COMPARISON OF PROJECT-BASED LEARNING AND DISCOVERY LEARNING ON BIOLOGY LEARNING OUTCOMES BY CONTROLLING STUDENTS' INITIAL KNOWLEDGE

PERBANDINGAN MODEL PEMBELAJARAN PROJECT-BASED LEARNING DAN DISCOVERY LEARNING TERHADAP HASIL BELAJAR BIOLOGI DENGAN MENGONTROL PENGETAHUAN AWAL SISWA

Muhammad Sirih[1*)], Nurdin Ibrahim[2)], Priyono[3)]
[1*)]Pendidikan Biologi, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Halu Oleo, Sulawesi Tenggara, Indonesia, email: muhammad.sirih@uho.ac.id (coressponding author)
[2), 3)]Teknologi Pendidikan, Sekolah Pascasarjana, Universitas Negeri Jakarta, Jakarta, Indonesia, email: [2)]nurdin.ibrahim@unj.ac.id, [3)]priyono@unj.ac.id

Submitted: August 2020; Approved: September 2020; Published: September 2020

Abstract

The study aimed to compare the influence of project-based learning and discovery learning models on biology learning outcomes by controlling students' initial knowledge. The aim of this study was also to analyze the role of initial knowledge in learning by involving the both learning models. The study was conducted in State Senior High School 4 Kendari using quasi-experimental design (Non-equivalent pretest and posttest control-group). The samples were conducted by a random sampling technique, Class XI MIA 1 as the experimental class and Class XI MIA 4 as a control class. The variables consisted of: a) biology learning outcomes as the dependent variable; b) learning models (project-based learning and discovery learning) as the independent variables; and c) students' initial knowledge as the covariate variable. The data were analyzed using ANCOVA at a significance level 0.05. The study results showed there was significant difference of biology learning outcomes between students that taught using the project-based learning and students taught using the discovery learning by controlling the initial knowledge (sig. 0.025 < α 0.05). The average of students' biology learning outcomes that taught using the project-based learning (76.63) was higher than students taught using the discovery learning (73,37). Then, there was the influence of the initial knowledge on students' biology learning outcomes (sig. 0.000 < α 0.05). The initial knowledge is one of the crucial prerequisites for learning, conceptualized as knowledge of students' relevant and dominant content with what they learn.

Keywords: project-based learning, discovery learning, initial knowledge

Abstrak

Penelitian ini bertujuan membandingkan pengaruh model project-based learning *dan* discovery learning *terhadap hasil belajar biologi dengan mengontrol pengetahuan awal siswa. Penelitian juga bertujuan menganalisis peran pengetahuan awal dalam pembelajaran. Penelitian dilakukan di SMA Negeri 4 Kendari dengan menggunakan desain eksperimen semu* (non-ekuivalen pretest dan posttest control group). *Pengambilan sampel dilakukan dengan teknik random sampling, Kelas XI MIA 1 sebagai kelas eksperimen dan Kelas XI MIA 4 sebagai kelas kontrol. Variabel penelitian terdiri dari: a) hasil belajar biologi sebagai variabel terikat; b) model pembelajaran* (project-based learning dan discovery learning) *sebagai variabel bebas; dan c) pengetahuan awal siswa sebagai variabel kovariat. Analisis data menggunakan ANCOVA pada tingkat signifikansi 0,05. Hasil penelitian menunjukkan terdapat perbedaan yang signifikan hasil belajar biologi antara siswa yang diajar menggunakan* project-based learning *dan siswa yang diajar menggunakan* discovery learning *dengan mengontrol pengetahuan awal (sig. 0,025 <α 0,05). Rata-rata hasil belajar biologi siswa yang diajar menggunakan* project-based learning *(76,63) lebih tinggi daripada siswa yang diajar menggunakan* discovery learning *(73,37). Kemudian ada pengaruh pengetahuan awal terhadap hasil belajar biologi siswa (sig. 0,000 <α 0,05). Pengetahuan awal merupakan salah satu prasyarat penting untuk pembelajaran, dikonseptualisasikan sebagai pengetahuan tentang konten siswa yang relevan dan dominan dengan apa yang mereka pelajari.*

***Kata kunci**: project-based learning, discovery learning, pengetahuan awal*

p-ISSN 2549-5267
e-ISSN2579-7352

Introduction

The development of learning models is a series of activities in designing learning as a form of teacher accountability to students, the community, nation, and state. The learning model remains a conceptual framework that explains a systematic procedure in organizing learning experiences to achieve the learning objectives. There is no good learning model, and each learning model has advantages and disadvantages (Arends, 2012). Therefore, the using of the learning model, teachers need to adapt to various considerations such as the characteristics of subjects, basic competency or learning topic, components and learning modalities of students that will learn with the model, as well as other learning support facilities.

In the 2013 Curriculum, some recommended learning models include discovery learning, problem-based learning, and project-based learning. The third difference in the learning model lies in its purpose (Kosasih, 2013). The use of these two learning models for this research based on the results of observations and interviews with biology teachers at Senior High School 4 Kendari. Based on the results of observations and interviews, it was found that at State Senior High School 4 Kendari (SMA Negeri 4 Kendari), four learning models were applied, one of which was discovery learning. However, implementations in classroom, teachers faced several barriers in applying the discovery learning model. The biggest challenge was students did not understand how to compare the concepts learned to the problems encountered. Additionally, sometimes students did not understand the description of the learning objectives given. Another obstacle was the students had difficulties in analyzing, integrating, organizing material and making a conclusion during the learning process.

The implications of the discovery learning model application, visible from student learning outcomes for subjects in class XI MIPA biology in academic year 2014/2015, that was 2% of students scored outstanding category (A), 31% of students got good category (B) dan 67% of students got enough category (C). Based on that data, these numbers of students who achieved the Minimum Completion Criteria score 33% (Minimum Completion Criteria set by the school was 62). While in the academic year 2015/2016, the results showed that students who got outstanding category was 3%, 15% students in good category, 30% students in enough category, and 52% students in fewer category. Based on that data, the number of students achieved the Minimum Completion Criteria score was 48% with the Minimum Completion Criteria set by the school was 73 (Data and Information Center of State Senior High School 4 Kendari). These data illustrated that there were still students who have not met the minimum competency standards that have set for biology subjects on class XI in State High School 4 Kendari.

To solve the problem, one model of learning that as a solution is Project-Based Learning. This learning model emphasizes learning activities; students explore, evaluate, interpret, and synthesize information to obtain various learning outcomes (knowledge, skills, and attitude). In project-based learning, students create actively by utilizing the experience and ability to do activities and produce work that they deem useful to themselves or others. Then after completing the project, students remember longer what they have learned and learn how to exercise responsibility and create self-confidence, solve problems, work collaboratively, express ideas, and become innovators (Păvăloiu, Petrescu & Dragomirescu, 2015). The study that has conducted by Jagsantara, Adnyana & Manik (2014) concluded that there was difference in the improvement in biology learning outcomes between students with project-based learning and direct learning models. The research that was conducted by Chiang & Lee (2016) showed the project-based learning model had a positive effect on students' motivation and could help students' skills in problem-solving. Another research, conducted by Wekesa & Ongunya (2016), showed the application of project-based learning could improve students' understanding of organisms classification concept, which led to enhance academic achievement with positively change of students' reaction.

In this study, in addition to learning model, it is also essential to be known by a teacher about students' initial knowledge before they participate in the learning process. The initial knowledge is the learning outcomes obtained before getting a higher ability. Students' initial knowledge is a prerequisite for participating in learning so students can carry out the learning process well. Students' initial knowledge is essential for the teacher to be able to determine the right entry behavior in. The initial knowledge is also useful in taking the necessary steps of learning. Therefore, it is necessery to find out the phenomena of both types of learning models (project-based learning and discovery learning) on biology subjects, and how the initial knowledge in improving students' learning outcomes. Suparman (2014) suggested that for individual students need to be identified the initial behavior because it was related to competence, knowledge, skill, and attitude that were mastered by students to qualify for learning.

The level of competence and characteristics of students varies widely or differes from one to the others. The initial knowledge can be as a factor is expected to influence the level of success in achieving learning objectives. Therefore, the aim of conducted study was to compare the influence of project-based learning and discovery learning models on biology learning outcomes by controlling students' initial knowledge. In addition, the aim of this study was also to analyze the role of initial knowledge in learning by involving the both learning models.

Research Methods

Variable and Research Design

The variables in this study consisted of: a) the dependent variable, namely biology learning outcomes; b) the independent variables, namely learning models that consisting of project-based learning and discovery learning; and c) the additional variable was students' initial knowledge as a covariate variable. The study was Quasi-Experimental design (Non-equivalent pretest and posttest control-group design). The study design was displayed in Figure 1.

Group A:	A	X	A
Group B:	O	X	O

Figure 1. Design research: non-equivalent pretest and posttets control group design

Where, A: Group experiment with project-based learning, B: Group experiment with discovery learning, X: Treatment

The treatment in this study was given to two classes, namely experimental class (A) that was treated with project-based learning, and control class (B) that was treated with discovery learning. Treatment implementation procedures was divided into three stages: (1) preparation, (2) stage of implementation, and (3) final stage of treatment.

Population and Sample

The population of this study was all students of State Senior High School 4 Kendari in class XI MIA that consisting of 9 parallel classes with 372 students. The samples in this study were conducted by a random sampling technique. The determination of experimental and control classes was prepared by drawing with several lottery numbers, one to nine number. The first number that came out was used as an experimental class (Class XI MIA 1) and the second number that came out was used as a control class (Class XI MIA 4). Before being given the treatment to two classes, both the experimental class and the control class, they were given the initial knowledge test to obtain students' initial knowledge scores.

Data Analysis Technique

The data on biology learning outcomes and students' initial knowledge were obtained by giving the test. Data analysis techniques included: 1) descriptive analysis, 2) analysis prerequisite testing: a) normality test, done using Lilliefors test with the criteria: data was normal if $L_{count} < L_{table}$ and unnormal if $L_{count} > L_{table}$ at the level $\alpha = 0.05$, b) homogeneity test, done using Bartlett test with the criteria: acceptence of H_0 if $F_{count} > F_{table}$ at the level $\alpha = 0.05$ (data was homogen) and rejection of H_0 if $F_{count} < F_{table}$ (data was not homogen), c) linearity

test; done to test whether the regression equation model of covariate *X* on the dependent variable *Y* was linear or not. Being aforementioned was because the inferential statistical test with ANCOVA (analysis of covariate) requires the regression model covariate *X* on the dependent variable *Y* that is linear (Garson, 2012). Regression linearity test showed by the test squares (Suyono, 2015). Influence of significance of regression test; intended to find out whether students' initial knowledge as a covariate *X* has a significant or no influence on biology learning outcomes as the dependent variable *Y*. This test was accomplished by testing the significance of regression coefficient $Y = a + bx$ using F-test with the criteria: H_0 was accepted if $F_{count} > F_{table}$ at the level $\alpha = 0.05$, and H_0 was rejected if $F_{count} < F_{table}$ at the level $\alpha = 0.05$, 3) inferential analysis, it was conducted to test the research hypothesis using Covariance Analysis (ANCOVA) (Kadir, 2016).

Results and Discussion

The results of the descriptive analysis of the research data taught with the project-based learning (A) model and discovery learning (B) were viewed in Table 1. Table 1 illustrates that, on average, biology learning outcomes of students that taught using the project-based learning (76.63) was higher than the discovery learning (73.37). Data of students' biology learning outcomes that taught using the project-based learning and the discovery learning were displayed in the histograms in Figure 2.

Table 1. Descriptive Analysis of Learning Models in Learning Outcomes in Terms of Initial Knowledge

Variable	Statistics											
	Data Total (n)		Average		Median		Minimum		Maximum		Standard Deviation	
	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
A	20	20	58.82	76.63	60.29	76.74	41.18	67.44	70.59	88.37	8.15	6.15
B	20	20	58.68	73.37	60.29	74.42	44.12	60.47	70.59	88.37	8.45	6.81

Where, *A*: Project-based learning, *B*: Discovery learning, *X*= Initial knowledge, *Y*= learning outcomes

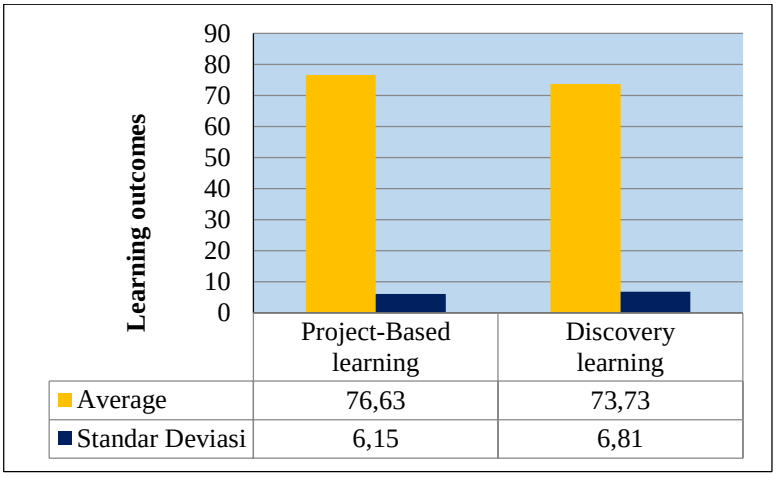

Figure 2. Histogram of the average score of students' biology learning outcomes that taught using project-based learning and discovery learning

In Figure 2, it was interpreted that there are differences in the average learning outcomes between students taught using project-based learning and students taught using discovery learning. To be more explicit about the differences between the two types of learning models used can be seen in Table 1. Next, the results of Lilliefors test (the normality test) of students' learning outcomes using Microsoft Excel 2010 presented in Table 2. From Table 2, the learning outcomes using the project-based model and the discovery model showed that the value of $L_{count} < L_{table}$,

it meant that the data usually normal distributed. Furthermore, the homogeneity analysis between two samples were analyzed using Microsoft Excel 2010, presented in Table 3.

Table 2. The Normality of Learning Outcomes

Variable	$L_{table\ (20;\ 0.05)}$	L_{count}	Information
Project-based learning (A)	0.190	0.168	Normal
Discovery learning (B)	0.190	0.110	Normal

Table 3. The Results of The Homogeneity Test

Variable	$F_{table\ (19,19;\ 0.05)}$	F_{count}	Information
Learning models	2.15	1.23	Homogenous

Table 3 provided the information that the variables (both learning models: project-based model and the discovery model) were non-different variance or homogeneous variance data with $F_{count} < F_{table}$. The next was the results of linearity of regression analysis, presented in Table 4.

Table 4. The results of The Regression Test: Linearity and Significance

Varian's	DK	JK	RJK	F_{count}	F_{table} ($\alpha = 0.05$)
Total	40	226708.93		-	-
Regression (a)	1	225003	225003		
Regression (b|a)	1	929.92	929.92	45.54	4.10
Residual	38	776.01	20.42		
Lack of fit	9	260.91	28.99	1.63	2.22
error	29	515.10	17.76		

DK: Degree of freedom; JK= Sum of squares; RJK: Average Sum of Squares

From the results of the analysis shown in Table 4 were obtained $F_{count}(b/a)= 45.54 > F_{table}= 4.10$ and F_{count} (Tc) = $1.63 < F_{table}= 2.22$. Thus, the initial knowledge as a covariate variable in this study influenced the learning outcomes, and its effect was linear. Next, to test the hypothesis of whether there was the influence of two models on learning outcomes by controlling the initial knowledge, ANCOVA analysis was used in SPSS 17. Its results presented in Table 5.

Table 5. The ANCOVA Results of Hypothesis Test
Tests of Between-Subjects Effects
Dependent Variable: learning outcomes

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1030.276[a]	2	515.138	28.210	0.000
Intercept	1199.045	1	1199.045	65.662	0.000
A*B	100.361	1	100.361	5.496	0.025
Initial Knowledge	924.261	1	924.261	50.614	0.000
Error	675.652	37	18.261		
Total	226708.928	40			
Corrected Total	1705.928	39			

a. R Squared = 0.604 (Adjusted R Squared = 0.583); A = Project-based leaning; B = Discovery learning

The result of ANCOVA test in Table 5, for the source of variance between project-based learning and discovery learning was obtained that the value of significance was $0.025 < \alpha\ 0.05$ (or $F_{count}= 5.496 > F_{table}= 4.06$). It showed that there was significant difference of biology learning outcomes between students that taught using the project-based learning and students taught using the discovery learning. It meant that there was the influence of the learning models on students' learning outcomes by controlling the initial knowledge. Based on Figure 2 and being emphasized by this result of ANCOVA test, students' biology learning outcomes that taught using the project-based learning were higher than students taught using the discovery learning after controlling the initial knowledge. Thus the project-based learning model applied in this study can

improve students' biology learning outcomes compared to the discovery learning model.

The results of this study reinforced Arcidiacono, Yang, Trewn, & Bucciarelli (2016) that project-based learning was a learning based on constructivist findings, the application centered on project development as a learning tool catalyzing knowledge discovery and having a significant influence on the quality and results of learning. Further Bagheri, Zah, Ali, Chong, Abdullah, & Daud (2013) and Dias & Brantley-Dias (2017*)* stated that students taught using project-based learning perform better and have independent learning abilities and help students to think critically in understanding knowledge more deeply to achieve expected goals.

In this learning model, students learn self through goal setting, planning, design, implement learning activities in real-life situations and students also develop social skills through the study of their collaboration to become intrinsically motivated to be encouraged to use the element of choice while learning at their level (Giri, 2016; Kokotsaki, Menzies & Wiggins, 2016). Another advantage of project-based learning is that students learn the base skills of communicating productively, respecting others, teamwork while generating ideas together, negotiating ways to solve problems collectively, and at the end of project activities, students evaluate activities that have done (Bell, 2010).

The result of the study by Afriana, Permanasari & Fitriani (2016) showed that the project-based learning (PjBL) model integrated with science, technology, engineering, and mathematics (STEM) can improve students' science literacy more significantly than in the control class. Project-based learning model is the approache that is preferred by students and increasing the level of learning. In addition, students' control of the learning process and its construction individually make the experience gained more valuable. In the context of renewal in the field of learning technology, project-based learning is perceived as an approach to create a learning environment that can encourage students to construct knowledge, attract student interest, think critically and achieve skills through direct experience (Miftari, 2014). Project-based learning supports 21st-century learning goals and a national curriculum that encourages student-focused learning activities (Thomas, 2000; Samsudin, Harun, Nordin, Haniza, & Abdul-Talib, 2014).

Furthermore, the source of variance for the initial knowledge in Tabel 5 was obtained that the value of significance was $0.000 < \alpha\ 0.05$ (or $F_{count} = 50.614 > F_{table} = 4.06$). It indicated that there was the influence of the initial knowledge on students' biology learning outcomes. This influence in this research was in line with the constructivist view that the new experience built on top of existing knowledge and constructivist ideas lead to four key principles of active learning, namely: 1) students construct their meaning, 2) new learning is built based on previous knowledge, 3) learning enhances with social interaction, and 4) learning develops with assignments (Genovese, 2003; Kudryashova & Rybushkina, 2016).

Many studies have proven that students' initial knowledge has a vital function in learning (Yuksel, 2012; Sirih, Ibrahim & Priyono 2019). The initial knowledge is one of the crucial prerequisites for learning, conceptualized as knowledge of students' relevant and dominant content with what they learn (Wang & Adesope, 2016; Sirih, & Ibrahim, 2019). The importance of building students' knowledge of core positions in contemporary learning theory, in educational research, has shown that what a person knows has tremendous impact on what can be remembered and studied before. According to Dick, Carey & Carey (2015), the entry skills are a set of skills students should have before they enter the new learning process, and the information of initial knowledge is relevant for development of new knowledge (Costley & West, 2012). Likewise, Keller (2010) and Kalyuga (2013) argued that the initial knowledge was the most important factor that influence the learning and identify the fundamental knowledge and the essential characteristics because it will have some significant influence on learning process.

Students' initial knowledge needs to be identified because it relates to

competence, ability, skills, and attitudes that have been mastered by students so that they can qualify for learning (Suparman, 2014). The level of students' competence and characteristic are very diverse or different from each other. These traits are expected to affect the level of success in achieving learning goals (Greedler, 2011). Therefore, the researchers assume in carrying out the learning process, it is essential to know students' characteristics and initial behavior before following the learning process. The characteristics and initial behaviors in question are knowledge, skills, and attitudes that have relevance to new knowledge that they learned. Misidentification without considering students' characteristics and initial knowledge can impact on learning ineffective.

Conclusion

There was significant difference of biology learning outcomes between students that taught using the project-based learning and students taught using the discovery learning (sig. 0.025 < α 0.05). It meant that there was the influence of the learning models on students' learning outcomes by controlling the initial knowledge. The average of students' biology learning outcomes that taught using the project-based learning was 76.63, it was higher than students taught using the discovery learning (73,37). In addition, there was the influence of the initial knowledge on students' biology learning outcomes (sig. 0.000 < α 0.05). The initial knowledge is one of the crucial prerequisites for learning, conceptualized as knowledge of students' relevant and dominant content with what they learn.

Acknowledgments

The authors would like to thank Senior High School 4 Kendari for facilitating the authors in conducting the research. The authors also thank University of Halu Oleo for the assistance doctoral scholarships given.

References

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Project Based Learning Integrated to STEM to Enhance Elementary School's Students Scientific Literacy. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 261–267. https://doi.org/10.15294/jpii.v5i2.5493

Arcidiacono, G., Yang, K., Trewn, J., & Bucciarelli, L. (2016). Application of Axiomatic Design for project-Based Learning Methodology. *Procedia CIRP*, *53*, 166–172. https://doi.org/10.1016/j.procir.2016.08.003

Arends, R. I. (2012). *Learning to Teach* (Ninth Ed.). New York: McGraw-Hill Education.

Bagheri, M., Zah, W., Ali, W., Chong, M., Abdullah, B., & Daud, S. M. (2013). Effects of Project-based Learning Strategy on Self-directed Learning Skills of Educational Technology Students. *Contemporary Educational Technology*, *4*(1), 15–29. Retrieved fromhttps://files.eric.ed.gov/fulltext/EJ1105523.pdf

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House*, *83*(2), 39–43. https://doi.org/10.1080/00098650903505415

Chiang, C. L., & Lee, H. (2016). The Effect of Project-Based Learning on learning Motivation and Problem-Solving Ability of Vocational High School Students. *International Journal of Information and Education Technology*, *6*(9), 709–712. https://doi.org/10.7763/IJIET.2016.V6.779

Costley, K. C., & West, H. G. (2012). Teaching Practice: A Perspective on Inter-text and Prior Knowledge. *SRATE Journal*, *21*(2), 21–25. Retrieved from https://files.eric.ed.gov/fulltext/EJ990632.pdf

Dick, W., Carey, L., & Carey, J. O. (2015). *The Systematic Design of Instruction* (Eighth Ed.). New Jersey: Pearson Education, Inc.

Garson, G. D. (2012). *Univariate GLM, ANOVA, & ANCOVA*. Asheboro, NC: Statistical Associates Publishers.

Genovese, J. E. C. (2003). Piaget, Pedagogy, and Evolutionary Psychology. *Evolutionary Psychology*, *1*, 127–137. https://doi.org/10.1177%2F147470490300100109

Giri, D. R. (2016). Project-Based Learning as 21st-Century Teaching Approach: A Study in Nepal Private School. *China Education Review*, *6*(8), 487-

497. https://doi.org/10.17265/2161-623X/2016.08.004

Greedler M. E. (2011). *Learning in Instruction: Theory and Practice*. (6th Edition). (Terjemahan Tri Wibowo, B.S). Jakarta: Kencana Perdana Media Group.

Kadir. (2016). *Statistik terapan. Konsep, Contoh dan Analisis Data dengan Program SPSS/Lisrel dalam Penelitian* (Edisi Kedua). Jakarta: Rajagrafindo Persada.

Kalyuga, S. (2013). Effects of learner Prior Knowledge and Working Memory Limitations on Multimedia Learning. *Procedia - Social and Behavioral Sciences*, *83*(1965), 25–29. https://doi.org/10.1016/j.sbspro.2013.06.005

Keller, J. M. (2010). *Motivational Design for Learning and Performance: The ARCH Model Approach*. New York: Springer Science.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-Based Learning: A Review of the Literature. *Improving Schools*, *19*(3), 267-277. https://doi.org/10.1177/1365480216659733

Kosasih, N. (2013). *Pembelajaran Quantum dan Optimalisasi Kecerdasan*. Bandung: Alfabeta.

Kudryashova, A., & Rybushkina, S. (2016). Teacher's Roles to Facilitate Active Learning. *Mediterranean Journal of Social Sciences MCSER Publishing*, *7*(1). 460-466. https://doi.org/10.5901/mjss.2016.v7n1p460.

Dias, M., & Brantley-Dias, L. (2017). Setting the Standard for Project Based Learning: A Proven Approach to Rigorous Classroom Instruction. *Interdisciplinary Journal of Problem-Based Learning*, *11*(2). https://doi.org/10.7771/1541-5015.1721

Miftari, I. (2014). Project-Based Learning: Developing 21st Century Collaborative and Technology Skills. *European Journal of Research on Education*, *2*, 52-57.

Păvăloiu, I.-B., Petrescu, I., & Dragomirescu, C. (2015). Interdisciplinary Project-Based Laboratory Works. *Procedia - Social and Behavioral Sciences*, *180*(November 2014), 1145–1151. https://doi.org/0.1016/j.sbspro.2015.02.230

Samsudin, M. A., Harun, A. H., Nordin, N., Haniza, N. H., & Abdul-Talib, C. (2014). The Effect of Online Project-Based Learning on Students' Attitudes towards Renewable Energy. *Malaysian Journal of Distance Education*, *16*(2), 39-57.

Sirih, M., & Ibrahim, N. (2019). The Effect of Learning Models and Spatial Intelligences to Biology Learning Outcomes by Controlling the Initial Knowledge. *International Journal of Learning, Teaching and Educational Research*, *18*(6), 20-38. https://doi.org/10.26803/ijlter.18.6.2

Sirih, M., Ibrahim, N., & Priyono (2019). Effect of Learning Models on Biology Learning Outcomes in Terms of Student Spatial Intelligence. *International Journal of Innovation, Creativity and Change (Special Edition: Science, Applied Science, Teaching and Education)*, *5*(3), 523-536. Retrieved from https://www.ijicc.net/images/Vol_5_Iss_3/31_Sirih_P534_2019R.pdf

Suparman, A. (2014). *Desain Instruksional Modern: Panduan Pengajar dan Inovator Pendidikan*. Jakarta: Penerbit Erlangga.

Suyono. (2015). *Analisis Regresi untuk Penelitian*. Yogyakarta: Deepublish.

Thomas, J. W. (2000). A review of research on project-based learning. San Rafael, CA: Autodesk Foundation. Retrieved fromhttp://www.bobpearlman.org/BestPractices/PBL_Research.pdf

Wekesa, N. W., & Ongunya, R. O. (2016). Project Based Learning on Students' Performance in the Concept of Classification of Organisms among Secondary Schools in Kenya. *Journal of Education and Practice*, *7*(16), 25–31. Retrieved from https://eric.ed.gov/?id=EJ1105278

Wang, Z. (J.), & Adesope O. (2016). Does Learners' Prior Knowledge Moderate the Detrimental Effects of Seductive Details in Reading From Text? A 2 by 3 Study. *International Journal of Instruction*, *9*(2), 35–50. https://doi.org/10.12973/iji.2016.923a

Yuksel, I. (2012). Activating students' prior knowledge: the core strategies. *World Applied Sciences Journal*, *20*(8), 1197–1201. Retrieved from https://www.idosi.org/wasj/wasj20(8)12/21.pdf