24 (3), 2023, 640-645

Jurnal Pendidikan MIPA

e-ISSN: 2685-5488 | p-ISSN: 1411-2531
http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Implementation of a Stem-Integrated PJBL Model to Improve Science Processes and Learning Outcomes

Haryanto & Minarni*
Program of Chemistry Education, Universitas Jambi. Jambi, Indonesia

Abstract: This project-based learning research aims to provide alternative problem-solving in the Biochemistry II course to improve students' scientific process abilities and learning outcomes in solving a problem. Quantitative data on student learning outcomes C4, C5, and C6 for protein synthesis material taught using the PjBL model. Quantitative data in the pretest and posttest found for the average, and then the increase from the pretest to the posttest is seen to conclude. Implementing the STEM-based Project Based Learning (PjBL) model can be carried out well at 74% in the implemented category. At the second meeting, the percentage was 85% in the implemented category. At the third meeting, the percentage was 93% in the immensely successful category. If averaged, the average percentage of implementation of the STEM-based learning project model is 84% in the implemented category. Implementing the STEM-based Project Based Learning (PjBL) model can improve students' learning outcomes and science process skills.

Keywords: stem integration pjbl model, proses sains, and learning outcomes.

Abstrak: *Penelitian pembelajaran berbasis proyek ini bertujuan untuk memberikan alternatif penyelesaian pemasalahan pada matakuliah Biokimia II untuk meningkatkan kemampuan proses sains dan hasil belajar mahasiswa dalam menyelesaikan suatu permasalahan.. Data kualitatif ini diambil dari video kegiatan mahasiswa dan waktu presentasi proyek. Data kuantitatif, yaitu data hasil belajar mahasiswa C4, C5 dan C6 untuk materi sintesis protein yang diajar dengan model PjBL.Data kuantitatif berupa pretest dan posttest dicari rata-ratanya kemudian dilihat peningkatannya dari pretest ke posttes untuk menarik kesimpulan. Pelaksanaan model Project Based Learning (PjBL) berbasis STEM dapat terlaksana dengan baik sebesar 74% dengan kategori terlaksana. Pada pertemuan ke dua jumlah persentasinya 85% dengan kategori terlaksana. Pada pertemuan ketiga jumlah persentasinya adalah 93% dengan kategori sangat terlaksana. Jika dirata-ratakan maka diperoleh rata-rata persentasi pelaksanaan model Projek besed learning berbasis STEM Sebebsar 84% dengan kategori terlaksana. Implementasi model Project Based Learning (PjBL) berbasis STEM dapat meningkatkan hasil belajar dan keterampilan proses sains mahasiswa.*

Kata kunci: *model pjbl terintegrasi stem, the science process, dan hasil belajar.*

▪ INTRODUCTION

This project-based learning research aims to provide alternative problem-solving in the Biochemistry II course to improve students' scientific process abilities and learning outcomes in solving problems. In learning, students are guided to carry out a discovery process that can stimulate them to be actively involved (Kelana & Wardani, 2021). Using local materials in the environment around students will likely develop student KPS. Several courses in university study programs have different characteristics from each other (Kisworo et al., 2021). Implementing it requires different methods, approaches, or learning models (Hakim et al., 2020; Karimah et al., 2020; Wijayati, 2017). For example, the Biochemistry II course, which consists of teaching materials of different natures,

Haryanto & Minarni
*Email: minarni@unja.ac.id

DOI: http://dx.doi.org/10.23960/jpmipa/v24i3.pp640-645
Received: 17 October 2023
Accepted: 17 November 2023
Published: 30 November 2023

requires a suitable method to achieve learning objectives. One is implementing the STEAM (Science, Technology, Engineering, Art, and Mathematics) integrated PjBL learning model. This model is a lecture activity involving students producing a STEAM-integrated project. According to Wijayati (2017); Sholahuddin et al., (2021); Karimah et al., (2020); states that the PjBL model is a learning model that focuses on project-based learning, namely that students are given projects/tasks that can increase the creativity of each individual. In its implementation, the STEAM-integrated PjBL model has also never been applied in Biochemistry II lectures, even though this model can provide high opportunities for students to gain empirical experience in conducting tests on protein in the urine (Heller test).

Applying the KPS approach can develop students' scientific attitudes, such as discovering facts, concepts, and principles of science (Septantiningtyas et al., 2020). Basic skills used in the science process include observing, grouping and comparing, measuring, communicating, conducting experiments, connecting, concluding, and applying (Yafie & Sutama, 2019). Students can carry out KPS activities provided they involve their intellectual thinking. Kusumastuti (2020) said that students' psychomotor abilities are relatively low. Low student learning achievement can be caused by several factors, such as monotonous learning methods, lack of learning experience, learning resources only using student books, and only discussing theory without practice.

Learning outcomes are the result of the learning process. According to Sudjana (2009), learning outcomes are essentially changes in behavior resulting from learning in a broader sense, including the cognitive, affective, and psychomotor domains. Dimyati and Mudjiono (2009) also stated that learning outcomes result from an interaction between learning and teaching actions. From the teacher's side, the act of teaching ends with a process of evaluating learning outcomes. From the student's perspective, learning outcomes are the end of teaching from the peak of the learning process. According to Anderson (2012), the cognitive domain (C) is remembering (C1), understanding (C2), applying (C3), analyzing (C4), assessing (C5), and creating (C6). From data from the lecturer who taught the Biochemistry II course for the last three years, student scores on the protein synthesis material were relatively low, with an average of 62.5. Students have difficulty answering analysis questions (C4) and assessing (C5).

▪ METHOD

This research produces qualitative data, namely data on the implementation of learning using the PjBL model on protein synthesis material and student KPS data on learning using the PjBL model on protein synthesis material. Qualitative data was presented as descriptive text, narrated, leading to conclusions. This qualitative data was taken from videos of student activities and project presentation times. The Quantitative data on student learning outcomes C4, C5, and C6 for protein synthesis material taught using the PjBL model. Quantitative data in the pretest and posttest are found for the average, and then the increase from the pretest to the posttest is seen to conclude. The subjects of this research consisted of 30 students who were taking biochemistry courses at chemistry education, teaching and educational sciences faculty, Jambi University.

Observation sheets to observe the implementation of PjBL learning and observation sheets are prepared based on the stages of implementing the integrated PjBL learning model for students with STEAM and KPS. The essay test to measure student learning outcomes in the form of an essay test is prepared based on protein synthesis material for components C4-C6 of Anderson's taxonomy. The essay question items were validated (content) by asking for comments from 2 chemistry education lecturers considered to have more abilities.

The indicator of success in this research is the increase in Science Process Skills (KPS) including observing, classifying, interpreting, predicting, communicating, asking questions, hypothesizing, planning experiments, using tools/materials and applying concepts (Rustaman, 2003) and student learning outcomes in the Biochemistry II course in the chemistry education study program using the project-based PjBL model.

▪ RESULT AND DISSCUSSION

Data on implementing the STEM-based Project Based Learning model can be seen by observing teacher activities as qualitative data and student activities as quantitative data. Through the results of observing student activities, a recapitulation of scores for observed student activities is obtained based on the model syntax, the scores, and the criteria for implementing the STEM-based Project Based Learning model in the classroom at each meeting. At the same time, teacher activities can be obtained from a summary of observer comments. The implementation of the STEM-based Project Based Learning model by educators in the learning process was carried out over three meetings and observed by an observer. The observation sheet for implementing the STEM-based Project Based Learning model by Educators consists of 16 statements, which are explained based on the syntax of the Project Based Learning model.

At the first meeting, the percentage of implementation of all-based learning project model syntax was 74% in the implemented category. At the second meeting, the percentage was 85% in the implemented category. At the third meeting, the percentage was 93% in the immensely successful category. If averaged, the average percentage of implementation of the STEM-based learning project model is 84% in the implemented category. Furthermore, the data from the table above can be implemented into a percentage diagram of the implementation of the STEM-based learning project model above. There has been an increase in the implementation of the STEM-based learning project model from the average presentation obtained at 84%. The implementation of the STEM-based learning project model is 84%. This STEM was included in the highly implemented category. This observation sheet contains 16 questions based on indicators of science process skills, including observation, classifying, interpreting, predicting, communicating, asking questions, hypothesizing, planning experiments, using tools/materials, and applying concepts. The scores were filled in with the lowest value being one and the highest being five so that the minimum score is 16 and the maximum score is 80.

The percentage of students' science process abilities at the first meeting was 79% in the excellent category. The second meeting was 83% in the excellent category, and the third meeting was 88% in the excellent category. The average percentage of students' science process skills assessment results is 84% in the excellent category. Learning outcomes are carried out by providing questions before implementing the learning and after the learning process. This test was given to students using essay questions consisting of 10 essay questions. As for student scores, the pretest and posttest results at the first pretest meeting were obtained on average 72, and the posttest obtained 83.6. At the second meeting, the average of the posttest and pretest was 72.4, and the posttest was 85. At the third meeting, the pretest average was 72.6, and the posttest was 84. The average result of the pretest was 72.3, and the posttest was 84. From the results of the posttest and the pretest, it can be concluded that student learning outcomes increase using the STEM-based project-based learning model.

According to Wijayanto et al. (2020), the project-based learning model is a practical educational approach focusing on creative thinking, problem-solving, and interaction between students and their peers to create and use new knowledge. This project-based learning model includes problem-solving activities, decision-making, investigation skills, and work creation skills. Students should focus on solving problems or questions that guide them to understand the concepts and principles related to the project. Project-based learning integrates STEAM (Science, Technology, Engineering, Art, and Mathematics). Namely a lecture method by producing a form of the project as part of the lecture process to obtain and achieve attitudinal, cognitive, and skill competencies by implicating STEAM indicators.

The STEAM integrated project-based lecture process is a form of lecture activity that is process-oriented, relatively timed, and problem-focused, with a meaningful lecture unit that combines concepts originating from STEAM components to adapt to the era of the Industrial Revolution 4.0. In this model, learning activities are carried out through collaboration in heterogeneous groups, which can strengthen teamwork as a whole. This model also uses situation analysis and description as the first step in collecting and integrating new knowledge based on existing experience when carrying out factual activities that are conceptualized for use in situations that have high complexity and need to be investigated and understood in more depth.

According to Suryaningsih & Muliharto, (2021), ethno-STEM project-based learning significantly improves students' critical and creative thinking skills. This is supported by the opinion of Bahriah & Irwandi, (2020), who state that the PjBL-STEM model can improve science process skills and student learning outcomes. Apart from implementing learning models, using STEM-PjBL-based learning tools is also effective in learning. Using the STEM-based PJBL learning model is more effective in improving the critical thinking skills of class IV students with science learning content. In line with research (Juwita, 2022), the chemistry learning process using the project-based learning model is a best practice because it can build students' abilities in science process skills. The chemistry learning process using the project-based learning model can be integrated with the Science, Technology, Engineering, Art, Mathematics (STEAM) approach to build students' science process skills. Students' science process skills can be measured by direct and indirect observation (through the media). The media for collecting practicum report assignments resulting from PjBL can use an e-book creator through features that enable collaboration between students and teachers in the project completion process.

In this best practice, there are ten aspects of skills that are observed. The observed aspects of students' science process skills are planning experiments, using tools/materials, observing, communicating, classifying, applying concepts, interpreting, asking questions, hypothesizing, and predicting. Observations are made based on PjBL steps/syntax. These steps are grouped based on the planning, implementation, monitoring, and conclusion stages. In the project planning stage, the activities are forming groups, designing projects, dividing tasks within groups, collecting learning resources, and determining strategies for groups. At this stage, the science process skills involved are hypothesis, prediction, and interpretation.

In hypothesis skills it is interpreted as the student's ability to look for other possibilities regarding the results of observations so that students give reasons by guessing the causal factors that could occur. This indicator of knowing that there is more than one possible explanation for one incident involves the logical thinking of each student (Andayani et al., 2019). This means that students conduct experiments using logic to find reasons that can be used as a hypothesis for a problem. In this process, students' insight into concepts plays a vital role in formulating hypotheses (Farida, 2020). This skill can be observed in problem formulation, experimental objectives, conclusions, and discussion of results. Project implementation stage: At this stage, the science process skills involved are asking questions, planning experiments, and using tools and materials. Monitoring and product manufacturing stage. At this stage, the scientific process skills involved are observation and classification.

Students' ability to prepare practical reports correctly and systematically will make it easier to interpret the overall data. Implementing this practicum is an effort to provide direct and actual experience in proving the theory, concept, or knowledge students learn from the acid-base material. This means that this indicator has automatically been met for every student. This indicator is the practitioner's ability to build knowledge based on concepts from phenomena in the practicum (So'imah, 2020).

▪ CONCLUSION

Implementing the STEM-based Project Based Learning (PjBL) model can be carried out well at 74% in the implemented category. At the second meeting, the percentage was 85% in the implemented category. At the third meeting, the percentage was 93% in the immensely successful category. If averaged, the average percentage of implementation of the STEM-based learning project model is 84% in the implemented category. Implementing the STEM-based Project Based Learning (PjBL) model can improve students' learning outcomes and science process skills. Teachers must be able to manage their time well in order to complete all the steps of the Project Based Learning (PjBL) model during the learning process.

▪ REFERENCES

Abidin, Y. 2014. *Desain sistem pembelajaran dalam konteks kurikulum 2013*. Refika Aditama: Bandung.

Abidin, E. N., & Hariyono, E. 2020. Ecopreneurship-oriented project-based learning (pbl): an approach to enhance students' problem-solving skill. *Journal of Physics: Conference Series*, *1491*(1). https://doi.org/10.1088/1742- 6596/1491/1/012025

Al-Tabany, T. I. B. 2017. *Mendesain model pembelajaran inovatif, progresif, dan konteksual*. Prenada Media.

Dimyati & Mudjiono. 2009. *Belajar dan pembalajaran*, Rineka Cipta: Jakarta educational technology division ministry of education, malaysia. Project-Based Learning Handbook, "Educating the Millennial Learner". http://fliphtml5.com/ygry/apzb/basic, diakses 17 Juni 2021.

Fathurrohman, M. 2016. *Model pembelajaran inovatif: alternatif desain pembelajaran yang menyenangkan.* Yogyakarta: Ar-Ruzz Media Group.

Hakim, A. R., Wadu, L. B., & Hasanah. L. 2020. *Pengaruh model pembelajaran learning cycle 5e terhadap self efficacy siswa pada pembelajaran tematik kelas iv sdn tanjungrejo* 5 Kota Malang. Seminar Nasional PGSD UNIKAMA 4: 1–7

Hamalik, O. 2007. *Proses belajar mengajar*. Bumi Aksara: Jakarta.

Jauhariyyah, F. R., Suwono, H., & Ibrohim. 2017. Science, technology, engineering and mathematics project based learning (stem-pjbl) pada pembelajaran sains. In *Prosiding Seminar Pendidikan IPA Pascasarjana UM.* 2, pp. 432– 436). http://pasca.um.ac.id/conferences/index.php/ipa2017/article/view/1099/767.

Karimah, M., Dafik, Tirta, I. M., Wangguway, Y., & Jabbar, Z. L. A. 2020. The analysis of the implementation of project based learning and its influence to the student deductive reasoning based on cognitive style on solving super edge local antimagic total labelling. *Journal of Physics: Conference Series*, *1538*(1). https://doi.org/10.1088/1742-6596/1538/1/012095.

Kelana, J. B., & Wardani, D. S. 2021. *Model pembelajaran ipa SD*. Cirebon: Edutrimedia Indonesia.

Kisworo, K., Ngabekti, S., & Indriyanti, D. 2021. *Faktor determinan dari guru dalam implementasi pembelajaran ipa terpadu tingkat smp di wonosobo. Journal of Innovative Science Education*. 6(2): 179-185. https://doi.org/10.15294/jise.v6i2.197.

Mulyatiningsih, E. 2013. *Metode penelitian terapan bidang pendidikan*. Bandung: Alfabeta.

Purwanto, N. 2010. *Evaluasi hasil belajar.* Pustaka Belajar: Yogyakarta.

Ravitz, J. 2008. Project based learning as a catalyst in reforming high schools. *American Educational Research Association*, 1–14.

Rustaman, N. 2003. *Strategi belajar mengajar biologi, Universitas Negeri Malang*.

Semiawan. C. 1992. *Pendekatan keterampilan proses.* Gramedia : Jakarta

Sani, R. A. 2013. *Inovasi pembelajaran.* Jakarta: PT Bumi aksara

Sholahuddin, A., Hayati, N., Iriani, R., Saadi, P., & Susilowati, E. 2021. Project- based learning on ethnoscience setting to improve students' scientific literacy. *AIP Conference Proceedings*, *2330*(March). https://doi.org/10.1063/5.0043571

Sudjana, N. 2010. *Dasar-dasar proses belajar mengajar.* Bandung: Sinar Baru Algensindo.

Trianto. 2014. *Mendesain model pembelajaran inovatif, progresif dan kontekstual.* Jakarta: Pramedia Group.

Wijayati, N. 2017. Application of project based learning (pbl) model for materials of salt hydrolysis to encourage students' entrepreneurship behaviour. *International Journal of Active Learning*, *2*(1), 50–58. https://doi.org/10.15294/ijal.v2i1.10603

Zeidan, A. H., & Jayosi, M. R. 2015. Science process skills and attitudes toward science among palestinian secondary school students. *World Journal of Education*, *5*(1), 13—24. DOI: https://doi.org/10.5430/wje.v5n1p13.