Project Based Learning (PjBL) Learning Model in Science Learning: Literature Review

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Abstract. The world of education today not only requires students to be experts in the cognitive realm, but is required to be able to achieve 21st century skills. Based on the analysis and synthesis of journals, the appropriate learning model to face the 21st century is the Project Based Learning (PjBL) learning model. The purpose of this article is to identify PjBL from the characteristics, effectiveness and implementation aspects of science learning. This structured review reviewed 20 articles on PjBL for science learning based on the available Scopus database reference from 2017 to 2021. The data obtained were analyzed using content analysis methods. The results showed that on average PjBL can be categorized as a learning model that can improve student learning outcomes in science learning and train students in problem-solving (critical thinking). The review reveals that PjBL has an influence on student learning, especially in science learning. From this article, it can be concluded and can be recommended three recommendations related to the essential success of PjBL in schools.

1. Introduction

Project-Based Learning (PjBL) is a form of learning that focuses on students. Students are actively involved in the learning process. Through this PjBL learning process, it will train students' thinking in dealing with problems. In PBL, students work collaboratively with others and reflect on what they have learned. In addition, students can become active in the search, and decision-making process by improving their practical thinking skills (Harris, 2002; McGrath, 2002; Solomon, 2003) [1][2][3]. In addition, PBL develops students' scientific process skills. Therefore, students who develop scientific process skills produce solutions to their scientific problems by asking questions, discussing ideas, making observations and predictions, conducting experiments, collecting and analyzing data (Westwood, 2006). PjBL aims to involve students in the learning process. So that with project-based learning students are more active and learning will be more effective and efficient.

Finally, PjBL contributes to students' academic achievement by creating a more equal learning environment (Solomon, 2003) [3]. PjBL Project work is assigned to individuals or groups of students. Then, the project work begins with the selection of a particular topic by the learners with the teacher's scaffolding. Topics are generally problems that students can solve by experiment or observation (Bell, 2010) [5]. Project work provides opportunities for students to promote their achievements. In addition, these works allow students to work together in a real-world environment by collaborating on an assignment (Baş, 2011) [6]. PjBL according to Baran et al (2018) [7] which shows a positive impact on student learning outcomes in physics lessons on Newton's law concepts by showing there is a significant increase in the average test
scores obtained by participants in the experimental group and the control group (p < 0.05). In this case, it can be said that the PjBL learning model has an influence on student learning. Moreover, education is currently being faced with 21st century skills, so this PjBL learning model is considered capable of being used to cultivate 21st century skills.

Project-based learning is learning that is more student-centered. Project-Based Learning (PjBL) is one of the teaching strategies in which students are guided to solve problems. In addition, PjBL develops students' scientific process skills. Therefore, students who develop scientific process skills produce solutions to their scientific problems by asking questions, discussing ideas, making observations and predictions, conducting experiments, collecting and analyzing data (Kizapan & Bektas, 2016) [8]. In fact, in PjBL, students collaborate with each other and take on their responsibilities as team members. In addition, students recognize the similarities between what they learn and what happens outside of school. In addition, PjBL improves students' metacognitive skills, thereby; they make successful plans, and evaluate their solutions (Blumenfeld et al., 1991)[9]. Finally, PBL contributes to student academic achievement by creating a more equal learning environment. In PjBL learning, students are given a project in groups by the teacher.

2. Method

This research is a research with content analysis method and collects data through literature study, which is searched by researchers through Google Cendikia and publish or perish with the keywords project based learning (PjBL). Then the results of the search on PjBL obtained several articles relevant to PjBL. Then the articles were analyzed and synthesized to determine the role of PjBL in learning. The problems studied in this study are about the characteristics of PjBL, the effectiveness of PjBL, and the implementation of PjBL in learning.

3. Results and Discussion

3.1 Identifying the Characteristics of Project-Based Learning (PjBL)

Project work begins with selecting a topic that will lead students to a problem. Which of these problems can be solved by experiment or observation. Each individual or group begins to investigate information about a particular topic (Kizapan & Bektas, 2016) [8]. Thus, students offer suggestions for solving problems; these suggestions are called “Project Plans” in schools. Then, each individual or group collects the information and documents needed to prove or support the topic. They conduct experiments, make observations, collect and interpret data and record the results. At the end of the session, each group made a report and presented the results of their study in class. The presented project is discussed and evaluated by all students and teachers (Frank & Barzilai, 2004; Herron, Magomo & Gossard, 2008) [10,11]. In essence, it can be concluded that Project-Based Learning is a learning model designed to develop desired student characteristics such as research skills, self-confidence, responsibility and cooperation, through activities where students work individually or in groups to design plans. And program within the specified time. The PjBL syntax is:

| No | Syntax       | Activities                                                                 |
|----|--------------|---------------------------------------------------------------------------|
| 1  | Reflection   | Students are led into the context of the material and relate what is known to what needs to be learned. Then students are given a problem around. |
| 2  | Research     | Students collect relevant sources of information to solve problems. Each group is directed to joint discussion |
| 3  | Discovery    | Each group designs an experiment                                             |
| 4  | Application  | Each group will test the results of the experiments that have been designed. |
| 5  | Communication| Each group reports the results of their research, and draws conclusions together |
In Table 1 it is explained that there are six learning syntaxes regarding PjBL. Based on this syntax, students can be trained to combine the concepts they have learned with the problems around them. In addition, students are also trained to collect information related to the material. Then students are trained to design experiments and work with their groups. In PjBL syntax, students are also trained to communicate the results of their work in front of the class. Based on the literature review regarding PjBL, there are several characteristics that can be stated, including those listed in table 2.

### Table 2 Characteristics of PjBL in Learning

| No | Researcher (Year) | Country     | Study                      | Key Findings                                                                 |
|----|-------------------|-------------|----------------------------|------------------------------------------------------------------------------|
| 1  | Pengyu Guo, Nadira Saab, Lysanne S. Post, Wilfried Admiraal (2020) | Netherlands | The PjBL - The Learning    | PjBL improves student learning outcomes in higher education                  |
| 2  | Mohd Ali Samsudin, Seyedh Mahboobeh Jamali, Ahmad Nurulazam Md Zain, Nader Ale Ebrahim (2020) | Turkey      | The PjBL - Self Efficacy Students | PjBL increases student's self-efficacy in solving physics problems             |
| 3  | I Wayan Santyasa, Ni Ketut Rapi, I Wayan Windu Sara. (2020) | Indonesia   | PjBL - Academic Value      | PjBL improves student's academic scores                                        |
| 4  | Muchsin and Mariati (2020) | Indonesia   | PjBL - Creative Thinking   | PjBL improves student's creative thinking                                      |
| 5  | Mohd Ali Samsudin, Ahmad Nurulazam Md Zain, Seyedh Mahboobeh Jamali, and Nader Ale Ebrahim. (2018) | Malaysia    | PjBL - Problem solving skills | The PjBL improve Enhancing the ability of solving the problem of students |

Based on the findings in Table 2, it can be seen that PjBL learning plays an important role in the student learning process at school. A review of the literature listed in Table 2, PjBL does not only affect student learning outcomes, as revealed by Pengyu Guo, Nadira Saab, Lysanne S. Post, Wilfried Admiraal (2020) [12]. Other studies listed in the table as research by Mohd Ali Samsudin, Seyedh Mahboobeh Jamali, Ahmad Nurulazam Med Zain, Nader Ale Ebrahim (2020) [13] stated that PjBL after being applied to students there was an increase in student self-efficacy, especially in problems in the field of physics. Whereas according to my Wayan Santyasa, Ni Ketut Rapi, I Wayan Windu Sara (2020) [14] stated that PjBL can increase students' academic scores. Muchsin and Mariati (2020) [15] stated that PjBL can improve students' creative thinking in applying learning materials. So it can be concluded that project-based learning can train students' ability to solve problems. Mohd Ali Samsudin, Ahmad Nurulazam Md Zain, Seyedh Mahboobeh Jamali, and Nader Ale Ebrahim. (2018) [16] PjBL improves students' problem solving abilities. In addition, project-based learning can improve students' creative thinking. So students are trained to be creative in working on projects and products. So that it can be concluded that PjBL learning greatly affects students' academics, through PjBL students can be trained to be independent in solving problems, and making projects according to the direction of the teacher.

### 3.2 Identifying Evidences of the Effectiveness of Project-Based Learning (PjBL)

Most of the literature reviews on Project-Based Learning (PjBL) involved students, both students in the control group using the conventional learning model and students in the experimental group using the PjBL model. It was found that PjBL had a positive influence on student learning. Good effectiveness of learning
outcomes, student motivation, students' creative level, and increasing scientific literacy. As for the literature review that discusses the evidence of the effectiveness of PjBL in learning, it can be seen in Table 3.

### Table 3 Effectiveness of Project-Based Learning in Learning

| No | Author (Year) | Study | Key Findings |
|----|---------------|-------|--------------|
| 1  | Ashley M. Craft, Robert M. Capraro (2017) | PjBL - Student academic engagement | Effective in increasing student academic engagement |
| 2  | Horse Admawati & Jumadi (2018) | PjBL - Rasa want to know the attitude of science, cooperation with others | Effective in improving the attitude of science students, develop a sense of wanting to know, and cooperation with an other |
| 3  | Fikriye Kirbağ Zengin, and Afak Yucasu (2017) | PjBL - Results Postes students | Effective in improving student posttest results |
| 4  | Derya Basera, c, M. Yasar Ozdenb and Hasan Karaarslan (2017) | PjBL - student advanced technology and collaboration | Effective and efficient in improving students' advanced technology and collaboration |
| 5  | Kristin Huysken, Harold Olivey, Kevin McElmurry, Ming Gao, and Peter Avis (2019) | PjBL- Student understanding | Effective in improving student's understanding |
| 6  | Medine Baran, Abdulkadir Maskan, and eyma Yaşar (2018) | The PjBL -The Learning | Effective in improving student physics learning outcomes |
| 7  | Muchsin and Mariati (2020) | PjBL-Thinking creatively | Effective in improving student's creative thinking |
| 8  | Adwan Mohammad Hasan Bani-Hamad, Abdul Hakim Abdullah (2019) | The PjBL-Skills Century 21 | Effective in improving skills of Century 21 |

Based on Table 3 it can be seen that the results of the study show that academic rigor and relevance provided through STEM PBL lessons increase students' academic engagement (Ashley et al., 2017) [17]. Then the results of the study also stated that STEM PjBL had a significant effect on students' scientific attitudes. This shows that PjBL STEM can develop students' curiosity, open-mindedness, and cooperation with others (Horse Admawati Jumadi, 2018) [18]. The results of the study revealed that project-based learning had a significant effect on improving student posttest outcomes (Fikriye Kirbağ Zengin and Afak Yucasu, 2017) [19]. Interdisciplinary, collaborative PjBL studies are efficient in improving students' advanced collaborative and technological skills (Derya Basera, c, M. Yasar Ozdenb and Hasan Karaarslan, 2017) [20]. Then the results of research from articles that have been explored show that PjBL improves student performance and student understanding of the subject matter (Kristin, 2019) [21]. The results show that PjBL has a positive impact on student learning outcomes in physics lessons on Newton's law concepts by showing a significant increase in the average test scores obtained by participants in the experimental group and the control group (p < 0.05) (Medine Baran, Abdulkadir Maskan, and email Yaşar, 2018) [7].
The results show that PjBL according to can improve students' creative thinking with an average n-gain acquisition in the experimental class I of 0.75 belonging to the high category and in the experimental class II of 0.77 and belonging to the high category, with an average acquisition the value of n-gain for both classes is 0.76 in the high category (Muchsin and Mariati, 2020) [16]. The results showed that there was a statistically significant difference in the level (α = 0.05) of students' 21st century skills test (4Cs) between the scores before and after the test, indicating better performance in the post-test. In other words, the project-based learning approach has a significant effect on improving 21st century skills (4C) (Adwan Mohammad Hasan Bani-Hamad, Abdul Hakim Abdullah, 2019) [22]. So it can be concluded that PjBL has a positive influence on learning. So the literature review can illustrate that students are more honed in their learning.

3.3 Implementation of Project-Based Learning (PjBL)
Implementation of the use of the project-based learning model (PjBL) will require quite a lot of implementation time. Careful preparation of subject teachers before implementing PjBL is an important step. To prepare for project-based learning, a teacher is not only required to prepare what projects are in accordance with the learning material. However, teachers are also required to be mature in preparing student worksheets (LKPD), tools and materials used during the project-based learning process.

The successful implementation of PjBL in the classroom lies in the ability of teachers to effectively assist student learning, motivate, and guide students during the learning process. In the PjBL process, collaboration between students and students, then students and teachers are very important. The project-based learning model is a learning model that provides opportunities for teachers to manage learning in the classroom by involving project work carried out by students both in groups (Nasir et al., 2019) [23]. In addition, project-based learning is an instructional approach that offers the potential to help students develop flexible understanding and lifelong learning skills (Hmelo-Silver, 2004) [24].

The use of project-based models has been suggested in the literature review as the first effective learning model in assisting students in developing the required knowledge and skills. To then design and manufacture products independently or in groups.

Recommendations in Learning Based on the literature review, there are recommendations that can make the implementation of the project-based learning model (PjBL) more effective in the school environment. Then also recommendations regarding the achievements that can be obtained by students using PjBL, especially the achievements of the 21st century.

1. Student support: Students need to be mentored and supported effectively while implementing PjBL. Make the best use of the time possible to work on projects that have been guided by the teacher. In addition, students must be taught to be able to work with groups. and directed

2. Teacher support: Support for peer teachers is essential for the successful implementation of project-based learning models. Exchanging experiences regarding the implementation of PjBL will make the implementation of the model more focused.

3. Application of PjBL to measure 21st century skills: Based on a review of the literature, it is still rare for research to measure the effect of PjBL on 21st century skills, particularly regarding critical thinking. Therefore, further research is expected to examine the effectiveness and influence of PjBL implementation on students' critical thinking skills.

4. Conclusion
Based on the literature review above, it can be concluded that PjBL learning has a positive influence on student learning in schools. And it is known that PjBL can improve students' thinking power in dealing with a problem, then improve learning outcomes as well. In addition, PjBL learning can make students more active when participating in classroom learning.

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