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The Influence of Project-based Learning to Empower Students' Cognitive Abilities

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ABSTRACT: This research aimed to describe the influence of *project-based learning* (PjBL) on the cognitive abilities of students. The research method used an experimental design. The samples were classified into two studies and collected in a non-randomized manner. The subjects were the students of the first semester in FKIP Universitas Muhammadiyah Surabaya who was programming Indonesian course. The research data was collected by using tests to test cognitive abilities or learning outcomes. The data was then analyzed descriptively, especially against the mean and its standard deviation. Before the statistical test, a check was carried out on the normality and uniformity of the data. The next step is the analysis of MANOVA. Based on the results of the discussion, it can be concluded that the value of F calculating cognitive ability was 21,836 with a significance level of 0.000. There was a significant influence of the project-based learning model on cognitive abilities between the experimental group and the control group. Therefore, Ho was rejected because there was an influence on students' cognitive abilities or learning outcomes. Thus, the hypothesis of this research was proven. The results showed that there was an influence of project-based learning models on cognitive abilities, in this case student learning outcomes

KEYWORDS: Project-based Learning, cognitive ability, critical thinking, high school, collaborative

I. INTRODUCTION

Information technology and science continue to develop dynamically. Previously some activities took place conventionally. Today almost all fields cannot be separated from digitization. The use of data becomes unlimited. All of that is happening along with the rapid development of the internet network. In addition, digital-based technology is developing massively. This industrial era indirectly disrupts various human activities. No exception is the development of the world of science, technological progress, the dynamization of higher education (Laal et al., 2012; Laal & Laal, 2012).

The industrial revolution 4.0 and social society 5.0 play a very important role in accelerating this development (Mahajan et al., 2021; Koes-H & Princess, 2021). Almost the entire human life cannot be separated from the dynamism of science, technology, and information (Suherman et al., 2020; Yunita et al., 2021). Indirectly, the community must be able to harmonize themselves. Progress in the economic field and various problems must also be able to find solutions in an integrated manner. The advancement of the internet and everyday reality are inseparable. The two combines into one unit

Education stakeholders need to collaborate to find and determine strategies to deal with these conditions (Romero & Molina, 2011). Thus, the educational process must be revolutionized to shape the proficiency of the students in the 21st century. With the proficiency of the century, citizens will be able to be competitive at the national and international levels (Wang, 2015; Zhao et al., 2015).

The results of a research are definitely directed at acquiring high-level cognitive skills. If new achievements are achieved at a low cognitive level, the impact can be less positive. The students can be individualistic. They lack tolerance and cooperation (Chu et al., 2011; Steinberg, 2005). For this reason, educators really need to pay attention to the needs of students to be smart, critical, and creative. The students are also expected to work together to address the problems faced on a daily basis.

However, today's learning process seems to be more focused on learning what and how to be (Braver, 2012; Wang, 2015). The usability value of learning is difficult to build. The purpose of studying is also just to seek high scores. Furthermore, they tend to value the ego of a personal individual (Basilotta Gómez-Pablos et al., 2017; Hofmann et al., 2012). This condition can usually last until they are adults. As a result, they can find it difficult to get along and cooperate with other people or the community in their environment. Therefore, learning outcomes oriented to a high level of cognitive dimensions are a necessity. The acquisition of skills in the field of analysis, synthesis, evaluation, affective and psychology should be an integral block (Bennett & Gadlin, 2012; Chiong & Jovanovic, 2012).

Model learning that aims to improve skills, among others, project-based learning. This old learning model remains relevant to be applied today because it contains several advantages (Alloway & Elsworth, 2012; Kettanun, 2015). For this reason, project-

based learning can be applied to improve the quality of learning skills (Kok et al., 2021; Van de Weijer-Bergsma & Van der Ven, 2021). Among other things, students are required to be able to design and complete their learning tasks. They must be able to make planners, set schedules, streamline negotiations, and have responsibilities. With this learning model, students have the opportunity to reflect on the dynamism of reality in society (Grønlien et al., 2021; Liu et al., 2016).

Project-based learning can also be utilized to improve reflective thinking skills. With a way of deliberation and good reasoning, it is hoped that students will overcome their duties (Mulyadi et al., 2021; Sart, 2014). The application of project-based learning can guide students to hone their competence to overcome a learning problem. The problems of everyday scientific reality can be approached with a project-based learning model. Indirectly, this will encourage students to achieve maximum learning outcomes (Loes & Pascarella, 2017; Ríos et al., 2010). The ability to think at a high level and reason rationally coupled with collaborative efforts can create a conducive academic environment. Learning also has a hand in strengthening values. The provision of tasks that are contextual, at least to innovate students in order to solve various reality problems. If this is the case, indirectly their learning outcomes meet the requirements for obtaining the ability to understand the problem of their duties (Gavin, 2011; Loes & Pascarella, 2017; Ríos et al., 2010; Tascı, 2015).

Learning outcomes are a picture of an individual's final competence after undergoing learning. Therefore, optimizing various factors that affect learning outcomes really needs to be considered (Nasution & Lubis, 2019). A factor that cannot be ignored today is the use of the technology of disambiguation. It has an important role to improve the quality of teachings. The appropriate incorporation of materials, pedagogy and technology will increase learning motivation. Indirectly, the cognitive competence of the learner will increase as well. (Orús et al., 2016).

In today's digital era, educators must be willing to change. It is necessary to pilot contextual, innovative, and interesting learning so that students are motivated to study hard. Wygal & Stout (Saptono et al., 2020) outlines several determinants of the effectiveness of learning. These include learning and practice environments, attention, preparation and management, teaching commitment, and design of learning environments. As a learning facilitator, lecturers are able to deliver students to learning outcomes (Saptono et al., 2020). The results of the study are in line with the results of the Murnane and Gamini an studies (Murnane et al., 2014). It concluded that the improvement of learning outcomes in developing countries must be balanced with the intensity of pedagogical practice. In addition, in order for learning outcomes to improve, seminars, workshops, or strengthening empathy programs are needed about differences in the character of educators (Araujo et al., 2016).

Learning outcomes are a change in behavior. The form is in the form of knowledge, skills, and attitudes. This is the result of learning activities. Therefore, learning outcomes are an achievement after learning (Edrizal et al., 2018). Learning outcomes are in the form of grades and are measured by tests. A person can be said to be successful if he has reached the criteria set in learning (Susanti, 2014).

Related to the concept of changing knowledge, processes, and cognitive end results has been put forward in the writings of Michelene T. H. Chi (2009). Cognitive results it is associated with the way of learning the initial information and the alteration of knowledge that occurs (Chi & Wylie, 2014). This statement proves the existence of a link between interactivity and learning. Assessment of learning outcomes refers more to the output of the process, not to the process itself. This means that learners are expected to be able to answer exam questions correctly by memorizing learning materials so that their learning outcomes reach the target (Kent et al., 2016).

Project-based learning applications are possible to help students to think at a higher level. The ability to think rationally is also necessary when entering life in society. In this project-based learning, students work on their respective group assignments. Therefore, it is necessary to cooperate with each other to find a solution to the problem. In this regard, the lecturers can provide feedback on ways to solve problems(Lavrijsen et al., 2021; Stolte et al., 2019). So, in accordance with the objectives of project-based learning, students will be guided to observe, explore, and evaluate tasks contextually and comprehensively. Indirectly, psychomotor aspects can be well-categorized (Kazemi et al., 2012; Ogawa et al., 2020).

II. METHODS

A. Design

This research was designed using factorial experiments. The construction of factorial experiments is a simultaneous act of engineering. This research used pseudo-experiments to test the relationship of one variable to another. The selected samples were divided into experimental groups and control groups. For this reason, the research sample was not determined randomly, but adjusted to the variables studied. This type was included in the experimental research of nonequivalent control group design. Based on experiments on non-equivalent control groups used, the main effects and interactions between variables can be interpreted.

B. Participants

Variables were quantifiable characters of individuals or organizations (Supratics, 2015). For that, a variable must have a different variation of values or categories (Johnson & Christensen, 2014); (Siyoto & Sodik, 2015). Variables can also be referred to as

variations in attributes, traits, or values of people, objects, or activities that were determined to be inferred (Sugiyono, 2019). In the field of education, examples of variables were intelligence, learning outcomes, skills, attitudes, and so on. Learning outcomes are variables because they have different values for each individual.

In quantitative research, variables consisted of free and bound variables. A free or independent variable was an influencing or preceding a bound variable. Whereas bound or dependent variables can be influenced or bonded by free variables. It is the relationship between the two variables that was used for the formulation of the hypothesis (Priyono, 2008); (Hardani et al., 2020).

In this research, project-based learning as a free variable, cognitive style as a moderator variable, and cognitive ability or learning outcomes as a bound variable. The research was conducted at the Faculty of Teacher Training and Education, Universitas Muhammadiyah Surabaya that had taken compulsory Indonesian course in the first semester? Several methods were used to collect research data. The data was obtained by two steps. First, pre-test and post-test. The tests were carried out to determine the student's understanding as well as the uniformity and normality of the sample. The post-test was carried out to find out the differences in the understanding of the students of the experimental and control groups. Second, questionnaire which was used to obtain data on the project-based learning process as well as field-dependent and field-independent cognitive styles of students.

C. Data Collection

The validity of the test was of high value if its functions to measure and produce the results of the test objectives. To test the validity that used product-moment correlation and significance level of 0.05. The data was said to be meaningful and useful if it can measure the values of variables and represent each research questionnaire. Furthermore, the calculation r product moment compared with the value in r table. If the value of r counts more than the value of r table, then the data was valid.

Furthermore, it was necessary to test the reliability. This stage was carried out to determine the accuracy, stability, and accuracy of research instruments. Examination r of instrument reliability used the SPSS application program, in particular measurements based on the Cronbach alpha coefficient. If the score of the Cronbach alpha counting results showed a $\geq$ value of 0.60, the instrument device was already reliable. However, if the score $\leq$ 0.60, the instrument device needed to be reviewed. Therefore, the purpose of uji reliability found out the level of reliability of research measuring instruments. If reliable, the research results already met scientific research standards.

D. Data Analysis

The analysis was conducted with the SPSS Version 21 application program. This program was used to find the average and standard deviation of pre-test and posttest scores about learning outcomes. This research was linked to project-based learning-free variables. Before the variable data bound to the student's learning value was tested statistically that was necessary to test normality and homogeneity. Normality test to describe that the research data is normally distributed. Uji normality was carried out by the formula Kolmogorov-Smirnov. Meanwhile, the homogeneity test is used to determine the uniformity of variables. The data was homogeneous if the result of calculating the probability (p) exceeds the number 0.05.

Data on learning outcomes were obtained from the post-test. Then, the influence of project-based learning on cognitive ability or student learning outcomes was analyzed using the Multivariate Analysis of Variance (MANOVA) statistical test. This technique was also used to describe the interaction between a free and bound variable. The question of the influence between variables used a significance level of 5% or =0.05. ∂

III.RESULT AND DISCUSSION

Learning with a project-based learning model gave students the opportunity to deepen the path material. In addition, the potential of students can be honed to make observations and explorations. With the post-Pandemic Covid-19 conditions, the project-based learning model can be applied online. For this reason, research in Universitas Muhammadiyah Surabaya was carried out online. However, control class learning was held offline while maintaining health protocols. The learning process used e-learning in Universitas Muhammadiyah Surabaya. Therefore, the learning can still take place. The appearance of e-learning was like on the https://elearning.um-surabaya.ac.id/ page.

Before the treatment was held the pretest. The goal obtained an overview of the research sample. Therefore, the pretest was used to describe the initial competence of the respondent. Hasil *pretest* the cognitive abilities of students appear as in the table below.

Table 1. Descriptive analysis of pretest data on learning outcomes

	Class	N	Mean	Std. Deviation	Std. Error Mean
Learning Outcome	Experiment	66	67.05	5.076	.625
pretest	Control	64	63.45	6.071	.759

Based on the data in table 1, it was known that the pretest results of the research results of the experimental group students showed an average of 67.05 and a standard deviation of 5.076. Meanwhile, the control group showed an average of 63.45 and a standard deviation of 6.071. The steps performed before the t-test are testing the normality of the data and testing the homogeneity of the data as a requirement for the analysis of the t-test. Based on the normality and homogeneity test of pretest data on learning outcomes obtained data from the normality test of *pretest* data on learning outcomes with the Kolmogorov-Smirnov test, a significant number (sig) of 0.87 was obtained. Because this result was greater than 0.05, both groups of *pretest* data have a distribution normally. The results of the test with Levine's Test on the basis of the average obtained significance (sig) of 0.66 > 0.05. Therefore, pretest data on student learning outcomes were also declared homogeneous. After the pretest data was found to be normally distributed and had homogeneous variance, a t-test analysis of two independent samples was held against the pretest data. The elaboration of the t-test analysis can be seen in the table below.

Table 2. Results of Pretest Analysis of Independent Test Cognitive Ability Test Sample

		Levine's Test for Equality of Variances		t-test for Equality of Means						
		F	Itself.	t	D	Sig.(2-tailed)	Mean Difference	Std. Difference	Error	95% Confidence Interval of the Difference Lower	Upper
Learning outcomes pretest	Equal variances assumed	.451	.066	3.665	128	.216	.592	.980		1.653	5.532
	Equal variances not assumed			3.654	122.713	.204	3.592	.983		1.647	5.538

Based on table 2, the results of the independent sample test t-test analysis showed a figure of 0.216 (sig > 0.05). It showed that the initial learning outcomes of the experimental group and the control group did not have significant differences. Thus, there were no differences in the two groups. It was the abilities of both groups are the same in learning outcomes. The results of this research needed to be described to interpret the research data that had been obtained. The first step of data description was data tabulation which included learning outcomes data. After tabulating the data, the next step was to test normality and homogeneity as a test of analysis requirements. After the learning outcomes data had a normal distribution with homogeneous variants, a hypothesis test was carried out using MANOVA statistics. The descriptive results of the research were presented as in table 3 below.

Based on the data in table 3, it can be seen that the learning outcomes with an independent field cognitive style, the average value of the experimental class is 90.85. The cognitive style of the field dependent average value of the control class was found to be 78.69. Thus, the learning outcome value of the experimental class was higher than that of the control class with a difference of 12.16. The results of the data normality test from Kolmogorov-Smirnov found that the significance value of collaborating skills was 0.625. While the learning outcome was 0.173. Since the significance value was more than 0.05, it can be concluded that the data was normally distributed.

Homogeneity tests were carried out to find similarities or differences in variants of research data groups. It can be interpreted that homogeneity is the set of data studied having a character equality. The homogeneity test was applied to data on the learning outcomes of groups of students who were treated with Google Classroom-based project-based learning. The group of students of field independent cognitive style and field dependent cognitive style was carried out using the Levence Test with a significance level of 0.05. The hypothesis tested was the null hypothesis (Ho) which stated that the variance in each group was the same (homogeneous). Acceptance or rejection was based on: (1) if the significance or probability obtained > 0.05, the variance of each sample was the same (homogeneous). Acceptance or rejection was based on if the significance or probability obtained > 0.05, the variance of each sample was homogeneous. If the significance or probability value obtained <0.05, the variance of each sample was not the same (inhomogeneous). The result of the calculation was illustrated in the following table.

Table 3. Descriptive Analysis of Learning Outcomes

	Project Based Learning	Cognitive Style	Mean	Std. Deviation	N
Learning outcome	Google Classroom	Field Independent	90.85	3.919	66
		Total	90.85	3.919	66
	LMS	Field Dependent	78.69	10.671	64
		Total	78.69	10.671	64
	Total	Field Independent	90.85	3.919	66

Field Dependent	78.69	10.671	64
Total	84.86	10.030	130

Table 4. Homogeneity Test Results learning outcomes

Levine's Test of Equality of Error Variances

	F	df1	df2	Itself.
Learning Outcomes	2.764	1	128	.275

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Table 4 of the variance homogeneity test above showed that based on the average learning outcomes data obtained levene test of 0.275 significance. Since the significance level of the > 0.05, a conclusion can be drawn that learning outcomes are homogeneous. The MANOVA test required a condition that the matrix of variants or covariances of dependent variables must be the same. Homogeneity tests of the variant matrix were observed based on the results of the box test. The calculation results showed a > 0.05. That was, the matrix of dependent variables had something in common. Therefore, manova analysis was actionable. After the normality and homogeneity test and the data were declared to be normally distributed, and have homogeneous variants, the next step was to test the research hypothesis with the MANOVA test. The results were presented in the following table.

MANOVA Multivariate test and the test of between subject effects, the statistical test above the hypothesis of this research was declared proven. The results of data calculations to test the influence of the project-based learning model on student learning outcomes in compulsory courses Indonesian FKIP showed the value of the learning model, namely Pillai's Trace 0.218, Wilks' Lambda 0.941, Hotelling's Trace 0.312 and Roy's argest Roots 0.312. The value is equivalent to a calculated F value of 27.028 and a significance of 0.000. It meant that the project-based learning model affects student learning outcomes when taking compulsory courses Indonesian FKIP. This condition was confirmed by the calculation of the MANOVA Test Between-Subjects Effects. The calculated F value was 21.836, while the significance value was 0.000. Thus, it can be concluded that Ho was rejected because there was a significant influence of learning outcomes between the experimental and control groups. Thus, the hypothesis was stated to be proven.

Based on the results of the MANOVA Test Between Effects analysis, it was known that the calculated F value was 27.028, while the significance value was 0.000. The score proved the influence of the project-based learning model on student learning outcomes. This was based on pretest and posttest result data. The average value of the experimental group's learning outcomes was higher than that of the control group. ForeignM-67.05 and 63.45, respectively, with a difference of 3.6. Based on these findings, it can be concluded that the application of a Project-based learning model based on Google Classroom has a better influence on student learning outcomes than control classes (Kettanun, 2015).

The Google Classroom-based project-based learning model was one of the platforms that can help the student learning process and facilitate supervision from lecturers. The concept of this learning model was that materials, videos and other sources were sent through the platform. In addition, there is a reminder for students about the deadline for the project. Supervision was also easy to do (Kwan & Wong, 2015; Lavrijsen & Verschueren, 2020). This can be interpreted to mean that project-based learning played an important role in improving students' cognitive competence. The results of the research stated that project-based learning can significantly increase cognitive competence (Mulyadi et al, 2021; Stolte et al, 2019).

Table 5. Hasil Uji MANOVA Test of Between Subject Effects

Tests of Between-Subjects Effects							
Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Itself.	Partial Eta Squared
Corrected Model	Learning outcomes	4805.273[b]	1	4805.273	75.264	.000	.370
Intercept	Learning outcomes	933908.534	1	933908.534	14627.613	.000	.991
Project Based Learning	Learning outcomes	5629.458	2	17976.000	21.836	.000	.761
Cognitive Styles	Learning outcomes	3464.836	1	3328.000	72.826	.000	.243
Project Based Learning * Cognitive Styles	Learning outcomes	5346.375	1	254.000	126.397	.000	.072
Error	Learning outcomes	8172.235	128	63.846			

Total	Learning outcomes	949170.000	130				
Corrected Total	Learning outcomes	12977.508	129				
a. R Squared = .675 (Adjusted R Squared = .603)							
b. R Squared = .724 (Adjusted R Squared = .629)							

Referring to the above presentations, it can be said that project-based learning provided valuable experience to students. The mechanism of a project, the allocation of time, human resources, equipment, and materials must be properly managed in order for the task to be completed (Braver, 2012; Suherman et al., 2020; Wang, 2015). This was in accordance with the opinion of Chaijum & Hiranyachattada (2020) that project-based learning can improve cognitive competence or student learning outcomes. Then student learning outcomes were the final assessment of learning based on the process and introduction that had taken place repeatedly. In addition, learning outcomes participate in shaping individual characteristics to obtain better results. It can also change the mindset and create better performance as well (Alloway & Elsworth, 2012; Lavrijsen & Verschueren, 2020). Learning outcomes become the object of class assessment in the form of new competencies obtained by students after undergoing a certain learning process (Kazemi et al., 2012; Lim & Richardson, 2020).

IV. CONCLUSIONS

It had a result of the MANOVA Test Between-Subject Effects analysis showed that the calculated F value was 21.836 and the significance was 0.000. It proved the influence of the project-based learning model on cognitive competence or student learning outcomes in compulsory courses Indonesian FKIP, Universitas Muhammadiyah Surabaya. Thus, the project-based learning (PJBL) model was able to improve the cognitive abilities of students in Universitas Muhammadiyah Surabaya in compulsory courses Indonesian

REFERENCES

1) Alloway, T. P., & Elsworth, M. (2012). An investigation of cognitive skills and behavior in high ability students. *Learning and Individual Differences*, *22*(6), 891–895. https://doi.org/10.1016/j.lindif.2012.02.001
2) Araujo, M. C., Carneiro, P., Cruz-Aguayo, Y., & Schady, N. (2016). Teacher Quality and Learning Outcomes in Kindergarten. *The Quarterly Journal of Economics Advance*, *202*, 1–39. file:///Users/ManojAtolia/AppData/Local/Mendeley Ltd./Mendeley Desktop/Downloaded/Ludema, Mayda, F - 2013 - an us cr ip t Ac ce pt.pdf
3) Basilotta Gómez-Pablos, V., Martín del Pozo, M., & García-Valcárcel Muñoz-Repiso, A. (2017). Project-based learning (PBL) through the incorporation of digital technologies: An evaluation based on the experience of serving teachers. *Computers in Human Behavior*, *68*, 501. https://doi.org/10.1016/j.chb.2016.11.056
4) Bennett, L. M., & Gadlin, H. (2012). Collaboration and team science: From theory to practice. *Journal of Investigative Medicine*, *60*(5), 768–775. https://doi.org/10.2310/JIM.0b013e318250871d
5) Braver, T. S. (2012). The variable nature of cognitive control: A dual mechanisms framework. *Trends in Cognitive Sciences*, *16*(2), 106–113. https://doi.org/10.1016/j.tics.2011.12.010
6) Chaijum, N., & Hiranyachattada, T. (2020). Integrated learning and project-based learning for project of electrical measurement and instrumentations in electrical engineering course. *European Journal of Science and Mathematics Education*, *8*(1), 6–11. https://doi.org/10.30935/scimath/9543
7) Chi, M. T. H. (2009). Active-Constructive-Interactive: A Conceptual Framework for Differentiating Learning Activities. *Topics in Cognitive Science*, *1*(1), 73–105. https://doi.org/10.1111/j.1756-8765.2008.01005.x
8) Chi, M. T. H., & Wylie, R. (2014). The ICAP Framework: Linking Cognitive Engagement to Active Learning Outcomes. *Educational Psychologist*, *49*(4), 219–243. https://doi.org/10.1080/00461520.2014.965823
9) Chiong, R., & Jovanovic, J. (2012). Collaborative learning in online study groups: An evolutionary game theory perspective. *Journal of Information Technology Education:Research*, *11*(1), 81–101. https://doi.org/10.28945/1574
10) Chu, S. K. W., Tse, S. K., & Chow, K. (2011). Using collaborative teaching and inquiry project-based learning to help primary school students develop information literacy and information skills. *Library and Information Science Research*, *33*(2), 132–143. https://doi.org/10.1016/j.lisr.2010.07.017
11) Edrizal, Fardi, A., & Emral. (2018). Hubungan Antara VO2max Dengan Hasil Belajar Siswa. *Sport Science*, *18*(1), 10–20. https://doi.org/10.24036/jss.v18i1.13
12) Gavin, K. (2011). Case study of a project-based learning course in civil engineering design. *European Journal of Engineering Education*, *36*(6), 547–558. https://doi.org/10.1080/03043797.2011.624173
13) Grønlien, H. K., Christoffersen, T. E., Ringstad, Ø., Andreassen, M., & Lugo, R. G. (2021). A blended learning teaching

strategy strengthens the nursing students' performance and self-reported learning outcome achievement in an anatomy, physiology and biochemistry course – A quasi-experimental study. *Nurse Education in Practice*, *52*(April). https://doi.org/10.1016/j.nepr.2021.103046

14) Hardani, Andriani, H., Ustiawaty, J., Utami, E. F., Istiqomah, R. R., Fardani, R. A., Sukmana, D. J., & Auliya, N. H. (2020). *Metode Penelitian Kualitatif & Kuantitatif*. Yogyakarta: CV Pustaka Ilmu Group.
15) Hofmann, S. G., Asnaani, A., Vonk, I. J. J., Sawyer, A. T., & Fang, A. (2012). The efficacy of cognitive behavioral therapy: A review of meta-analyses. *Cognitive Therapy and Research*, *36*(5), 427–440. https://doi.org/10.1007/s10608-012-9476-1
16) Johnson, R. B., & Christensen, L. (2014). *Educational Research, Quantitative, Qualitative, and Mixed Approaches* (5th ed.). Sage Publications.
17) Kazemi, F., Yektayar, M., & Abad, A. M. B. (2012). Investigation the impact of chess play on developing meta-cognitive ability and math problem-solving power of students at different levels of education. *Procedia - Social and Behavioral Sciences*, *32*(Iccs 2011), 372–379. https://doi.org/10.1016/j.sbspro.2012.01.056
18) Kent, C., Laslo, E., & Rafaeli, S. (2016). Interactivity in online discussions and learning outcomes. *Computers and Education*, *97*, 116–128. https://doi.org/10.1016/j.compedu.2016.03.002
19) Kettanun, C. (2015). Project-based Learning and Its Validity in a Thai EFL Classroom. *Procedia - Social and Behavioral Sciences*, *192*, 567–573. https://doi.org/10.1016/j.sbspro.2015.06.094
20) Koes-H, S., & Putri, N. D. (2021). The Effect of Project-Based Learning in STEM on Students' Scientific Reasoning. *Journal of Physics: Conference Series*, *1835*(1). https://doi.org/10.1088/1742-6596/1835/1/012006
21) Kok, M., Kal, E., van Doodewaard, C., Savelsbergh, G., & van der Kamp, J. (2021). Tailoring explicit and implicit instruction methods to the verbal working memory capacity of students with special needs can benefit motor learning outcomes in physical education. *Learning and Individual Differences*, *89*(June), 102019. https://doi.org/10.1016/j.lindif.2021.102019
22) Kwan, Y. W., & Wong, A. F. L. (2015). Effects of the constructivist learning environment on students' critical thinking ability: Cognitive and motivational variables as mediators. *International Journal of Educational Research*, *70*, 68–79. https://doi.org/10.1016/j.ijer.2015.02.006
23) Laal, M., & Laal, M. (2012). Collaborative learning: What is it? *Procedia - Social and Behavioral Sciences*, *31*(2011), 491–495. https://doi.org/10.1016/j.sbspro.2011.12.092
24) Laal, M., Laal, M., & Kermanshahi, Z. K. (2012). 21st Century Learning; Learning in Collaboration. *Procedia - Social and Behavioral Sciences*, *47*, 1696–1701. https://doi.org/10.1016/j.sbspro.2012.06.885
25) Lavrijsen, J., Preckel, F., Verachtert, P., Vansteenkiste, M., & Verschueren, K. (2021). Are motivational benefits of adequately challenging schoolwork related to students' need for cognition, cognitive ability, or both? *Personality and Individual Differences*, *171*(October 2020), 110558. https://doi.org/10.1016/j.paid.2020.110558
26) Lavrijsen, J., & Verschueren, K. (2020). Student characteristics affecting the recognition of high cognitive ability by teachers and peers. *Learning and Individual Differences*, *78*(June 2019), 101820. https://doi.org/10.1016/j.lindif.2019.101820
27) Lim, J., & Richardson, J. C. (2020). Predictive effects of undergraduate students' perceptions of social, cognitive, and teaching presence on affective learning outcomes according to disciplines. *Computers & Education*, 104063. https://doi.org/10.1016/j.compedu.2020.104063
28) Liu, X., Shi, Y., Niu, B., Shi, Z., Li, J., Ma, Z., Wang, J., Gong, P., Zheng, A., Zhang, F., Gao, X., & Zhang, K. (2016). Polymorphic variation in CHAT gene modulates general cognitive ability: An association study with random student cohort. *Neuroscience Letters*, *617*, 122–126. https://doi.org/10.1016/j.neulet.2016.02.002
29) Loes, C. N., & Pascarella, E. T. (2017). Collaborative Learning and Critical Thinking: Testing the Link. *Journal of Higher Education*, *88*(5), 726–753. https://doi.org/10.1080/00221546.2017.1291257
30) Mahajan, H., Naik, S. M., Sreeramulu, M., Kannaiah, C., & Majeedullah, S. (2021). Impact of project-based learning for improving students skills by incorporating design thinking process. *Journal of Engineering Education Transformations*, *34*(Special Issue), 243–249. https://doi.org/10.16920/jeet/2021/v34i0/157150
31) Mulyadi, M., Tonapa, S. I., Rompas, S. S. J., Wang, R. H., & Lee, B. O. (2021). Effects of simulation technology-based learning on nursing students' learning outcomes: A systematic review and meta-analysis of experimental studies. *Nurse Education Today*, *107*(September), 105127. https://doi.org/10.1016/j.nedt.2021.105127
32) Murnane, R. J., Ganimian, A. J., Trongé, M. Á., Barrera-osorio, F., Beuermann, D., Bruns, B., Deming, D., Fiszbein, A., Guaqueta, J., Hill, H., Lisman, M., Llach, J., Narodowski, M., Ñopo, H., Oliveira, J. B., Puryear, J., & Sánchez, A. (2014). Improving Educational Outcomes in Developing Countries : *NBER Working Paper Series*.
33) Nasution, E. Y. P., & Lubis, F. H. (2019). Meningkatkan aktivitas dan hasil belajar siswa melalui model pembelajaran kooperatif tipe jigsaw berbasis algebrator. *Pythagoras*, *8*(2), 82–92.

34) Ogawa, K., Kawamura, T., & Matsushita, K. (2020). Effects of cognitive ability and age on giving in dictator game experiments. *Research in Economics*, *74*(4), 323–335. https://doi.org/10.1016/j.rie.2020.10.002
35) Orús, C., Barlés, M. J., Belanche, D., Casaló, L., Fraj, E., & Gurrea, R. (2016). The effects of learner-generated videos for YouTube on learning outcomes and satisfaction. *Computers and Education*, *95*, 254–269. https://doi.org/10.1016/j.compedu.2016.01.007
36) Priyono. (2008). *Metode Penelitian Kuantitatif*. Sidoarjo: Zifatama Publishing.
37) Ríos, I. D. L., Cazorla, A., Díaz-Puente, J. M., & Yagüe, J. L. (2010). Project-based learning in engineering higher education: Two decades of teaching competences in real environments. *Procedia - Social and Behavioral Sciences*, *2*(2), 1368–1378. https://doi.org/10.1016/j.sbspro.2010.03.202
38) Romero, D., & Molina, A. (2011). Collaborative networked organisations and customer communities: Value co-creation and co-innovation in the networking era. *Production Planning and Control*, *22*(5–6), 447–472. https://doi.org/10.1080/09537287.2010.536619
39) Saptono, L., Soetjipto, B. E., Wahjoedi, & Wahyono, H. (2020). Role-playing model: Is it effective to improve students' accounting learning motivation and learning achievements? *Cakrawala Pendidikan*, *39*(1), 133–143. https://doi.org/10.21831/cp.v39i1.24781
40) Sart, G. (2014). The Effects of the Development of Metacognition on Project-based Learning. *Procedia - Social and Behavioral Sciences*, *152*, 131–136. https://doi.org/10.1016/j.sbspro.2014.09.169
41) Siyoto, S., & Sodik, M. A. (2015). *Dasar Metodologi Penelitian*. Karanganyar: Literasi Media Publishing.
42) Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends in Cognitive Sciences*, *9*(2), 69–74. https://doi.org/10.1016/j.tics.2004.12.005
43) Stolte, M., Kroesbergen, E. H., & Van Luit, J. E. H. (2019). Inhibition, friend or foe? Cognitive inhibition as a moderator between mathematical ability and mathematical creativity in primary school students. *Personality and Individual Differences*, *142*(June), 196–201. https://doi.org/10.1016/j.paid.2018.08.024
44) Sugiyono. (2019). *Metode Penelitian Kuantitatif, Kualitatif dan R & D*. Bandung: Alfabeta.
45) Suherman, Prananda, M. R., Proboningrum, D. I., Pratama, E. R., Laksono, P., & Amiruddin. (2020). Improving Higher Order Thinking Skills (HOTS) with Project Based Learning (PjBL) Model Assisted by Geogebra. *Journal of Physics: Conference Series*, *1467*(1). https://doi.org/10.1088/1742-6596/1467/1/012027
46) Supratiknya, A. (2015). *Metodologi Penelitian Kuantitatif & Kualitatif dalam Psikologi*. Yogyakarta: Universitas Sanata Dharma.
47) Susanti, R. (2014). Pembelajaran model examples non examples berbantuan powerpoint untuk meningkatkan hasil belajar IPA. *Jurnal Pendidikan IPA Indonesia*, *3*(2), 123–127. https://doi.org/10.15294/jpii.v3i2.3110
48) Tascı, B. G. (2015). Project Based Learning from Elementary School to College, Tool: Architecture. *Procedia - Social and Behavioral Sciences*, *186*, 770–775. https://doi.org/10.1016/j.sbspro.2015.04.130
49) Van de Weijer-Bergsma, E., & Van der Ven, S. H. G. (2021). Why and for whom does personalizing math problems enhance performance? Testing the mediation of enjoyment and cognitive load at different ability levels. *Learning and Individual Differences*, *87*, 101982. https://doi.org/10.1016/j.lindif.2021.101982
50) Wang, Y. C. (2015). Promoting collaborative writing through wikis: a new approach for advancing innovative and active learning in an ESP context. *Computer Assisted Language Learning*, *28*(6), 499–512. https://doi.org/10.1080/09588221.2014.881386
51) Yunita, Y., Juandi, D., Kusumah, Y. S., & Suhendra, S. (2021). The effectiveness of the Project-Based Learning (PjBL) model in students' mathematical ability: A systematic literature review. *Journal of Physics: Conference Series*, *1882*(1). https://doi.org/10.1088/1742-6596/1882/1/012080
52) Zhao, D., McCoy, A. P., Bulbul, T., Fiori, C., & Nikkhoo, P. (2015). Building Collaborative Construction Skills through BIM-integrated Learning Environment. *International Journal of Construction Education and Research*, *11*(2), 97–120. https://doi.org/10.1080/15578771.2014.986251