Analysis of Student Responses to the Application of the Project Based Learning (PJBL) Model in the Introduction to Solid State Physics Course

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Abstract. This research aims to elucidate student responses to the application of the Project Based Learning (PjBL) learning model in the introduction to solid State physics course. Physics education study program students are the population of this study, FKIP Jambi University who took the introduction to solid state physics course and found 60 people. The object of the research is the application of the PjBL model in the introduction to solid substance physics course. This study uses a quantitative approach with empirical methods. The data collection method used is a combination research method by using response questionnaires and interview questionnaires using google form. The data were analyzed using quantitative and qualitative descriptive data analysis techniques. Based on the results of student questionnaire responses, research shows that the application of the Project Based Learning (PjBL) learning model in the introduction to solid state physics course is in the good category of 3.19 and the percentage is 79.76%. The data from the interviews show that the Project Based Learning model can bring changes to the way students learn, increase creativity and activeness in learning, and make learning more fun.

Keywords: Project Based Learning (Pjbl) · Model · Physics Course · Student

1 Introduction

One important element in education is the learning process. The learning process is made teacher-centered, so the essence and goals to be achieved cannot be drawn from the learning itself. This causes students to be less active in the learning process. Less active students in the learning process, of course, resulted in less than optimal learning outcomes. Lecturers as agents of change in the world of education must have many strategies in teaching, finding innovations, and solutions in solving learning problems in the classroom.

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One of the learning problems at the university level that requires special attention is the subject with abstract material which requires high thinking and imagination skills. Introduction Solid matter physics is one of the compulsory subjects studied in the Physics Education study program at Jambi University with a high level of difficulty. The materials studied in this solid matter physics course are abstract and microscopic. Based on the results of online learning of Solid State Physics in odd semesters in the 2020/2021 school year using the Zoom Cloud Meeting application, students only listen to the teacher's explanation. So that students often have difficulty understanding learning materials, especially on crystal structure material. Learning to use this application is not effective and efficient. One of the efforts to improve the quality of Preliminary Solid Substance Physics learning is to implement the Project Based Learning (PjBL) model.

Response is defined as answers, responses and reactions. Responses or responses given by students in the learning process can be seen from changes in student behaviour. A good response can actively build shared understanding or relevance through a communicative exchange, where students learn from the perspective of a more knowledgeable speaker [1]. Therefore, a positive response between lecturers and students is needed in the learning process. One of the efforts to improve the response given between lecturers and students in the learning process and the quality of learning in Introduction to Solid Substance Physics is to implement the Project Based Learning (PjBL) model.

Project-Based Learning (PjBL) is learning carried out by students and facilitated by lecturers to learn [2]. Project Based Learning is defined as experience-based learning, and learning that is rooted in real-life problems [3]. This learning model emphasizes exploration carried out by students to gain more knowledge which is directed by lecturers through research. When working on projects, students are encouraged to explore creativity to solve existing cases by using their science and expertise so that students can create unique and creative outcomes [4]. PjBL has advantages including (Ummah et al., 2019): (1) it makes it easier for students to work together in understanding concepts of knowledge and higher-order thinking; (2) facilitating students to expose higher abilities; (3) invite students to solve real problems and become a good cooperative team; (4) encouraging students; and (5) improve knowledge of concepts and meet the needs of students with different skills and learning styles [5].

This article is the result of research that has been carried out by researchers. In the process of writing this article, it also refers to previous studies listed in articles such as the following:

The implementation of (PjBOL) from student perceptions includes: 1) Student and Lecturer Interaction; 2) Able to motivate/increase student interest in learning; 3) Competence to understand learning materials; 4) Competence to think critically, effectively and efficiently; 5) Competence in time management well; 6) Good project results; 7) The appropriate of the application of learning methods with the characteristics of the subjects, obtained the average result of student perceptions of the implementation of Project Based Online Learning in science experiment subjects has a "Good" category with a percentage of 77% [6].

Based on research conducted by Amaral, Santos, and Rodrigues [7] which presents the results of the "Research Methodology" course offered to 22 new students in the first year of administrative science at the Federal University of Sao Paulo in Osasco, Brazil. In

the second semester of 2016, a course was developed that combined community-based research and project-based learning. Students work in teams on certain aspects of NGOs helping people in need. The NGO is selected from a list of organizations that have agreed to act as community partners. The main findings are as follows. 1) Students have difficulty working in groups, planning meetings with community partners, and writing articles. 2) Project-based learning approach improves student learning outcomes. 3) Conducting community-based research is a rich and meaningful experience for students. 4) This course has succeeded in improving students' research abilities.

Based on research conducted by Suwarno, Wahidin, and Nur [8] which was conducted to determine the effectiveness of a project-based learning model (PjBL) with the support of LKPD Applied Waste Management on creativity and student learning outcomes. Learning outcomes data were obtained through multiple-choice tests, while creativity data used a response questionnaire. The data obtained was analysed using a covariance one-way analysis of variance. The results showed that the learning model had a significant impact on student creativity and learning outcomes. It was concluded that the PBL model supported by LKS had a positive impact on student abilities, especially creativity and learning outcomes in physics.

Based on the description that has been described above, this study aims to determine and analysis student responses to the utilization of project-based learning model (PjBL) in preliminary solid-state physics course. With the implementation of PjBL, it is expected to intensify the active role of students in the learning, provide more understanding of a topic, increase motivation and learning outcomes.

2 Method

This study uses a combination of research methods (quantitative and qualitative). The population in this research were 60 students of the Physics Education Study Program, FKIP University, who already picked up the Introduction to Solid Substances Physics course. Data collection techniques were carried out using response questionnaires (questionnaires) and interview questionnaires via google form. The questionnaire used was a closed questionnaire containing questions and respondents were asked to choose 4 graded answers provided. The questionnaire was prepared using a Likert scale based on indicators representing research variables with categories of sincerely agree, agree, disagree, and sturdily disagree. After the data is collected, the data is calculated using Microsoft Excel and the average response value is obtained in the form of a percentage using the following mathematical equation:

$$Pers\,(\%) = \frac{\sum j}{\sum j_m} \times 100\% \tag{1}$$

Information:

Pers: Percentage
$\sum j$: Total value obtained
$\sum j_m$: Maximum number of values

Table 1. Likert scale percentage category

Interval Score	Category
81,25%–100%	Very good
62,50%–81,25%	Well
43,75%–62,50%	Good enough
25%–43,75%	Not good

The percentage categories of the average response values with a Likert scale of 1–4 are grouped as in Table 1.

The results of the calculation of the percentage of the average value of student responses to the application of the PjBL model in the introduction to solid state physics course were analysed using quantitative descriptive data analysis techniques and interview questionnaires were analysed using qualitative descriptive data analysis techniques. This interview questionnaire is used to strengthen the results of the student response questionnaire.

3 Result and Discussion

The application of PjBL in the introduction of solid state physics course uses zoom meeting, Siakad, and UNJA iLMS applications. The implementation of PjBL is carried out at the third and twelfth meetings. Researchers start learning by asking complex questions about the material that will be used as a project with the aim of exploring students' initial understanding and arousing students' enthusiasm for learning. Then the researcher explains the description of the project that will be given to students using Project-based LKM like in Fig. 1.

The first project is on various crystal structures and the second project is on the synthesis and characterization of semiconductor materials. Next, students design the project to be worked on. After that, the researcher asked the students to explain again about the description of the project that the students would work on. Projects carried out by students are group in nature by utilizing learning media that have been made by researchers, namely in the form of videos and looking for other reference sources, either from textbooks or journals. The researcher serves as a facilitator, guides, provides resources needed by students, monitors the progress of student projects, and assesses the project-based learning process. Then the students submit the completed project and the researcher conducts an open reflection with the students to conduct an assessment and provide input and feedback so that the student's work becomes better. After the students make revisions, the project is made on a Youtube sharing video page. The student projects can be seen in Fig. 2.

After the process of applying the Project Based Learning (PjBL) learning model in the introduction to solid state physics course was completed, students were then given response questionnaires and interview questionnaires by the researcher. The results of the student response questionnaire as shown in Table 2.

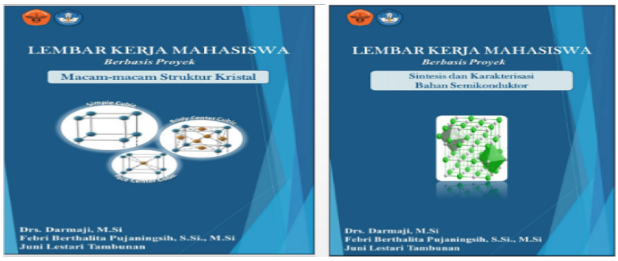

Fig. 1. Project-based Student Worksheets (LKM) in the Introduction to Solid Substance Physics

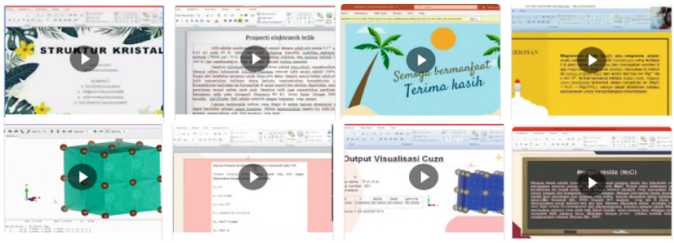

Fig. 2. Student Project Results

From Table 2 it can be seen that the student responses in terms of student and lecturer interactions are in the good category with an mean value of 3.33 (83.32%). Student responses in terms of motivation/increasing student interest are in the good category with an mean value of 3.17 (79.25%). Student responses in terms of understanding the subject matter are in the good category with an mean value of 3.16 (79.00%). Student responses in terms of critical, effective, and efficient thinking competencies are in the good category with an mean value of 3.07 (76.75%). Student responses in terms of time management competence are in the good category with an mean value of 3.22 (80.50%).

Of the six indicators of PjBL implementation in terms of student responses, which include: (1) student and lecturer interactions; (2) able to motivate/intensify student interest in learning; (3) understand the subject matter of lectures; (4) critical, effective, and efficient thinking competence; and (5) Good Time Management Competence; The average result of student responses to the implementation of PjBL in the introduction of solid matter physics courses has a good category of 3.19 and a percentage of 79.76%. In this case, the "Good" assessment of the student's response to the implementation of PjBL provides a major role in the implementation of the Introduction to Solid Substance Physics learning, which can be done with an online learning system. This is in accordance with the results of interviews which show that the Project Based Learning (PjBL) learning model can bring changes in the way students learn, increase creativity and activeness in learning, and make learning more fun.

Table 2. Description of student responses to the implementation of PjBL

No	Indicator	No. Question	Score Average	Total Score Maximum	Rating Percentage (%)
1	Student and Lecturer Interaction	1, 2, 3, 4, 5, 6	3,33	4	83,32
2	Able to Motivate / Increase Student Interest	7, 8, 9, 10	3,17	4	79,25
3	Understanding Lecture Materials	11, 12, 13, 14, 15, 16	3,16	4	79,00
4	Critical Thinking Competence, Effective, and Efficient	17, 18	3,07	4	76,75
5	Good Time Management Competence	19, 20	3,22	4	80,50
Category Average					79,76 (Well)

4 Conclusion

When we use the PjBL model, this means that it requires proper planning and careful preparation, checking the appropriate of the material, and timing in class. Based on the results of the student response questionnaire, the study showed that the application of the Project Based Learning (PjBL) learning model in the introductory solid state physics course was in the good category of 3.19 with a percentage of 79.76%. In this case, the "Good" assessment of student responses to the implementation of PjBL provides a major role in the implementation of Solid Object Recognition Physics learning that can be done with an online learning system. This is in accordance with the results of interviews which show the Project Based Learning (PjBL) learning model can bring about changes in the way students learn, increase creativity and activeness in learning, and make learning more fun.

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