of the standard preparation of learning instruments and the effectiveness of the materials taught. These grids are translated into assessment indicators so that the statements contained in the assessment instrument are in accordance with the expected data.

Table 2: Grid of Learning Instrument Validation Instruments by Experts

Variable	Indicator	Description	Item Number
Development CPL, Syllabus, RPS,	Content device learning	Clarity of Learning Objectives	1
		Clarity of Learning Resources	2
		Clarity of Teaching Materials	3
		Clarity of Learning Outcomes	4
		Clarity of Teaching Methods	5
		Conformity of Compilation Format CPL, Syllabus, RPS, RTM, LPHB	6
Development Material Evaluation Learning (RTM, LKM, and LPHB)	Evaluation Content Learning	Clarity of Working Instructions questions/projects	7
		The sequence of questions presented	8
		Difficulty level of questions/projects	9
		Conformity evaluation with learning achievement	10
		Compatibility with training learning achievement	11
		Balance of proportions questions/projects	12
		Accuracy of giving feedback on user answers	13

2. Closed Questionnaire Method.

The closed questionnaire uses the e-point format of the Likert Scale, where the answer is very much agreed (SS), agree (S), undecided (RG), or disagree (TS). Reasons for using a Likert scale of seven are because the process is relatively easier and the level of reliability (provision of evaluation tools) tall. This questionnaire will be tested first for its validity and reliability. Questionnaire instruments that are valid and reliable are used for perception data collection.

Table 4: Student Perceptions Questionnaire Grid of learning activities Computer Programming

Indicator	Statement	No Item Instrument
Motivation Study	1. Use of teaching instruments to make students more eager to Study. 2. The use of teaching instruments to make learning Computer Programming more pleasant. 3. The use of teaching instruments to make students not feel bored. 4. The use of teaching instruments to make students more interested in learning Computer Programming 5. Use of teaching instruments stimulate the curiosity of student to study Computer Programming 6. Use of teaching instruments increases student attention to learning program computer	1, 2, 3, 4, 5, 6
Activity Study student	7. The use of teaching instruments can make students study independently. 8. The use of teaching instruments can increase student participation in learning programming computer 9. The use of teaching instruments helps students solve problems that appear in learning computer programming. 10. The use of teaching instruments helps students think creatively	7,8,9,10

3. Data Analysis Technique

1) Student Perception Questionnaire

In this study, a set of data will be given to students to do an analysis used to see student perceptions, after which it will be carried out validity and reliability analysis as follows:

a. Validity analysis

Validation is a measure that shows the levels of validity or validity of an instrument. (Arikunto, 2006) "an instrument is said to be valid if it is capable measure what is desired; an instrument is said to be valid if it can reveal the facts of the variables studied precisely. High and low instrument validation indicates the extent to which the collected data does not deviate from the validation picture meant". For the validation analysis, the product-moment correlation formula is used as follows:

$$r_{count} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\{N\sum X^2 - (\sum X)^2\}\{N\sum Y^2 - (\sum Y)^2\}}} \quad (1)$$

With:

r_{count} : specific validation coefficient
X: score of each questionnaire item
Y: total score
N: number of samples

If the instrument is valid, then the interpretation criteria regarding the correlation index (r) are seen as follows:

0.800 to 1.000 : Very High
0.600 to 0.799 : High
0.400 to 0.599 : Fairly High
0.200 to 0.399 : Low
0.000 to 0.199 : Very Low

The calculation results of r_{hitung} are compared to the critical table r with a significant level of 5%. Valid and invalid criteria are based on the interpretation of the correlation index (r).

b. Reliability Analysis

From the results of the questionnaire trial, the reliability of the questionnaire can also be determined. (Arikunto, 2006) states that "an instrument is reliable enough to be used as a tool data collector because the instrument is already good. Determination of the reliability of the questionnaire can be done using the alpha formula as follows:

$$r_{11} = \left(\frac{n}{n-1}\right)\left(\frac{S^2 - \sum pq}{S^2}\right) \quad (2)$$

$$S_1{}^2 = \frac{\sum X^2 - \frac{(\sum X)^2}{N}}{N} \quad (3)$$

with:

r_{11} = correlation index (price reliability)
n = number of items
p = the proportion of subjects who answered the item correctly
q = 1 – p = proportion of subjects who answered the item incorrectly
S = standard deviation
Σpq = number of multiplications between p and q

The test reliability coefficient ranges from 0.00 – 1.00 with details of the correlation:

$0.00 \leq r_{xy} \leq 0.20$: very low reliability
$0.21 \leq r_{xy} \leq 0.40$: low reliability
$0.41 \leq r_{xy} \leq 0.60$: moderate reliability
$0.61 \leq r_{xy} \leq 0.80$: high reliability
$0.81 \leq r_{xy} \leq 1.00$: very high reliability

3. Result and Discussion

Research on computer programming courses based on learning The project is carried out in the form of preparation, implementation, and evaluation. At the time of preparation, the research team discussed the research outputs produced during the implementation of project-based learning. During preparation, the research team produced an output draft from research courses such as the draft Graduate Learning Outcomes (CPL), Syllabus and course contracts, Semester Learning Plans (CPL), Project Task Plans Student (RTM) and Learning Outcomes Assessment Sheet (LPHB). The outcome of this research validation was carried out by a team of experts so that they could assess the suitability of the output instrument from this research.

Then after carrying out the preparation for this course, the implementation will then be carried out as a research project for computer programming courses. This research consisted of 3 projects carried out by students, including:

a. Project 1 discusses flowcharts, data types, and operations. Then this 1st project was also carried out by displaying the results of student projects in-class lectures. Implementation of Project 1 was carried out at meeting 5 lectures.
b. Project 2 discusses functions and conditional loops in scripts. Project 2 This will be held at the 12th meeting.
c. Project 3, discussing the guide. In this project, students create a guide through a case. Implementation of Project 3 will be carried out at a meeting of 15 periods of lectures.

After the computer programming course was finished and ended with the final semester exam, students were asked to fill out a questionnaire on student perceptions of the activity of Computer Programming learning. The following are the results of student perceptions:

Learning Motivation Indicator For teaching instruments to make students more enthusiastic about learning, it is obtained as much 67% agreed and 33% strongly agreed. For teaching instruments to make students more fun to learn obtained, as much as 4% do not agree, as much as 63% agree, and 33% strongly agree. For teaching instruments, students don't feel bored to learn obtained, as much as 8% do not agree, as much as 59% agree, and 33% strongly agree. For teaching instruments to make students more interested in learning to ,learn obtained as much as 59% agree, and as much as 41% strongly agree. for instruments, teaching stimulates students' curiosity to learn as much as 52% agree and 48% strongly agree. For teaching instruments to increase student attention to learning obtained, as much as 4% do not agree, as much as 55% agree, and as much as 41% very agree.

Student learning activity indicators for teaching instruments to help students do learning independently obtained as much as 7% disagree, as much as 41% agree, and as much as 52% strongly agree. For teaching instruments to help students participate actively when learning is obtained, 4% disagree, 74% agree, and 22% strongly agree. For teaching instruments to help students solve problems that arise when learning, obtained as much as 22% disagree, as much as 48% agree, and as much as 30% totally agree. For teaching instruments to

help students think creatively when 10 learning, obtained as much as 7% disagree, as much as 56% agree and as much as 37% strongly agree.

The results of these perceptions were analyzed using the validity test and reliability test, obtained for the validity test that the correlation between question 1 items is "teaching instrument make students more enthusiastic about learning" on question 8, namely "teaching instruments help students participate actively during learning" and item question 10 namely "teaching instruments help students think creatively when learning" correlation is quite weak. question 2, namely "teaching instruments to make more fun to learn," towards question item 8, namely "teaching instruments help students participate actively during learning," and question item 10, namely "teaching instruments help students think creatively while learning," has a correlation pretty weak. Question 3, namely "teaching instruments make students not feel bored to learn," question 6, namely "teaching instruments improve students' attention to learning," and question item 9, namely "teaching instruments help students solve problems that arise during learning," has a positive correlation pretty weak. Question 4 is "teaching instruments make students more interested to learn" question 9, namely "teaching instruments help students solve problems that arise during learning," and question item 10, namely "teaching instruments help students think creatively while learning," has a correlation pretty weak. Question 5, namely "teaching instruments make it more stimulating want to know students to learn," on question 10, namely "teaching instruments help students think creatively during learning," the correlation is quite weak. Grain question 6, namely "teaching instruments increase student attention to learning," to question 3, namely "teaching instruments make students not feel bored to learn," question item 7, namely "teaching instruments help students do independent learning," and question item 10, namely "teaching instruments help students think creatively during learning" has a fairly weak correlation. Grain question 7, namely "teaching instruments to help students carry out learning in a practical way independently," on question 6, namely "teaching instruments increase attention students to learn," question item 9, namely "teaching instruments help students solve problems that arise during learning" and question item 10 namely "teaching instruments help students think creatively while learning" has a correlation pretty weak. question item 8, namely "teaching instruments help students participate actively during learning," on question 1, namely "teaching instruments make students more enthusiastic about learning", point question 2, namely "teaching instruments make it more fun to learn"; question item 9, namely "teaching instruments help students solve problems that arise during learning" and items question 10 namely "teaching instruments help students think creatively when learning" has a fairly weak correlation. Question 9 is "teaching instrument help students solve problems that arise during learning question item 3, namely "teaching instruments make students not feel bored with learning," question item 4, namely "teaching instruments make students more interested in learning," question item 7, namely "teaching instruments help students do independent learning," and question item 8 namely "teaching instruments help students participate actively during learning" has a fairly weak correlation. Grain question 10 namely "teaching instruments help students think creatively when learning" on question 3, namely "teaching instruments make students not feel bored to learn" and question item 9 namely "teaching instruments help 11 students solve problems that arise during learning" has a positive correlation strong enough.

Furthermore, a reliability test was carried out on student perceptions with Cronbach's test scores alpha of 0.89, meaning that students' perceptions of computer programming courses with project based learning model were very high, with indicator motivation study and student activity. Project based learning motivate student to learn according to research (Insyasiska et al., 2015) and student activity in learning based on research (Hariyati et al., 2018).

4. Conclusion

Project-based learning clarifies the objectives of course learning computer programming so that students can analyze data in detail and have expertise in computer programming with programming languages. The implementation of Learning computer programming courses has been going according to plan, and output the output is in the form of Graduate Learning Outcomes (CPL)-Learning Outcomes, Syllabus, and Lecture Contracts, Semester Learning plans (RPS), Project Task Plans Student (RTM) or Student Project Worksheet (LKM), Outcome Assessment Sheet Learning (LPHB) according to the project-based learning model (Project Based Learning) or blueprints of exam questions and assessment rubrics that have been reviewed.

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