

Project-Based Learning: Enhancing the Psychomotor Domain of Vocational School Students Reviewed Collaboration Skills

Deni A. Sucahya^{1,*} Muhaji Muhaji² Euis Ismayati³ Tri Rijanto⁴

Muhammad Y. Pratama⁵

^{1,4} Technology and Vocational Education Postgraduate, Universitas Negeri Surabaya Surabaya, Indonesia

^{2,5} Department of Mechanical Engineering Faculty of Engineering, Universitas Negeri Surabaya Surabaya, Indonesia

³ Department of Electrical Engineering Faculty of Engineering, Universitas Negeri Surabaya Surabaya, Indonesia

*Corresponding author. Email: deni.17070895017@mhs.unesa.ac.id

ABSTRACT

This study aims to analyze the effectiveness of the learning model and collaboration skills on the psychomotor domain achievement. This research is a quasi-experimental study with 68 students using the experimental group (PjBL) and the control group (DI) as the samples. The method used in the data analysis is the two-way Anova. The results indicate that there are (1) differences in psychomotor domain achievement between students who use PjBL compared to DI; (2) differences in psychomotor domain achievement between students with high collaboration skills and low collaboration skills; and (3) the interaction between learning models and collaboration skills in the psychomotor domain achievement.

Keywords: Project-based learning, Direct instruction, Collaboration skills, Psychomotor domain achievement.

1. INTRODUCTION

Education is one of the human efforts to grow the potential possessed both in terms of physical, spiritual, and values in social life. In line with this, Law Number 20 of 2003 also explains that education is a conscious and planned effort that aims to develop every potential possessed by students [1]. However, the fact is that the quality of education in Indonesia is still far behind some countries in Southeast Asia. The Education For All (EFA) index shows that education in Indonesia decreases every year, even in 2015 Indonesia was ranked 57 out of 115 countries [2]. According to this data, we should make the concrete efforts to support the massive quality improvement of education in Indonesia.

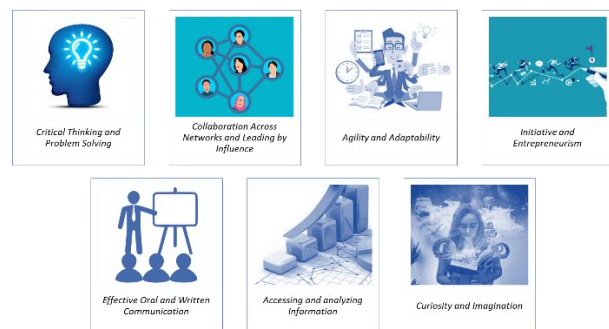


Figure 1 The seven survival skills.

In this industrial revolution 4.0 era, disruption is a keyword that needs to be watched out for. This keyword implies that the main purpose of education is to prepare human resources who can think, behave, and act creatively to deal with unexpected changes [3]. In line with this, Wagner (2008) explains that to enter the industrial revolution 4.0 era in the 21st century, ideally seven survival skills must be provided to students (Figure 1).

The figure above shows the importance of survival skills for graduates of Vocational High Schools (VHS) [5]. Therefore, various efforts must be made by schools in order to produce the students that have the required skills and are ready to compete in the industry. Generally, the failure of the learning process is caused by the implementation of the learning model that does not match with the learning competence's characteristics. Most of teachers still use the direct instruction model (DI) so the teacher is more active during the learning process. Rusyadi & Irhasyuarna (2018) explained that DI model requires the teachers to deliver learning materials in a structured way step by step. In line with this statement, Liem & Martin (2019) stated that DI has a positive and consistent impact when it is used to develop the students' basic skills. Therefore, in practicum competencies, teachers must be innovated to use learning models that can improve psychomotor domain achievement [8].

There are several learning models offered in the 21st Century era. *Pacific Policy Research Center* (2010) recommends several 21st-century learning models such as, project-based learning model (PjBL). PjBL is one of the innovative learning models that are currently used to be developed in various universities in Indonesia. The PjBL model is interesting because this model has a student-centered character. During the learning process, students must actively learn to improve their competence [10][11]. Thus, each student is expected to construct their own psychomotor competence in order to create the meaningful learning [12], compared with Direct Instruction Model [13].

Meaningful learning will have a positive impact towards students skills' development. In this case, four skills are needed to be developed in the 21st-century era or better known as 4C's. One of these skills is collaboration skills. It should be noted that the PjBL model and collaboration skills have a close relationship between the concept of learning in school and real life [14]. This is certainly one of the main points and a plus for schools that use the model and develop these skills. According to the background description and relevant research results, the researcher is motivated to conduct similar research with the aim of analyzing the effectiveness of PjBL and collaboration skills on psychomotor domain achievement. Besides, the researchers are also interested to investigate whether there is an interaction between the learning model and collaboration skills in the psychomotor domain achievement.

2. METHODS

This quasi-experimental research combined with a quantitative approach was carried out with the aim of analyzing the effectiveness of Project-Based learning (PjBL) on the competence of Lathe Machining Engineering (LME) at VHS Maskumambang 1 Gresik.

Table 1. 2x2 Factorial Design

Group	Pre-test	Treatment	Collaboration	Post-test
Experiment	Pr _E	PjBL	K _T	PO _{ET}

Group	Pre-test	Treatment	Collaboration	Post-test
			K _R	PO _{ER}
Control	Pr _C	DI	K _T	PO _{CT}
			K _R	PO _{CR}

The research design refers to the 2x2 factorial [15], the control and experimental groups were not chosen randomly. Pre-test and post-test were carried out in both study groups, the only difference was the treatment given to each group [15]. Furthermore, a 2x2 factorial research analysis was arranged as shown in Table 2.

Table 2. Factorial analysis design

Collaborative Skills	Learning Model	
	PjBL (X ₁)	DI (X ₂)
High (Y ₁)	Y ₁ X ₁	Y ₁ X ₂
Low (Y ₂)	Y ₂ X ₁	Y ₂ X ₂

Information:

- Y₁X₁ : The achievement of the psychomotor domain of students who learn to use PjBL in the collaboration group is high.
- Y₂X₁ : The achievement of the psychomotor domain of students who learn to use PjBL in the collaboration group is low.
- Y₁X₂ : The achievement of the psychomotor domain of students who learn to use DI in the collaboration group is high.
- Y₂X₂ : The achievement of the psychomotor domain of students who learn to use DI in the collaboration group is low.

3. RESULTS AND DISCUSSION

3.1. Normality test

Normality test is needed in order to analyze the level of normality of student psychomotor domain achievement data. The method used is the Kolmogorov-Smirnov test with a 5% 5% significance value of [16]. The more detailed analysis are shown in Table 3.

Table 3. Kolmogorov-Smirnov Test Results

Information	PjBL	DI
Kolmogorov-Smirnov	N	34
	KS-Z	0.494
	Asymp. Sig. (2-tailed)	0.968
Decision	H0 accepted	H0 accepted
Conclusions	Normal	Normal

Based on the results of the Kolmogorov-Smirnov one-sample test, a significance value (2 tailed) was obtained for the psychomotor domain achievement in PjBL of 0.968 and DI of 0.776. Because both learning models get a significance value greater than 0.05 (0.968

> 0.05), it is stated that H0 is accepted, which means that both learning models have data that are normally distributed.

3.2. Homogeneity test

Table 4. Levene's test results

Variable	Learning Model	Collaborative Skills	Learning Model * Collaborative Skills
F	0,001	5,309	1,537
df1	1	1	3
df2	66	66	64
Sig.	0,969	0,064	0,213
Decision	H0 accepted	H0 accepted	H0 accepted
Conclusion	Homogen	Homogen	Homogen

The homogeneity test was conducted to analyze the level of homogeneity of the variance of the psychomotor domain achievement data of students. The method used is

Levene's equality of error variances test with a 5% significance value of [17]. The detailed analysis results are shown in Table 4. Based on the homogeneity test's results in Table 4, it is known that the three variables get a sig value greater than 0.05 so that they meet the criteria for accepting H0. Thus, it is stated that the achievement of the psychomotor domain between students who learn to use PjBL and DI on the LME competence has a homogeneous variance. In addition, the psychomotor domain achievement between students with high and low collaboration skills also has a homogeneous variance. Then, the interaction between the learning model and collaboration skills on the psychomotor domain achievement on LME competence also shows a homogeneous variance. This study has met the prerequisite analysis test, where before testing the hypothesis the data must be normally distributed and the sample must come from a population with the same variance. [18].

3.3. Hypothesis Test

The hypothesis test criteria used as a reference in determining the acceptance of H0 is if the value of Sig > 0.05, whereas if the value of Sig < 0.05, it is declared that the value of Sig is > 0.05. The results of the two-way Anova test for each hypothesis are explained as follows.

Table 5. Two Paths Anova Test Results

Dependent Variable: Psychomotor Domain Achievements						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Learning_Model	107.755	1	107.755	9.566	0.003	Accepted
Collaborative_Skills	49.471	1	49.471	4.392	0.040	Accepted
Learning_Model * Collaborative_Skills	234.212	1	234.212	20.793	0.000	Accepted

The first hypothesis test in the Anova calculation obtained F-statistic 9.566 with Sig 0.003 < 0.05. This means that there is a significant difference in psychomotor domain achievement between students who learn to use PjBL and students who learn to use DI. Students who learn to use PjBL have higher psychomotor domain achievements than students who learn to use DI. In line with these results, Eliyasni et al. (2019) stated that PjBL is an appropriate learning model if it is used to improve students' high-level abilities [19]. In this case, being effective learning is certainly due to the form of student-centered teaching [20]. During the learning process students are given the freedom to choose, arrange, investigate and produce products according to the needs of the world of work autonomously [21].

Thus it is hoped that schools are able to produce graduates with qualifications in accordance with the needs of the current world specification, competent and skilled workers in their fields [22]. King & Smith (2020) further said that Project-Based Learning has tremendous potential to increase student competence [23]. The opportunity for students to receive feedback from teachers and classmates is also getting bigger. On the other hand, in this study the learning outcomes of classes

using DI tend to be lower because during the learning process the knowledge center is only with the teacher. Students who learn basic skills are generally quicker to understand the learning material delivered directly by the teacher [24].

In line with this opinion, Warju et al. (2020) explained that DI is a procedural learning model. This model is ideal when being applied to the students who are studying basic material, where the teacher teaches knowledge in a step-by-step manner [25]. DI can run well if the teacher is able to plan a neat and organized learning scheme, so that students are able to achieve their learning goals. Furthermore, the second hypothesis test in the Anova calculation shows the F-statistic result of 4.392 with Sig 0.040 < 0.05. It means that there is a significant difference in psychomotor domain achievement between students who have high and low collaboration skills. Students with high collaboration skills have higher psychomotor domain achievements than those with low collaboration skills.

The findings of this study are in line with the research of Zamanzadeh et al. (2014) also revealed that collaboration skills are one of the important elements of

the future work system. Workers with high collaboration character find it easier to work in teams [26]. On the other hand, workers with low collaboration characteristics will find it difficult to interact because of the lack of social skills in the team. This opinion is in line with the research results of Sislian et al. (2015) which shows that the learning scheme in Finland is based on a process perspective. Students with good collaboration skills will more easily complete a job [27]. It cannot be separated from communication and verbal reflection with friends in the team. Then, test related with the third hypothesis in the calculation of Anova obtained F-statistic 20,793 with Sig 0.000 <0.05, while the interaction graph can be seen as follows.

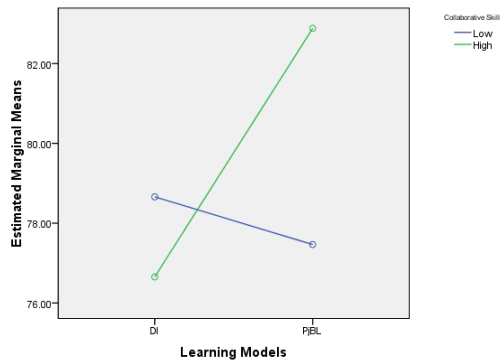


Figure 2 Interaction between learning models and collaboration skills.

The picture above shows that there is an interaction between the learning model and collaboration skills on the achievement of the psychomotor domain. It means that there are differences in students' psychomotor domain achievements in the two learning models, both for students with high and low collaboration skills. Riswanto & Aryani (2017) through their research explain that it is a certainty that when students can carry out learning optimally, it will have an impact on increasing learning achievement [28]. In line with this, Giri (2016) stated that PjBL has become an effective approach to motivate students to be actively involved during the learning process. Although there are several challenges in its implementation, PjBL is proven to be able to provide success to students [29].

Prahani et al. (2018) which revealed that there was a large increase in learning achievement with high cooperative abilities when applying the right learning model. In addition, through these results, it was found that there was an attitude of mutual trust towards the entire investigative group [30]. In addition, Trisdiono et al. (2019) in his research shows that multidisciplinary integrated project-based learning can improve students' critical thinking and collaboration skills [31][32]. Meanwhile, Ralph (2016) through his research shows that there is a positive relationship between content knowledge learning and PjBL in collaborative conditioning [33]. PjBL has been transformed as one of the important learning models for future education and careers. Therefore, the educational curriculum must be immediately adapted to the demands of this century. The aim is none other than to enable students to further explore interdisciplinary skills and the use of PjBL.

From the findings and relevant research results, we can know that the application of PjBL and collaboration skills affect student psychomotor learning outcomes. The effect of the implementation of PjBL on student learning outcomes is certainly determined from the high and low collaboration skills of students. It is because students who have high collaboration skills tend to be more active, creative, have a stronger desire when compared to students who have low collaboration skills.

4. CONCLUSIONS

Based on the results and discussion, it can be concluded that: (1) there is a significant difference in psychomotor domain achievement between students who learn to use PjBL and students who learn to use DI; (2) there is a significant difference in psychomotor domain achievement between students who have high and low collaboration skills; and (3) there is an interaction between the learning model and collaboration skills on the achievement of the psychomotor domain.

AUTHORS CONTRIBUTION

All authors conceived and designed this study. All authors contributed to the process of revising the manuscript, and at the end all authors have approved the final version of this manuscript.

REFERENCES

- [1] Republik Indonesia, *Undang-Undang No. 20 Tahun 2003 tentang Sistem Pendidikan Nasional*. Indonesia, 2003, pp. 1–33.
- [2] Humas PMK, “Indonesia Peringkat ke- 57 EDI dari 115 Negara Tahun 2014,” 2015. <https://www.kemendiknas.go.id/artikel/indonesia-a-peringkat-ke-57-edi-dari-115-negara-tahun-2014> (accessed Feb. 20, 2020).
- [3] S. Riadi, S. Triono, S. Syahril, and D. Nofriansyah, “Effectiveness of Metacognitive Learning’s Model in Engineering,” *Int. J. Eng. Adv. Technol.*, vol. 9, no. 1, pp. 4438–4443, Oct. 2019, doi: 10.35940/ijeat.A1457.109119.
- [4] T. Wagner, *The Global Achievement Gap, 21st Century Skills*, vol. 29, no. 1. 2008.
- [5] Soeryanto, I. M. Arsana, R. S. Hidayatullah, and S. R. Ariyanto, “Analysis of HOTS Type Multiple-choice Test Items on Learning Automotive Electrical Systems in SMK Dharma Bahari Surabaya,” *J. Phys. Conf. Ser.*, vol. 1569, p. 032046, Jul. 2020, doi: 10.1088/1742-6596/1569/3/032046.
- [6] A. Rusyadi and Y. Irhasyurna, “Train Critical Thinking Skill with Direct Instruction,” *IOSR J. Res. Method Educ.*, vol. 8, no. 3, pp. 7–11, 2018, doi: 10.9790/7388-0803050711.

- [7] G. A. D. Liem and A. J. Martin, "Direct instruction," in *Visible Learning Guide to Student Achievement*, J. Hattie and E. M. Anderman, Eds. Schools Edition. | Abingdon, Oxon; New York, NY: Routledge, 2020. | Revised edition of: International guide to student achievement.: Routledge, 2019, pp. 277–284. 10.1080/03610911003615816.
- [8] S. R. Ariyanto, M. Munoto, and M. Muhaji, "Development of Psychomotor Domain Assessment Instrument on Brake System Competence in SMKN 1 Jetis Mojokerto," *Int. J. Educ. Vocat. Stud.*, vol. 1, no. 6, Aug. 2019, doi: 10.29103/ijevs.v1i6.1648.
- [9] Pacific Policy Research Center, "21st century skills for students and teachers," Honolulu, 2010. [Online]. Available: www.ksbe.edu/spi.
- [10] N. Jalinus, R. A. Nabawi, and A. Mardin, "The Seven Steps of Project Based Learning Model to Enhance Productive Competences of Vocational Students," 2017, doi: 10.2991/ictvt-17.2017.43.
- [11] I. M. Arsana, I. W. Susila, R. S. Hidayatullah, and S. R. Ariyanto, "Implementation of Troubleshooting Teaching Method to Develop Student's Competency in Conducting Motorcycle Tune-up," 2019, doi: 10.1088/1742-6596/1387/1/012096.
- [12] L. Rahmah, S. R. Ariyanto, Z. Iskandar, and I. C. Dewi, "Development of Authentic Psychomotor Instruments for Vocational School in the Covid-19 Pandemic," *J. Kependidikan J. Has. Penelit. dan Kaji. Kepustakaan di Bid. Pendidikan, Pengajaran dan Pembelajaran*, vol. 6, no. 3, p. 349, Nov. 2020, doi: 10.33394/jk.v6i3.2859.
- [13] M. T. D. Mohedo and A. V. Bújez, "Project based Teaching as a Didactic Strategy for the Learning and Development of Basic Competences in Future Teachers," *Procedia - Soc. Behav. Sci.*, vol. 141, pp. 232–236, Aug. 2014, doi: 10.1016/j.sbspro.2014.05.040.
- [14] R. S. Hidayatullah, S. R. Ariyanto, Muhaji, H. Mubarak, and A. Yohannes, "Collaborative Problem-based Learning: An Analysis of Problem-Solving Skills in Vocational Schools," *IJORER Int. J. Recent Educ. Res.*, vol. 1, no. 3, pp. 209–217, Oct. 2020, doi: 10.46245/ijorer.v1i3.62.
- [15] J. W. Creswell, *Research design: Qualitative, quantitative and mixed approaches (3rd Edition)*, 3rd ed. Los Angeles: SAGE Publications, Inc., 2009.
- [16] Z. Drezner, O. Turel, and D. Zerom, "A modified kolmogorov-smirnov test for normality," *Commun. Stat. Simul. Comput.*, vol. 39, no. 4, pp. 693–704, 2010, doi: 10.1080/03610911003615816.
- [17] B. B. Frey, "Levene's Homogeneity of Variance Test," in *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*, 2455 Teller Road, Thousand Oaks, California 91320: SAGE Publications, Inc., 2018.
- [18] M. J. Blanca, R. Alarcón, J. Arnau, R. Bono, and R. Bendayan, "Effect of variance ratio on ANOVA robustness: Might 1.5 be the limit?," *Behav. Res. Methods*, vol. 50, no. 3, pp. 937–962, Jun. 2018, doi: 10.3758/s13428-017-0918-2.
- [19] R. Eliasni, A. K. Kenedi, and I. M. Sayer, "Blended Learning and Project Based Learning: The Method to Improve Students' Higher Order Thinking Skill (HOTS)," *J. Iqra' Kaji. Ilmu Pendidik.*, vol. 4, no. 2, pp. 231–248, Dec. 2019, doi: 10.25217/ji.v4i2.549.
- [20] D. Kokotsaki, V. Menzies, and A. Wiggins, "Project-based learning: A review of the literature," *Improv. Sch.*, vol. 19, no. 3, pp. 267–277, Nov. 2016, doi: 10.1177/1365480216659733.
- [21] A. Habók and J. Nagy, "In-service teachers' perceptions of project-based learning," *Springerplus*, vol. 5, no. 1, p. 83, Dec. 2016, doi: 10.1186/s40064-016-1725-4.
- [22] M. Fjellström, "Vocational education in practice: a study of work-based learning in a construction programme at a Swedish upper secondary school," *Empir. Res. Vocat. Educ. Train.*, vol. 6, no. 1, p. 2, Dec. 2014, doi: 10.1186/1877-6345-6-2.
- [23] B. King and C. Smith, "Using Project-Based Learning to Develop Teachers for Leadership," *Clear. House A J. Educ. Strateg. Issues Ideas*, vol. 93, no. 3, pp. 158–164, May 2020, doi: 10.1080/00098655.2020.1735289.
- [24] T. Rüttemann and H. Kipper, "Teaching strategies for direct and indirect instruction in teaching engineering," *Int. J. Eng. Pedagog.*, vol. 1, no. 3, pp. 107–114, 2011, doi: 10.1109/ICL.2011.6059556.
- [25] Warju, S. R. Ariyanto, Soeryanto, R. S. Hidayatullah, and M. Nurtanto, "Practical Learning Innovation: Real Condition Video-Based Direct Instruction Model in Vocational Education," *J. Educ. Sci. Technol.*, vol. 6, no. 1, pp. 79–91, 2020.
- [26] V. Zamanzadeh, A. Irajpour, L. Valizadeh, and M. Shohani, "The Meaning of Collaboration, from the Perspective of Iranian Nurses: A Qualitative Study," *Sci. World J.*, vol. 2014, pp. 1–9, 2014, doi: 10.1155/2014/785942.

- [27] R. Sislian, M. M. Gabardo, S. S. da Hora Macedo, and G. G. Ribeiro, "Collaborative learning in the finnish educational system: brazilian teachers' perspectives," *Int. J. New Trends Educ. Their Implic.*, vol. 6, no. 1, pp. 63–69, 2015.
- [28] A. Riswanto and S. Aryani, "Learning motivation and student achievement : description analysis and relationships both," *COUNS-EDU Int. J. Couns. Educ.*, vol. 2, no. 1, p. 42, Mar. 2017, doi: 10.23916/002017026010.
- [29] D. R. Giri, "Project-Based Learning as 21st Century Teaching Approach: A Study in Nepalese Private Schools," *US-China Educ. Rev. A*, vol. 6, no. 8, Aug. 2016, doi: 10.17265/2161-623X/2016.08.004.
- [30] B. K. Prahani *et al.*, "The effectiveness of collaborative problem based physics learning (CPBPL) model to improve student's self-confidence on physics learning," *J. Phys. Conf. Ser.*, vol. 997, no. 1, pp. 0–6, 2018, doi: 10.1088/1742-6596/997/1/012008.
- [31] H. Trisdiono, S. Siswandari, N. Suryani, and S. Joyoatmojo, "Multidisciplinary Integrated Project-based Learning to Improve Critical Thinking Skills and Collaboration," *Int. J. Learn. Teach. Educ. Res.*, vol. 18, no. 1, pp. 16–30, Jan. 2019, doi: 10.26803/ijlter.18.1.2.
- [32] N. Fadilla, L. Nurlaela, T. Rijanto, S. R. Ariyanto, L. Rahmah, and S. Huda, "Effect of problem-based learning on critical thinking skills," *J. Phys. Conf. Ser.*, vol. 1810, no. 1, p. 012060, Mar. 2021, doi: 10.1088/1742-6596/1810/1/012060.
- [33] R. A. Ralph, "Post secondary project-based learning in science, technology, engineering and mathematics," *J. Technol. Sci. Educ.*, vol. 6, no. 1, Mar. 2016, doi: 10.3926/jotse.155.