RESEARCH ARTICLE

European Journal of Education and Pedagogy
www.ej-edu.org

Project-Based Learning (PjBL) Model in Chemistry Learning: Students' Perceptions

Faizal A. A. Masbukhin, Sandra S. Adji, and Ayu F. D. Wathi

ABSTRACT

Project Based Learning is one of the learning models that can be chosen by teachers in learning activities. This study aims to determine student perceptions as well as chemistry teachers on the Project Based Learning model in chemistry subjects. Data collection was carried out using a questionnaire that had been tested for validity and reliability. The research population is the chemistry education students of Universitas Terbuka. The results of the questionnaire dimension of teachers showed a score of 67.28, meaning that they agreed about teachers' creativity. On the dimensions of infrastructure, the score shows 72.26, which means that respondents agree about the need for learning resources. The curriculum dimension shows a score of 82.91, which means that they strongly agree with problem-solving in daily life. The dimensions of the students showed a score of 72.97, meaning that the respondents agreed with the support for 21st-century skills. Overall, this study illustrates the positive perception of chemistry education students at the Universitas Terbuka about the Project Based Learning model, thus providing an overview for educational institutions to equip prospective teachers with the learning models. The results of the study also provide knowledge to chemistry teachers about the Project Based Learning model.

Keywords: chemistry, perception, project-based learning.

Published Online: February 8, 2023

ISSN: 2736-4534

DOI: 10.24018/ejedu.2023.4.1.567

F. A. A. Masbukhin*
Department of Mathematics and Natural Sciences Education, Faculty of Education and Teacher Training, Universitas Terbuka, Indonesia
(e-mail: faizal.masbukhin@ecampus.ut.ac.id)
S. S. Adji
Department of Mathematics and Natural Sciences Education, Faculty of Education and Teacher Training, Universitas Terbuka, Indonesia
(e-mail: sandra@ecampus.ut.ac.id)
A. F. D. Wathi
Department of Mathematics and Natural Sciences Education, Faculty of Education and Teacher Training, Universitas Terbuka, Indonesia
(e-mail: ayu.wathi@ecampus.ut.ac.id)

****Corresponding Author***

I. Introduction

Education plays an important role in improving the quality of a nation. Education is a bridge to the progress of a country. Indonesia is one of the countries with the quality education that continues to spur development and improvement in all aspects. The professionalism of teachers, facilities and infrastructure, curriculum, as well as various policies from the Central Government to the Regions are aspects that support the progress of education in Indonesia.

Conditions that occur in the world of education in Indonesia, as revealed by Kurniawati (2022) stated that Indonesia was in 74th position out of 79 countries that took part in a survey on the secondary education system in 2018 using the PISA (Programme for International Student Assessment), an international assessment method. The data put Indonesia in the 6th lowest position when compared to other countries that routinely measure the quality of their education. Therefore, improvements in the education sector in Indonesia must be carried out continuously to improve quality.

Improving the quality of education in Indonesia is very dependent on the quality of teachers as a part of the educational process and is the spearhead of education in Indonesia. Qualified teachers will be able to develop learning resources around them by the learning objectives to be achieved. In addition, the quality of teachers can also be seen from the ability to develop learning models to improve student's learning experiences.

Teachers must always be in top condition to carry out their duties professionally. Based on Ma'ruf and Syaifin (2021), teacher professionalism can be seen from the ability to carry out tasks by always adhering to work ethics, being effective and efficient, productive, and innovative, free from external pressure, and based on the principles of excellent service. In addition, professional teachers must master their scientific fields and get positive recognition from the community.

The era of the 21st century provides challenges for teachers. The era known as the Industrial Revolution 4.0 requires teachers to improve students' mastery in terms of skills, knowledge, and digital literacy. 21st-century skills absolutely must be mastered by a teacher. Today, students have easy and fast access to authentic resources in the digital world. According to Arifin and Setiawan (2020), learning facilitated by teachers must be improved in terms of using technology to develop students' abilities. Teachers need to master the latest learning strategies and models such as Collaborative Learning, Blended Learning, and Project Based Learning.

Competency improvement is not only intended for teachers who have been teaching in schools for a long time but also

prospective teachers or students of education study programs at the Faculty of Teacher Training and Education (FKIP). Prospective teachers need to be equipped with various kinds of learning strategies properly so that they can convey messages or transfer knowledge when they will enter the world of education on time. Prospective teachers as facilitators of the learning process must also explore various learning models so that the learning process can run as expected.

As teachers and prospective teachers, students of the Chemistry Education Program, FKIP at the Universitas Terbuka (UT) need to constantly develop themselves to be more professional. Students are expected to be able to manage chemistry learning in an interesting and challenging manner which makes students learn independently and actively learn. One of the ways to manage learning in the classroom is to apply the PjBL model.

According to Rati *et al*. (2017), the PjBL model is a problem-centered learning model along with problem-solving, and decision-making by working collaboratively and presenting real products. PjBL makes it possible to provide facilities for students to investigate a problem. PjBL is very suitable to be used for student-centered learning by giving meaningful assignments.

Chemistry subjects as one of the natural education sciences clump that study changes in matter and the energy that accompanies it are considered appropriate to be implemented using the PjBL learning model. In this study, the researcher intends to study the perceptions of the Chemistry Education students at UT about the PjBL model in chemistry learning. The respondents in this study were students of Chemistry Education at UT who also worked as teachers. This study aims to determine the perception of chemistry education students at UT on the PjBL learning model in terms of the dimensions of teachers, infrastructure, curriculum, and students.

II. Research Method

This research is a descriptive type in the form of a survey with a quantitative approach, which describes the perceptions of chemistry education students at UT who are chemistry teachers, on the Project Based Learning (PjBL) model in chemistry subjects. The research was conducted at UT with a population of 112 undergraduate Chemistry Education students and a sample of 63 students. The sampling was carried out using a convenience sampling technique, i.e., anyone who was willing to fill out a questionnaire with predetermined sampling criteria. Data collection includes questionnaires, interviews, and a literature review.

The questionnaire instrument consisted of an open and closed questionnaire using a Likert scale for the respondents. An open questionnaire was used to collect respondents' demographic data and descriptive data on the perception of the PjBL model. Closed questionnaires were used to collect data on perceptions of PjBL. The open and closed questionnaires have been tested for content validity and construct validity. The content validity test was conducted on two experts in the field of chemistry education and chemistry. The construct validity test was conducted through the validity and reliability test of 33 respondents and data processing using the SPSS program. The item validity test determines the level of correlation (minimum r value) between the total score and the score of each item. The minimum r value for the relationship between each item score is 0.30 (Budiastuti & Bandur, 2018). The reliability test uses the alpha coefficient or better known as Alpha's Cronbach formula with coefficient values between 0–1 (without reliability to perfect reliability).

We also used data collection techniques in the form of direct interviews with Chemistry Education students at the Unit Program Belajar Jarak Jauh (UPBJJ) UT with the largest number of Chemistry Education students at UPBJJ UT Semarang. Literature studies through studies from various journals, reference books, and other sources are also carried out as one of the data collection techniques in this study to obtain information as supporting facts. This study is expected to produce findings on the perceptions of students of Chemistry Education at UT, who are chemistry teachers, on the PjBL model in chemistry learning.

III. Results and Discussions

A. *Respondent Demographics*

Demographics is information about a group of people based on certain criteria. This study grouped respondents based on gender, age, and length of teaching. The data was obtained through an open questionnaire and concluded as follows shown in Table I.

The data obtained shows that most of the respondents are Chemistry Education students at UT who are chemistry teachers, consisting of 71% women. The age of majority of respondents is still relatively young with the largest percentage of 60.3% aged 19–30 years. The largest percentage of the length of teaching, namely 71.4% of respondents have taught for 0-5 years. Such demographics indicate that respondents should be easy to learn and practice PjBL at a productive age and more creative to develop Project Based Learning. This is in line with Qomario *et al*. (2018) who state that there is a significant relationship although the relationship is low between teacher competency test scores and teacher age.

TABLE I: Respondent Demographics

Respondent Demographics	∑ of people	Percentage (%)
Gender		
Male	18	29
Female	45	71
Age (years)		
19–30	38	60.30
31–40	18	28,60
>40	7	11.10
Length of teaching (years)		
0–5	45	71.40
6–10	7	11.10
11–15	7	11.10
>15	4	6.30

B. *Teacher Dimension*

Teachers are an important factor in successful learning, so this study identifies aspects of the experience of Chemistry Education students at UT who are chemistry teachers and

explores their perceptions as teachers about Project Based Learning (PjBL). Data were obtained through closed, open, and interview questionnaires. The results of the data analysis are shown in Table II.

TABLE II: DIMENSIONS OF TEACHER

Closed Questionnaire Data		
Aspect	Score (%)	Interpretation
Collaboration between teachers	71.11	Agree
Teacher's knowledge and creativity	85.66	Strongly agree
Average	78.39	Agree
Open Questionnaire Data		
Aspect	Already	Not yet
Get to know the term PjBL		
∑ respondents	55	8
Percentage (%)	87.30	12.70
Studying PjBL		
∑ respondents	45	18
Percentage (%)	71.43	28.57
Knowing PjBL		
∑ respondents	55	8
Percentage (%)	87.30	12.70
Implementing PjBL		
∑ respondents	38	25
Percentage (%)	60.32	39.68

Table II shows that 71.11% of respondents agree that collaboration between teachers is needed in the implementation of the PjBL model. A total of 85.66% of respondents also agree that the PjBL model requires the knowledge and creativity of teachers. This is by the researcher's expectation that the respondent's perception of the teacher dimension is agreeable in this aspect. Usman and Ratnasari (2019) asserts that teachers who are creative when teaching can develop the potential and interest of students learning.

Based on the background of the respondents obtained through an open questionnaire and interviews, it is known that 87.30% of respondents are familiar with the PjBL model, 71.43% of respondents have studied the PjBL model, and 87.30 % of respondents only know PjBL. Sari *et al*. (2021) said that teachers in SMK (vocational school) have a good perception of the PjBL model and need to be implemented in the learning process in the classroom because it focuses on students.

Only 60.32% of respondents have ever implemented the PjBL model from the data above. In the teacher dimension, the reason respondents have not implemented the PjBL model is that they are constrained by the knowledge and readiness of teachers to design learning. Yusriani *et al*. (2020) reinforce that teachers are still not familiar with PjBL syntax and have difficulty in determining projects that are following the subject matter. Teachers' understanding of the PjBL model according to Baidowi *et al*. (2021) can be improved through the following activities, including seminars and dissemination of PjBL implementation in schools, workshops on the design, implementation, and evaluation of PjBL, as well as focus group discussions on the results of PjBL implementation in various schools.

C. Dimensions of Infrastructure

The learning process will take place better if it is supported by adequate facilities and infrastructure. However, not all educational institutions have ideal conditions. The Project Based Learning (PjBL) learning model is one solution for implementing learning by existing conditions, not depending on the completeness of facilities and infrastructure. The results of collecting data on respondents' perceptions of the dimensions of infrastructure are shown in Table III.

TABLE III: DATA DIMENSIONS OF INFRASTRUCTURE

Aspect	Score	Interpretation
Online and offline learning resources	59.42	Neutral
Electronic and non-electronic learning tools	69.21	Agree
A lot of implementation costs	44.13	Neutral
Scientific environment	40.63	Neutral
Average	53.35	Neutral

Table III shows a score of 59.42% with a neutral perception interpretation regarding aspects of online and offline learning resources. This means that some respondents have the perception that they agree with the needs of these two learning sources, and some have the perception that they do not have to depend on the two learning sources (can only be one). Putri *et al*. (2021) state that if the PjBL model is implemented to solve student learning barriers according to the characteristics, concepts, and syntax, learning can be carried out well even though it has come from online and offline resources.

In the aspect of electronic and non-electronic learning devices, it shows a score of 69.21% with the interpretation of perceptions agreeing on the need for these learning tools in the application of the Project Based Learning (PjBL) model. Hasbullah *et al*. (2020) provides the experience of research results that in the implementation of PjBL, students can complete projects using existing scientific equipment in the laboratory and technical equipment in their respective homes. In the aspect of the PjBL model that requires a lot of implementation costs, a perception score of 44.13% is obtained with a neutral interpretation. Fatma (2021) reinforces that PjBL has two weaknesses, namely, it takes a lot of time and requires a lot of money. However, this can be minimized by implementing PjBL cooperatively so that it can save time and costs.

The interpretation in the form of a neutral perception is also found in aspects of the scientific environment in the Project Based Learning (PjBL) model with a score of 40.63. Utomo *et al*. (2020) revealed that one of the student-centered learning is the PjBL model which is proven to be able to improve students' scientific attitude and responsibility. Based on the data of the aspects studied, the average perception score of the dimensions of infrastructure is 53.35 with a neutral interpretation. This shows that some respondents agree that the PjBL model does not depend on ideal infrastructure, while some other respondents perceive that the PjBL model requires ideal infrastructure conditions. On the other hand, Rahayu *et al*. (2019) said that if the facilities in schools can be used optimally, it will have a positive impact on student learning achievement.

In the open questionnaire and interviews, it is known that the infrastructure according to the respondent is needed such

as laboratory equipment and chemicals, the availability of a presentation room and equipment, internet network and computer equipment, and also sufficient costs. Kusworowati (2016) revealed that the limitations of facilities and infrastructure in the implementation of learning can be circumvented by the creative attitude of subject teachers so that the learning process can take place well. Creative teachers have the characteristics of being able to see problems, be able to create ideas and be open to something new.

D. Dimensions of Curriculum

A curriculum is briefly defined as a learning plan that involves many parties and is interrelated. Currently, Indonesian education runs a Kurikulum Merdeka, namely a curriculum with diverse intracurricular learning where the content will be more optimal, and students have enough time to explore concepts and strengthen competencies. Several advantages of an independent curriculum according to Kurniati *et al*. (2022) which is centered on fundamental material, is more flexible in the learning process, as well as relevant and interactive according to actual issues. Based on this explanation, the aspects described in collecting data on perceptions of the Project Based Learning (PjBL) learning model on the dimensions of the curriculum are shown in Table IV along with the respondents' perception scores obtained.

Table IV shows the average score of respondents is 82.91 with a strongly agree interpretation. This means that respondents have the perception that they strongly agree with the aspect of the PjBL model that is easy to implement, can be applied to solve daily problems, and can stimulate student activity. Fatma (2021) asserts that the STEAM-based PjBL model is easy to implement, but it takes a long time. Therefore, teachers who will apply the STEAM-based PjBL model are expected to make the best use of time, so that the planned learning runs as expected. Based on open questionnaires and interviews, most respondents have the perception that the subject matter of chemistry can be learned by applying the PjBL model. A total of 47.62% (30 people) of respondents gave the perception that the number of face-to-face hours for chemistry subjects was considered insufficient for the implementation of PjBL.

Most respondents have the perception that the PjBL model can develop through curriculum changes, although it requires extensive teacher knowledge, preparation, and infrastructure needs. Wahyu (2016) said that the 2013 curriculum is supported by various innovative learning models and supports scientific processes such as Project Based Learning, Problem Based Learning, Problem Solving, Inquiry, and Discovery Learning. On the other hand, Trinaldi *et al*. (2022) revealed that in the prototype curriculum, teachers can carry out a learning process that is by the characteristics of the curriculum, namely the PjBL model.

In the school curriculum, the number of hours of lessons for each subject has been determined, so it is considered to make learning exploration time limited. This can be overcome by combining several subjects in the implementation of Project Based Learning (PjBL) so that the learning objectives of several subjects are achieved. Collaboration between teachers is certainly needed to prepare for this learning. Tyagita (2018) explains that optimal collaboration between teachers can improve the pedagogic competence of teachers so that the quality of schools is also getting better. Collaboration between teachers can be done by sharing knowledge about learning models, class conditions and student conditions, team teaching, and lesson study.

TABLE IV: CURRICULUM DIMENSION DATA

Aspect	Score	Interpretation
Easy to implement	77.46	Agree
Solve daily problems	85.71	Strongly agree
Student participation	85.56	Strongly agree
Average	82.91	Strongly agree

E. Student Dimensions

Students are the subject of the implementation of learning, meaning that students must be active in learning so that they have a meaningful learning experience. In the end, it will improve the ability and learning achievement of students. Respondents' perceptions of the Project Based Learning (PjBL) model on the dimensions of students are shown in Table V.

Table V shows the average score of respondents' perceptions is 72.97 with the interpretation agreeing. This means that most respondents agree that the PjBL model supports active, critical thinking, communicative, and collaborative abilities for students. Respondents also agree that the learning model is easy, fun, and supports learning achievement for students. Simanjuntak *et al*. (2019) believe that PjBL is very suitable to be used to improve the quality of human resources in preparation for the demands of the globalization era. The 21st century requires improving the quality of education as a formal forum to form critical, creative, and innovative human resources who can solve problems in life so that they can compete in today's world.

Based on open questionnaires and interviews, it is known that respondents think that students need to prepare learning resources, knowledge, discipline, cost, and learning motivation to participate in the PjBL model. A lot of preparation makes 20.63% (13 people) of respondents perceive that the learning model is difficult to apply to students with varying levels of learning achievement. Winarsih, (2020) revealed that mathematics learning through PjBL can improve student learning outcomes and the quality of learning. 39.68% (25 people) of respondents perceive that the application of the PjBL model will be troublesome for students, although it will enrich the learning experience gained. This is by Nahdliyati *et al*. (2016) who explain that project assignments are rarely carried out at the end of the semester/study year because they are inconvenient for students and take up a lot of time.

The PjBL model has the stages of determining basic questions, making project designs, arranging schedules, monitoring project progress, evaluating results, and evaluating experiences.

TABLE V: STUDENT DIMENSION DATA

Aspect	Score	Interpretation
Support active, critical thinking, communicative, and collaborative skills	76.08	Agree
Easy and fun	71.07	Agree
Support learning achievement	71.75	Agree
Average	72.97	Agree

Based on Maudi (2016), in more detail the PjBL model has six syntaxes, namely: the teacher asks essential questions, the teacher facilitates students/groups of students to design project plans, the students develop a project implementation schedule, the students' complete projects with teacher supervision, the student's present project results, also the students and the teachers jointly evaluate the learning experience of the project. These stages take place under the supervision of teachers so that if there are students who have difficulties, teachers can help. In theory, a meaningful learning experience will improve students' understanding and learning achievement. Respondents also perceive that learning becomes interesting for students.

IV. CONCLUSION

Based on the discussion that has been described, it can be concluded that Chemistry Education students at the Universitas Terbuka (UT) have a perception of agreeing with the dimensions of teachers in the Project Based Learning (PjBL) model which requires collaboration between teachers, requires teachers' knowledge and creativity. Chemical education students at UT have a neutral perception of the dimensions of infrastructure in the PjBL model covering aspects of the need for online and offline learning resources, electronic and non-electronic learning tools, large implementation costs, and the scientific environment.

Chemistry education students at UT have a very agreeable perception of the dimensions of the curriculum in the PjBL model including aspects of ease of implementation, being able to solve daily problems and student participation. Chemistry education students at UT have a perception that agrees with the dimensions of students in the PjBL model which includes aspects of supporting active abilities, critical thinking, communication, collaboration, ease, and fun, as well as supporting student learning achievements.

FUNDING

The authors would like to thank the Lembaga Penelitian dan Pengabdian Kepada Masyarakat (LPPM) Universitas Terbuka which has fully funded this research.

REFERENCES

Arifin, M. Z., & Setiawan, A. (2020). Strategi belajar dan mengajar guru pada abad 21 [Teacher learning and teaching strategies in the 21st century]. *Indonesian Journal of Instructional Technology*, 1(2), Article 2. https://journal.kurasinstitute.com/index.php/ijit/article/view/45.

Baidowi, B., Novitasari, D., Subarinah, S., Apsari, R. A., & Kertiyani, N. M. I. (2021). Pendampingan perencanaan, pengelolaan dan evaluasi pembelajaran berbasis proyek bagi guru matematika smk kota mataram [Assistance in planning, managing and evaluating project-based learning for mathematics teachers in Mataram city high schools]. *Rengganis Jurnal Pengabdian Masyarakat*, 1(2), Article 2. https://doi.org/10.29303/rengganis.v1i2.96.

Budiastuti, D. D., & Bandur, A. (2018). *Validitas dan reliabilitas penelitian* [Research validity and reliability]. Jakarta: Mitra Wacana Media. p. 233.

Fatma, H. (2021). Kreativitas peserta didik dalam pembelajaran bioteknologi dengan pjbl berbasis STEAM [Student creativity in learning biotechnology with STEAM-based pjbl]. *Pedagonal: Jurnal Ilmiah Pendidikan*, 5(1), Article 1. https://doi.org/10.55215/pedagonal.v5i1.2574.

Hasbullah, A. H., Parno, P., & Sunaryono, S. (2020). Efikasi diri siswa dalam pembelajaran proyek berbasis STEM pada Materi Termodinamika [Student self-efficacy in STEM-based project learning on Thermodynamics Material]. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 5(3), Article 3.

Kurniati, P., Kelmaskouw, A. L., Deing, A., Bonin, B., & Haryanto, B. A. (2022). Model proses inovasi kurikulum merdeka implikasinya bagi siswa dan guru abad 21 [The independent curriculum innovation process model has implications for 21st century students and teachers]. *Jurnal Citizenship Virtues*, 2(2), Article 2. https://doi.org/10.37640/jcv.v2i2.1516.

Kurniawati, F. N. A. (2022). Meninjau permasalahan rendahnya kualitas pendidikan di indonesia dan solusi [Reviewing the problem of the low quality of education in Indonesia and solutions]. *Academy of Education Journal*, 13(1), Article 1. https://doi.org/10.47200/aoej.v13i1.765.

Kusworowati, T. (2016). Kreativitas guru ketrampilan dalam mengatasi keterbatasan sarana prasarana pembelajaran [Teacher creativity skills in overcoming the limitations of learning infrastructure]. *Keluarga: Jurnal Ilmiah Pendidikan Kesejahteraan Keluarga*, 2(2), Article 2. https://doi.org/10.30738/keluarga.v2i2.1933.

Ma'ruf, M. W., & Syaifin, R. A. (2021). Strategi pengembangan profesi guru dalam mewujudkan suasana pembelajaran yang efektif [Teacher professional development strategy in creating an effective learning atmosphere]. *Al-Musannif*, 3(1), Article 1. https://doi.org/10.56324/al-musannif.v3i1.54.

Maudi, N. (2016). Implementasi model project-based learning untuk meningkatkan kemampuan komunikasi matematis siswa [Implementation of project-based learning models to improve students' mathematical communication skills]. *JPMI (Jurnal Pendidikan Matematika Indonesia)*, 1(1), 39. https://doi.org/10.26737/jpmi.v1i1.81.

Nahdliyati, R., Parmin, P., & Taufiq, M. (2016). Efektivitas pendekatan saintifik dengan model project-based learning tema ekosistem untuk menumbuhkan kemandirian belajar siswa SMP [The effectiveness of a scientific approach with a project-based learning model with the theme of ecosystems to foster independent learning for junior high school students]. *Unnes Science Education Journal*, 5(2), Article 2. https://doi.org/10.15294/usej.v5i2.12146.

Putri, A. Y., Jayadinata, A. K., & Sunaengsih, C. (2021). Perspektif guru terhadap penerapan model project-based learning dalam mengatasi hambatan belajar pada PJJ [The teacher's perspective on the application of the project-based learning model in overcoming learning barriers in PJJ]. *Jurnal Pena Ilmiah*, 4(1), Article 1. https://doi.org/10.17509/jpi.v4i1.37659.

Qomario, Q., Kurniasih, S., & Anggraini, H. (2018). Studi analisis latar belakang pendidikan, sertifikasi guru dan usia guru paud di kota bandar lampung berdasarkan hasil nilai uji kompetensi guru (UKG) [Study of analysis of educational background, teacher certification and age of early childhood teachers in the city of Bandar Lampung based on the results of the teacher competency test (UKG) scores]. *Jurnal Caksana: Pendidikan Anak Usia Dini*, 1(02), Article 02. https://doi.org/10.31326/jcpaud.v1i02.180.

Rahayu, S. J., Sukarmin, S., & Karyanto, P. (2019). Penerapan model pembelajaran berbasis proyek pada sekolah menengah pertama di Surakarta [Application of the project-based learning model to junior high schools in Surakarta]. *EDUSAINS*, 11(2), 279–285. https://doi.org/10.15408/es.v11i2.11355.

Rati, N. W., Kusmaryatni, N., & Rediani, N. (2017). Model pembelajaran berbasis proyek, kreativitas dan hasil belajar mahasiswa [Project-based learning model, creativity, and student learning outcomes]. *Jurnal Pendidikan Indonesia*. 6(12), 60-71.

Sari, R. A., Musthafa, B., & Yusuf, F. N. (2021). Persepsi guru terhadap pembelajaran berbasis proyek di sekolah menengah kejuruan [Teacher perceptions of project-based learning in vocational high schools]. *Jurnal Penelitian Pendidikan*, 21(2), Article 2. https://doi.org/10.17509/jpp.v21i2.36972.

Simanjuntak, M. P., Bukit, N., Sagala, Y. D. A., Khairani, R., & Utami, Z. L. (2019). Desain pembelajaran berbasis proyek terhadap 4C [Project-based learning design towards 4Cs]. *Jurnal Inovasi Pembelajaran Fisika*, 7(3), 9.

Trinaldi, A., Afriani, M., Budiyono, H., Rustam, R., & Priyanto, P. (2022). Persepsi guru terhadap model pjbl pada kurikulum prototipe [Teachers' perceptions of the Pjbl model in the prototype curriculum]. *Jurnal Basicedu*, 6(4), Article 4. https://doi.org/10.31004/basicedu.v6i4.3526.

Tyagita, B. P. A. (2018). Strategi peningkatan kompetensi pedagogik guru untuk meningkatkan mutu sekolah [Strategies for improving teacher pedagogical competence to improve school quality]. *Jurnal Manajemen Pendidikan*, 5(2), 165–176.

Usman, U., & Ratnasari, D. (2019). Persepsi mahasiswa terhadap pembelajaran yang mengembangkan keterampilan berpikir kreatif yang

diintegrasikan dengan pembelajaran berbasis proyek [Student perceptions of learning that develop creative thinking skills that are integrated with project-based learning]. *Didaktika Biologi: Jurnal Penelitian Pendidikan Biologi*, 3(1), Article 1. https://doi.org/10.32502/dikbio.v3i1.1867.

Utomo, A. C., Abidin, Z., & Rigiyanti, H. A. (2020). Keefektifan pembelajaran project-based learning terhadap sikap ilmiah pada mahasiswa PGSD [The effectiveness of project based learning on scientific attitudes in PGSD students]. *Educational Journal of Bhayangkara*, *1*(1), Article 1. https://doi.org/10.31599/edukarya.v1i1.103.

Wahyu, R. (2016). Implementasi model project-based learning (PJBL) ditinjau dari penerapan kurikulum 2013 [Implementation of the project-based learning (PJBL) model in terms of the implementation of the 2013 curriculum]. *JURNAL TECNOSCIENZA*, 1(1), Article 1.

Winarsih, W. (2020). Upaya meningkatkan pembelajaran matematika melalui pjbl variasi group resume dengan media permainan buharun pada siswa kelas iva sd negeri tunas harapan losarang indramayu [Efforts to improve mathematics learning through pjbl variations of group resumes with buharun game media in class IV students of SD Negeri Tunas Harapan Losarang Indramayu]. *Jurnal Didactical Mathematics*, 3(2), 11.

Yusriani, Y., Arsyad, M., & Arafah, K. (2020). Kesulitan guru dalam mengimplementasikan model pembelajaran berbasis proyek pada mata pelajaran fisika di sma negeri kota makassar [Teachers' difficulties in implementing project-based learning models in physics subjects at SMA Negeri Makassar City]. *Prosiding Seminar Nasional Fisika PPs Universitas Negeri Makassar*, 2(0), Article 0.