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Asynchronous project-based learning: Is it effective in biology learning process?

Setiyo Prajoko*, Ika Sukmawati, Sekar Jati Pamungkas, Karunia Galih Permadani, Muhammad Radian Nur Alamsyah, Ericka Darmawan

Biology Education, Faculty of Teacher Training and Education, Universitas Tidar, Indonesia

*Corresponding author: setiyoprajoko@untidar.ac.id

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ABSTRACT

This study aims to determine the effectiveness of the Project-Based Learning model conducted via online (e-PjBL) on the concept understanding of evaluation in the biology learning. A quasi-experimental method with a non-equivalent pre-test and post-test group design is chosen in this study. The research is carried out at the Biology Education Study Program of Universitas Tidar in March - June 2021. A total of 63 college students become the sample in this research which are divided into experimental class and control class. The instrument used to collect the data is in the form of a concept understanding test about the evaluation of biology learning. Then, the results of the data are analyzed by quantitative. The results show that there is no difference in the use of online Project-Based Learning models on the concept understanding of evaluation in biology learning. This is indicated by the results of hypothesis test which is 0.184 > 0.05. Meanwhile, the average N-Gain in the experimental class is 0.2083 which belongs to the ineffective category. Next, several factors become obstacles to the online Project-Based Learning that causes this learning model to be ineffective.

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INTRODUCTION

One of the goals of national education in Indonesia is to educate the nation's life. In Law which is UU no. 20 of 2003 Article 3 concerning on the National Education System, there is clearly stated that education aims to develop a complete human being. Then, aspects developed include piety, knowledge, characters, independence, and responsibility. However, along with the times, the purpose of education continues to be adjusted. Currently, the world is in the era of the industrial revolution 4.0. Then, based on the Leapfrog's principles and practices regarding the core components of education, education in each era is prepared to respond to the different social issues (Harkins, 2008) Moreover, the issue of agrarian society is emphasized on education 1.0, industrial society on education 2.0, globalization on education 3.0, and innovation in education 4.0.

Some skills are needed by someone in the 4.0 era (Maisiri et al., 2019b). These skills are divided into technical skills which include technological, programming, and digital skills; and non-technical skills which include thinking skills (including creativity, innovation, collaboration, etc.), social skills, as well as personal skills. Therefore, based on this, it is clear that learning in the 4.0 era is not only targeting on the mastery of simple concepts, but also the most important thing which is soft skills (Prajoko et al., 2021). Furthermore, within this framework, we need to think again about innovative learning opportunities for teachers in educational organizations towards education 4.0. Somehow, the challenge is to be able to create an innovative learning environment for the prospective and novice teachers (Göker & Göker, 2020).

Next, the learning environment is one of the most decisive aspects in the success of learning process. The learning environment is very important. Moreover, in order to achieve an appropriate learning environment, a learning strategy is needed regardless of the form of learning which can be face-to-face (offline) or in an online network (Martin & Bolliger, 2018) However, the COVID-19 pandemic that has occurred since the beginning of 2020 has changed all learning activities to become online learning. Then, online learning is indeed not something new in developed countries, but for learning in developing countries, it still contains some problems. Adnan, M., & Anwar, K. (2020) revealed that most online learning has not achieved the expected results. Although, online learning has been implemented well, there are still some obstacles that need to be overcome in order to maintain the quality of learning (Agarwal & Kaushik, 2020).

Indonesia, which is one of the developing countries seems to still experience some obstacles in implementing an effective online learning. However, a study result showed that there is still students' dissatisfaction in doing the online learning, boredom and decreased interest in learning, and feeling discomfort because of many tasks and materials that are not comprehensive (Irawan et al., 2020; Mirawati et al., 2020; Surahman, 2020). As a result, these problems can have a negative impact on the learning process. Related to this, designing online learning with varied learning strategies in line with a more flexible national curriculum, technology readiness, and collaboration are very important for creating a successful online learning (Fauzi & Khusuma, 2020).

The problems mentioned above also appeared to occur in the lectures at the Biology Education Study Program of Universitas Tidar. Along with the online learning which has been going on for more than a year, the lecturers knew and realized their students' uninterest in learning. Some students also seemed to experience a significant decrease in learning outcomes (GPA), despite the efforts of academic advisory by their respective lecturers. Somehow, the decline in learning outcomes shows a lack of concept understanding in the courses that they are taken. Then, learning at home also seems to complicate the collaborative process between the students in problem solving, because online communication is relatively less effective than offline or in person in the class. Instead, students' attitudes, especially scientific attitudes, also began to experience problems, known by decreased the discipline, responsibility in doing assignments, and many others.

Some problems related to concept understanding need to be handled seriously so that the learning outcomes of graduates can be achieved properly. Not only that, solving the problems is also important related to achieving the learning goals in the era of 4.0 and the 21st century. Somehow, collaboration is one of the important skills in the learning process today and in the future, because this skill can also be related and build other 21st century skills such as problem solving; digital literacy; as well as oral, written, and visual communication skills (Greenstein, 2012). Then, as previously stated, collaborative problem-solving skills are also the important non-technical skills, in addition to interpersonal skills, and teamwork (Maisiri et al., 2019; Prajoko et al., 2022). Moreover, the emotional

aspect which is scientific characters or scientific attitude is equally important, because the appreciation of scientific attitudes contributes significantly to student performance, especially in the field of science (Suryawati & Osman, 2017).

In order to implement a learning that can empower the collaboration skills in problem solving, scientific attitudes, and concept understanding, it is necessary to apply an appropriate learning model, especially in the online learning today. Moreover, it is really necessary to optimize the existing learning models, so that the learning objectives and other aspects that are taught during the learning process can be achieved. In addition, optimization of learning models in online conditions can be done by adjusting the related methods, learning techniques, and even the assessment system in online learning.

In the Biology Education Study Program of universitas Tidar, one of the learning models that is often used is Project-Based Learning (PjBL). Project-Based Learning allows students to learn together more actively with six stages, which are: (1) formulating essential questions, (2) designing project plans, (3) designing or arranging schedules, (4) monitoring the progress of students' project (5) assessing the results, and (6) evaluating students' learning experiences. The benefits of Project-Based Learning in improving students' collaboration and problem-solving skills have been proven by many studies, some of them are (Nurfitriyanti, 2016; Saenab et al., 2017). Meanwhile, the benefits of Project-Based Learning in increasing scientific attitudes and responsibility have also been reported by Fuadah (2016).

All of those benefits are reported from Project-Based Learning that is carried out offline. However, in a pandemic condition which offline learning is not possible, Project-Based Learning must still be carried out optimally even though it is online. Therefore, in order to implement an effective Project-Based Learning syntax in online learning conditions, it is necessary to have appropriate and suitable teaching technical arrangement. Moreover, in order to manage the students' learning activities at each stage of Project-Based Learning, synchronous and asynchronous methods can be combined. This learning stage arrangement will be further designed in this research, with the aim of : optimizing the students' learning activities, obtaining the essence of each stage of Project-Based Learning, and most importantly solving problems related to concept understanding.

In order to facilitate online learning, Universitas Tidar has provided a Moodle-based Learning Management System (LMS) which is called as "Elita" (E-Learning Untidar). Moreover, in Universitas Tidar, including the Biology Education Study Program, Elita has been used to support online lectures, even before the pandemic of COVID-19. In 2020, as the use of Elita increases, some updates and improvements have been made including a larger server migration and the UI (User Interface) of Elita settings to make it easier to use for both the lecturers and the college students. In addition, the features in Elita are complete enough to support the online learning both synchronously and asynchronously. Therefore, in relation to this research, the use of Elita needs to be maximized in Project-Based Learning in order to form an e-PjBL model that has great benefits in lectures. Then, it is hoped that by the optimal implementation of e-PjBL, the Biology learning process will be better in terms of planning, implementation, and evaluation. Based on this background, research is needed to determine the effectiveness of project-based learning that is carried out boldly in increasing students' conceptual understanding of evaluation in biology learning.

METHODS

Research Design

This research uses a quasi-experimental method with a non-equivalent pre-test and post-test control group design. The groups used in this research are 2 classes, which are one class as an experimental class which is treated with the application of e-PjBL and the other one as a control class which is treated with discussion models. This discussion model was chosen because both of them can start from solving problems but this model is not oriented towards making a product. Moreover, the data collection is carried out twice, which is before treatment and after treatment. In detail, the research design that is carried out is presented in the following Figure 1.

O_1 X O_2
O_3 O_4

Figure 1. Research design with a non-equivalent pre-test and post-test control group design.

Description:
O_1: the pre-test of experimental class
O_2: the post-test of experimental class
O_3: the pre-test of control class
O_4: the post-test of control class
X : Treatment of e-PjBL

Population and Samples

This research is carried out with the target population which are all college students of the Biology Education Study Program of Universitas Tidar. In quasi-experimental research is experimental research where the research subjects cannot be assigned randomly, so the purposive sampling technique is chosen (Cresswell, 2014). Then, the sampling technique used is purposively by selecting 2 classes which conduct a lesson of Biology Learning Evaluation courses in the academic year of 2020-2021. Based on the sample limit, this research uses 2 classes of the 2019 students, which are 31 students in the control class and 32 students in the experimental class.

Instrument

The student's concept understanding variable is measured by using a test instrument consisting of 50 items. According to Bloom's taxonomy, the indicator of conceptual understanding is included in the C2 level (Netriwati, 2018). These items are developed based on the material indicators in the Biology Learning Evaluation courses, consist of (1) examine the nature of the evaluation of learning, (2) evaluation of Biology learning in the perspective of the 2013 Curriculum, (3) preparation of various Biology learning evaluation instruments in the form of tests and non-tests, (4) measurements in the cognitive, affective, and psychomotor domains, (5) objectives, functions, principles of class-based assessment, (6) assessment of benchmark references and norm references in the evaluation of Biology learning, (7) analysis of assessment instruments in Biology learning; and (8) preparation of Biology learning instruments. For the assessment of the question is done by giving a score of 1 if the answer is correct and a score of 0 if the answer is wrong. Before being developed, the instrument items are confirmed to have met the valid and reliable criteria.

Procedure

The research is carried out at the Biology Education Study Program of Universitas Tidar. There are several steps taken in this research procedure in March – June 2021 . First, the preparation which includes research facilities and infrastructure, classes, observers, and research instruments. Second, the implementation of the research in the experimental class and control class, this implementation lasted for 4 weeks including the implementation of the pretest and posttest. third, evaluation and analysis of research data. After the research is completed, an evaluation is carried out during the research activities. The next step was to analyze the research data using SPSS 22 software.

Data Analysis Techniques

In relation with the analysis, this research uses a descriptive analysis to analyze the initial data that has been obtained and continue with the inferential analysis or inferential test. Moreover, the inferential test used is in accordance with the design of this research which is the independent t test which is to determine the significance of the difference between 2 groups with different research subjects, but before conducting the independent t test, a prerequisite analysis test was carried out . In addition, in order to complete the analysis process, the comparison of the initial data and the final data is analyzed using the N-Gain test after the data is declared normal and homogeneous.

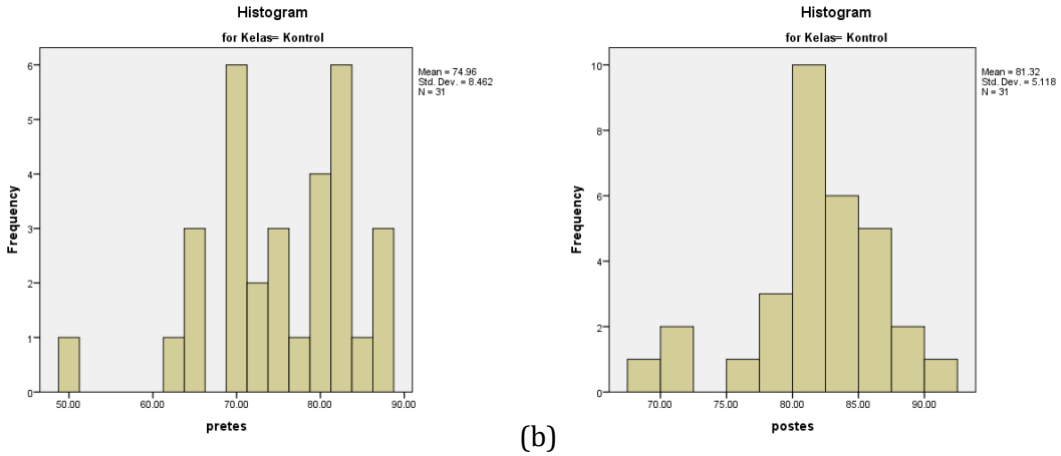
RESULTS AND DISCUSSION

Based on the research that was carried out in May until July 2021, the following data are obtained.

Table 1
The summary of Pre-test and Post-test Assessment Results for e-PjBL Class and Control Class.

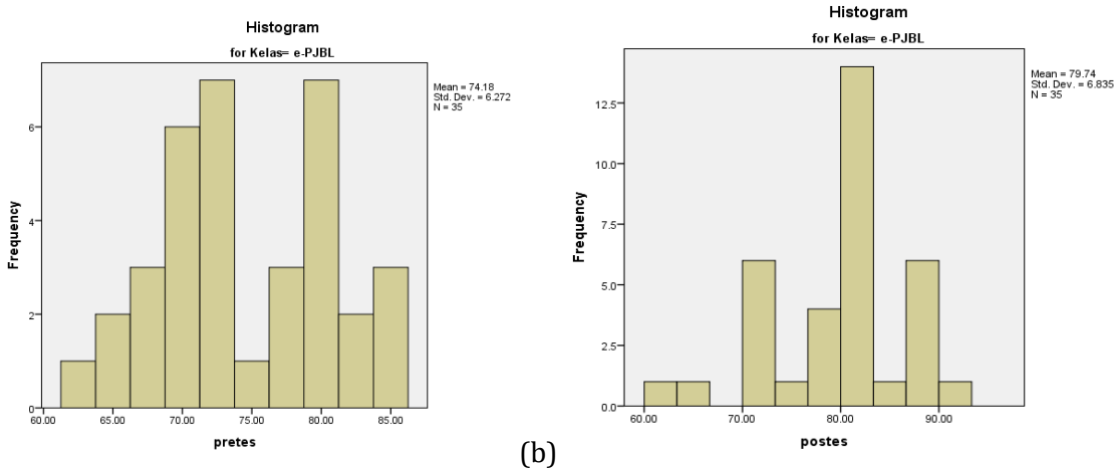
Aspect	Online learning			
	Asynchronous e-PjBL		Asynchronous	
	Pre-test	Post-test	Pre-test	Post-test
Mean	74.96	81.32	74.69	78.77
Median	75.00	81.67	73.13	80.00
Mode	81.25	80.00	72.50	83.33
Min	50.00	68.33	62.50	61.67
Max	87.50	91.67	85.00	88.33
Standard Deviation	8.46	5.12	6.32	6.57

Based on the Table 1, the pre-test and post-test profiles are obtained between the e-PjBL class and the Control Class. Somehow, in the experimental class, the average of the post-test assessment is 81.3 and the Standard Deviation is 5.1. Meanwhile, in the e-PjBL class, the average is 78.77 and the Standard Deviation is 6.57. Moreover, the frequency distribution data scores are presented in the Figures 2 and Figure 3.



(a) (b)

Figure 2. Histogram of the score's distribution of the control class (a) pre-test, (b) post-test.



(a) (b)

Figure 3. Histogram of the score's distribution of the experimental class (a) pre-test, (b) post-test.

In determining the hypothesis test, first, the analysis prerequisite test is carried out. The analyst prerequisite test results are presented in the Table 2 and Tabel 3.

Tabel 2
The Results of Data Normality Analyst Prerequisite Test.

Tests of Normality				
	Class	Kolmogorov-Smirnov		
		Statistics	df	Sig.
Post-test	Control	.173	31	0.019
	e-PjBL	.144	35	0.064
Pre-test	Control	.144	31	0.103
	e-PjBL	.148	35	0.049

Based on the Table 2, the significance score of post-test normality is 0.019 < 0.05. Thus, the data in the control class is not normally distributed. Meanwhile, in the experimental class, the significance score is 0.049 < 0.05, so that the experimental class data is also not normally distributed. Meanwhile, the results of the homogeneity test are presented in the Table 3.

Tabel 3
The Results of Homogeneity Analyst Prerequisite Test.

Test of Homogeneity of Variances	Sig.
Pre-test	0.166
Post-test	0.081

Based on the Table 3, the significance score of post-test homogeneity is 0.081 > 0.05. Thus, the data is taken from the homogeneous sample. While the pre-test obtains a significance score of 0.166 > 0.05 so that the pre-test data is also taken from the homogeneous sample as well. However, in the two analytical prerequisite tests, there is one aspect of the normality test that cannot be achieved. That is why, the next analysis uses non-parametric statistics.

The non-parametric statistical test results use the Mann Whitney test. The test results are presented in the Table 4.

Tabel 4
The Hypothesis Test Results.

Test Statistics	Post-test
Mann-Whitney U	399.500
Wilcoxon W	927.500
Z	-1.330
Asymp. Sig. (2-tailed)	0.184

Based on the Table 4, it is obtained a significance score of 0.184 > 0.05. Thus, the score's difference between the experimental class and the control class is not significant. In order to find out the effectiveness of improving learning, it is necessary to do an N-Gain analysis.

Based on the Table 5, the NGain score of the e-PjBL class is 0.2083, while the control class is 0.2060. Therefore, based on the criteria, the score belongs to the ineffective category. Based on the results of the study, the concept understanding of evaluation in the biology learning for both online learning asynchronously using e-PjBL and online learning in the control class is not significantly different. Moreover, concept understanding is a process carried out by students to connect one concept to another in the learning process (Sardiman, 2007). It means that this understanding serves to assist students in inferring the characteristics of the larger categories to the smaller categories (Jacobsen et al., 2009). Meanwhile, according to Hamalik (2011), understanding is defined as the ability to see the relationship between various factors or elements in a problematic situation. Moreover, some of the factors that cause this to happen include the external and internal factors. Internal factors come from the students' internal motivation, while external factors come from the environment around the students.

Tabel 5
The results of the Descriptive Statistical Test on the NGain scores.

Class			Statistic
Control	Mean		0.2060
	95% Confidence Interval for Mean	Lower Bound	0.1094
		Upper Bound	0.3026
	5% Trimmed Mean		0.2311
	Median		0.2500
	Variance		0.069
	Std. Deviation		0.26327
	Minimum		-0.60
	Maximum		0.56
	Range		1.16
	Interquartile Range		0.28
	Skewness		-1.666
	Kurtosis		3.269
e-PjBL	Mean		0.2083
	95% Confidence Interval for Mean	Lower Bound	0.1451
		Upper Bound	0.2715
	5% Trimmed Mean		0.2010
	Median		0.1818
	Variance		0.034
	Std. Deviation		0.18394
	Minimum		-0.14
	Maximum		0.78
	Range		0.92
	Interquartile Range		0.27
	Skewness		0.713
	Kurtosis		1.354

Students' internal motivation varies when participating in the learning process. There are students who have high motivation and students who have low motivation. A motivation to participate in an online learning for students with high motivation will result the high pre-test and post-test results as well. Meanwhile, students who have low motivation can result low pre-test and post-test scores. In this case, the treatment of the e-PjBL class does not necessarily increase students' motivation to master the concepts of learning materials. Whereas the position of motivation is important in the learning process (Andriani & Rasto, 2019; Emda, 2018). In addition, students' low learning motivation has an effect on the low learning outcomes as well. Moreover, saturation in learning during the COVID-19 pandemic causes students to have low intrinsic motivation (Aiyuda & Fadhli, 2022; Fatimah & Puspaningtyas, 2022; Pawicara & Conilie, 2020). However, online learning activities that are not in line with the expectation become routines that cause this saturation (Gopalan et al., 2017).

Based on the external factors, it can be investigated from several aspects such as supporting facilities and infrastructure, learning media, and learning models. In terms of supporting facilities and infrastructure, there are still many students who are constrained by their internet signals, so that the collaboration space to complete the project is disrupted. Somehow, communication is the most important thing in the Project-Based Learning. If this is disturbed, the effectiveness of learning will also be disrupted as well. That is why, internet network facilities and infrastructure in online learning have a very important role. In addition, if there is no internet network or disruption in the internet network, it can cause learning activities to not be carried out as they should (Muljana & Luo, 2019; Rahayu & Haq, 2021; Wulandari & Agustika, 2020). Next, in addition to the internet facilities, other supporting facilities such as gadgets that are less supportive or compatible are also an obstacle in online learning. Moreover, smartphone specifications do not meet the requirements can cause a not optimal learning. Most of the students have smartphones that are not supported, such as lack of RAM, antennas that can't reach 4G signals, and low screen resolution. Therefore, this condition causes disruption of the online learning process.

Viewed from the perspective of learning media, students use various devices to access learning media contained in the learning management system. Moreover, device performances also affect the smoothness in digging for information. Students tend to experience a decrease of motivation if the device used has less reliable performance. Of course, this affects the mastery of understanding the concept of each student to be uneven (Nurhikmah et al., 2018; Sahronih et al., 2019; Williamson et al., 2019). Next, in Project-Based Learning that is carried out asynchronously, the learning media used is video learning. Moreover, the quality of the learning videos is good. However, the device used to access the learning media do not support, so that the concepts conveyed through the learning media are not well constructed by the students. In this case, constructivism in learning is disrupted and it causes no difference between the experimental class and the control class.

Furthermore, it is reviewed from the Project-Based Learning model. Studies that have been done previously; Project-Based Learning should be able to improve students' concept understanding. However, that research is Project-Based Learning that was carried out offline. In this research, the Project-Based Learning is conducted online and has not been able to result a significant difference. Moreover, it is caused by one syntax that has not been optimally running well. Among these syntaxes are at the planning stages and monitoring activities stages. At the planning stage, there should be an interactive collaboration space between students. Supposedly, in offline Project-Based Learning, students in groups directly discuss the project planning (Sari et al., 2017). However, during online learning, each collaboration room activity is disrupted by facilities and infrastructure, so that the planning becomes unsuccessful and affects the learning outcomes. This is reinforced by the statement that online Project-Based Learning cannot increase students' activity if the facilities and infrastructure are disturbed (Rahma & Setyaningsih, 2021). Moreover, it is the same at the time of supervision. If it is done offline, educators can directly supervise the project activities that are carried out. However, when it was online learning, the supervision cannot be carried out optimally. In fact, this supervision activity is important, so that communication between educators and students is established (Ardiawan & Heriawan, 2020). Last but not least, Project-Based Learning does need special attention so that the syntaxes can run well (Altaftazani et al., 2020).

CONCLUSION

To sum up, based on the discussion above, the concept of evaluation in the biology learning for both online learning asynchronously using e-PjBL and online learning in the control class is not significantly different. It is evidenced by the difference test score of 0.184 > 0.05. Moreover, e-PjBL is not effective in increasing concept understanding based on the average NGain score of 0.2083. This is caused by the internal factors and external factors of the college students that occur during the Project-Based Learning process that is carried out online..

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REFERENCES

Adnan, M., & Anwar, K. (2020). Online Learning amid the COVID-19 Pandemic: Students' Perspectives. *Online Submission*, *2*(1), 45-51. https://doi.org/10.33902/JPSP.%202020261309

Agarwal, S., & Kaushik, J. S. (2020). Student's Perception of Online Learning During COVID Pandemic. *The Indian Journal of Pediatrics*, *87*, 554-554. https://doi.org/10.1007/s12098-020-03327-7

Aiyuda, N., & Fadhli, M. (2022). Kebosanan Akademik dan Kecanduan Gadget Selama Pandemi Covid-19 Pada Remaja. *Psychopolytan: Jurnal Psikologi*, *5*(2), 150-158. https://doi.org/10.36341/psi.v5i2.2346

Altaftazani, D. H., Arga, H. S. P., Kelana, J. B., & Ruqoyyah, S. (2020). Analisis Pembelajaran Daring Membuat Seni Kolase Menggunakan Model Project Based Learning Pada Masa Pandemi Covid 19. *Jurnal Ilmiah P2M STKIP Siliwangi*, *7*(2), 185-191. http://e-journal.stkipsiliwangi.ac.id/index.php/p2m/article/view/2006

Andriani, R., & Rasto, R. (2019). Motivasi Belajar Sebagai Determinan Hasil Belajar Siswa. *Jurnal Pendidikan Manajemen Perkantoran (JPManper)*, *4*(1), 80-86. https://doi.org/10.17509/jpm.v4i1.14958

Ardiawan, I. K. N., & Heriawan, I. G. T. (2020). Pentingnya Komunikasi Guru Dan Orang Tua Serta Strategi PMP Dalam Mendukung Pembelajaran Daring. *Danapati: Jurnal Ilmu Komunikasi*, *1*(1), 95-105. https://jurnal.ekadanta.org/index.php/danapati/article/view/37/10

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. California: SAGE publications.

Emda, A. (2018). Kedudukan Motivasi Belajar Siswa Dalam Pembelajaran. *Lantanida journal*, *5*(2), 172-182. https://jurnal.ar-raniry.ac.id/index.php/lantanida/article/view/2838/2064

Fatimah, C., & Puspaningtyas, N. D. (2022). Studi Literatur: Kejenuhan Belajar Pada Pembelajaran Daring Selama Pandemi Covid-19. *Jurnal Ilmiah Matematika Realistik*, *3*(1), 42-49. https://doi.org/10.33365/ji-mr.v3i1.1834

Fauzi, I., & Khusuma, I. H. S. (2020). Teachers' Elementary School In Online Learning Of COVID-19 Pandemic Conditions. *Jurnal Iqra': Kajian Ilmu Pendidikan*, *5*(1), 58-70. https://doi.org/10.25217/ji.v5i1.914

Fuadah, Kholisotul. (2016). Project Based Learning Bersumber Belajar Potensi Lingkungan Lokal terhadap Pemahaman Konsep, Keterampilan Ilmiah dan Sikap Ilmiah siswa. *Jurnal Pendidikan Biologi*, 8 (1), 10-16. http://dx.doi.org/10.17977/um052v8i1p10-16

Göker, S. D., & Göker, M. Ü. (2020). Rethinking Innovative Learning Opportunities for Teachers in Educational Organizations toward Education 4.0. In *A Closer Look at Organizational Culture in Action*. IntechOpen.

Gopalan, V., Bakar, J. A. A., Zulkifli, A. N., Alwi, A., & Mat, R. C. (2017). A review of the motivation theories in learning. In *AIP Conference Proceedings* (Vol. 1891, No. 1, p. 020043). AIP Publishing LLC.

Greenstein, Laura. (2012). *Assessing 21st Century Skills: A Guide to Evaluating Mastery and Authentic Learning*. California: A SAGE Company.

Hamalik, O. (2011). *Proses Belajar Mengajar*. Jakarta: Bumi Aksara

Harkins, A. M. (2008). Leapfrog principles and practices: Core components of education 3.0 and 4.0. *Futures Research Quarterly*, *24*(1), 19-31. http://www.filosofiacienciaarte.org/attachments/article/1128/HarkinsCoreComponents.pdf

Irawan, A. W., Dwisona, D., & Lestari, M. (2020). Psychological Impacts Of Students On Online Learning During The Pandemic COVID-19. *KONSELI: Jurnal Bimbingan dan Konseling (E-Journal)*, *7*(1), 53-60. https://doi.org/10.24042/kons.v7i1.6389

Jacobsen, D., Eggen, P., & Kauchak, D. (2009). *Methods for teaching: Metode-metode pengajaran meningkatkan belajar siswa TK-SMA*. Yogyakarta: Penerbit Pustaka Pelajar.

Maisiri, W., Darwish, H., & van Dyk, L. (2019). An Investigation Of Industry 4.0 Skills Requirements. *South African Journal of Industrial Engineering*, *30*(3), 90-105. http://dx.doi.org/10.7166/30-3-2230

Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning*, *22*(1), 205-222. http://dx.doi.org/10.24059/olj.v22i1.1092

Mirawati, I., Mahameruaji, J. N., & Trulline, P. (2020). Indonesian Student's Perception of Online Learning Activities in the Time of Pandemic. *European Journal of Molecular & Clinical Medicine*, *7*(1), 3645-3652. https://ejmcm.com/article_4179.html

Muljana, P. S., & Luo, T. (2019). Factors Contributing To Student Retention In Online Learning And Recommended Strategies For Improvement: A Systematic Literature Review. *Journal of Information Technology Education: Research*, *18*.

Netriwati, N. (2018). Penerapan Taksonomi Bloom Revisi Untuk Meningkatkan Kemampuan Pemahaman Konsep Matematis. *Desimal: Jurnal Matematika*, *1*(3), 347-352. https://doi.org/10.24042/djm.v1i3.3238

Nurfitriyanti, M. (2016). Model Pembelajaran Project Based Learning Terhadap Kemampuan Pemecahan Masalah Matematika. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *6*(2). http://dx.doi.org/10.30998/formatif.v6i2.950

Nurhikmah, H., Tahmir, S., Junda, M., & Bena, B. A. N. (2018). Blended Learning Media in Biology Classroom. In *Journal of Physics: Conference Series* (Vol. 1028, No. 1, p. 012027). IOP Publishing. https://iopscience.iop.org/article/10.1088/1742-6596/1028/1/012027/pdf

Pawicara, R., & Conilie, M. (2020). Analisis Pembelajaran Daring Terhadap Kejenuhan Belajar Mahasiswa Tadris Biologi IAIN Jember di Tengah Pandemi Covid-19. *ALVEOLI: Jurnal Pendidikan Biologi*, *1*(1), 29-38. https://doi.org/10.35719/alveoli.v1i1.7

Prajoko, S., Anjani, A., Oktaviani, R. D., Fathimah, P., & Kamaludin, W. (2021). Development Of Self-

Assessment Instruments To Measure Student Affective Domains On Online Biology Learning. *THABIEA: JOURNAL OF NATURAL SCIENCE TEACHING*, *4*(2), 185-197. http://dx.doi.org/10.21043/thabiea.v4i2.11964

Prajoko, S., Erawati, A., Amali, F. W., Zunaena, M., & Arganingtias, I. (2022). The Development of High Order Thinking Skills Test Based on Google Forms on Cell Biology Materials. *Journal Of Biology Education*, *5*(1), 64-79. http://dx.doi.org/10.21043/jobe.v5i1.14370

Rahayu, A. D., & Haq, M. S. (2021) Sarana dan Prasarana Dalam Mendukung Pembelajaran Daring Pada Masa Pandemi Covid-19. *Inspirasi Manajemen Pendidikan*, 9(1), 186-199. https://ejournal.unesa.ac.id/index.php/inspirasi-manajemen-pendidikan/article/view/38623

Rahma, F.N., & Setyaningsih, L. W. N. (2021). Implementasi Pembelajaran Berbasis Proyek dengan Integrasi Metode Daring Sinkron dan Asinkron pada Mata Kuliah Teknik Reaksi Kimia 2. *Refleksi Pembelajaran Inovatif*, 3(1), 325-336. https://journal.uii.ac.id/RPI/article/view/19497/11288

Saenab, S., Yunus, S. R., & Virninda, A. N. (2017, September). PjBL untuk Pengembangan Keterampilan Mahasiswa: Sebuah kajian deskriptif tentang peran PjBL dalam melejitkan keterampilan komunikasi dan kolaborasi mahasiswa. In *Seminar Nasional LP2M UNM* (Vol. 2, No. 1).

Sahronih, S., Purwanto, A., & Sumantri, M. S. (2019). The effect of interactive learning media on students' science learning outcomes. In *Proceedings of the 2019 7th International Conference on Information and Education Technology* (pp. 20-24).

Sardiman. (2007). *Interaksi dan Motivasi Belajar Mengajar*. Jakarta: Raja Grafindo Persada.

Sari, K. A., Prasetyo, Z. K., & Wibowo, W. S. (2017). Pengembangan Lembar Kerja Peserta Didik Ipa Berbasis Model Project Based Learning Untuk Meningkatkan Keterampilan Kolaborasi Dan Komunikasi Peserta Didik Kelas Vii. *Jurnal Pendidikan Matematika Dan Sains*, *6*(8), 461-467. https://journal.student.uny.ac.id/index.php/ipa/article/view/9045

Surahman, E. (2020, October). Student Satisfaction toward Quality of Online Learning in Indonesian Higher Education During the Covid-19 Pandemic. In *2020 6th International Conference on Education and Technology (ICET)* (pp. 120-125). IEEE.

Suryawati, E., & Osman, K. (2017). Contextual learning: Innovative approach towards the development of students' scientific attitude and natural science performance. *Eurasia Journal of mathematics, science and technology education*, *14*(1), 61-76. https://doi.org/10.12973/ejmste/79329

Williamson, B., Potter, J., & Eynon, R. (2019). New research problems and agendas in learning, media and technology: the editors' wishlist. *Learning, Media and Technology*, *44*(2), 87-91. https://doi.org/10.1080/17439884.2019.1614953

Wulandari, A., & Agustika, G. N. S. (2020). Dramatik Pembelajaran Daring Pada Masa Pandemi Covid-19. *Mimbar PGSD Undiksha*, *8*(3), 515-526. https://doi.org/10.23887/jjpgsd.v8i3.29259