IJORER : International Journal of Recent Educational Education
Homepage : https://journal.ia-education.com/index.php/ijorer
Email : ijorer@ia-education.com

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 1, No. 3, October 2020 : 209-217

Collaborative Problem Based Learning: An Analysis of Problem Solving Skills in Vocational Schools

***Rachmad Syarifuddin Hidayatullah[1], Sudirman Rizki Ariyanto[2], Muhaji[3], Husni Mubarok[4], Abebayehu Yohannes[5]**
[1,3]Universitas Negeri Surabaya, Surabaya, Indonesia
[2]Universitas Bhinneka PGRI, Tulungagung, Indonesia
[4]National Taiwan University of Science and Technology, Taipei, Taiwan
[5]Wolaita Sodo University, SNNP Region, Ethiopia

DOI : https://doi.org/10.46245/ijorer.v1i3.62

Sections Info
Article history:
Submitted: September 5, 2020
Final Revised: October 10, 2020
Accepted: October 22, 2020
Published online: October 31, 2020

Keywords:
Collaborative problem-based learning
Initial skills
Problem-solving skills
Vocational school

ABSTRACT
This study aims to analyze the effect of using Collaborative Problem-Based Learning (CPBL) on students' problem-solving skills. This study used a 2x2 factorial design, in which the selection of experimental and control groups was determined with convenience sampling. The data analysis technique of this research is divided into two types, namely the prerequisite analysis test and hypothesis testing. The findings of this study concluded that students who studied with CPBL had significantly higher problem-solving skills than students who studied with Direct Instruction (DI). Besides, high problem-solving skills were generally owned by students with high initial skills. Meanwhile, the complete the results of the hypothesis test this study also showed a significant interaction between the learning model and initial skills on students' problem-solving skills in internal combustion motor competencies. This shows that the selection of the right learning model is needed according to the initial skills of students so that problem-solving skills can be adequately developed. Thus, it is hoped that vocational school students can become graduates who can compete in the world of work.

INTRODUCTION

Collaborative learning is known as a method that emphasizes the ability of students to work together in small groups to achieve specific learning goals. Members in collaborative learning groups are synonymous with the concept of helping each other. And also, the burden of responsibility for the success of the learning process is shared. In this case, collaborative learning is ideal if it's used to increase achievement, motivation, and social skills. The study of Le et al. (2018) has confirmed that study groups that apply collaborative learning methods usually have advantages such as being able to work independently or in groups. Gokhale (2012) suggested that the implementation of collaborative learning can run effectively if each group can interact well with each other.

There are several techniques commonly used for group determination. Some of these techniques such as grouping randomly, determined by the teacher, or determined independently by students. Siew et al. (2017) argued that in group formation, ideally, the teacher determines heterogeneously without differentiating between abilities, sex, and ethnic backgrounds. The goal is that students can maximize individual differences in groups to achieve collective learning goals. On the other hand, Scager et al. (2016) stated that the success of collaborative learning was not only determined based on

student abilities, but also influenced by the learning model used by the teaching teacher.

One model that has relevance to collaboration skills is the Collaborative Problem-Based Learning (CPBL) model. The basis of this model is a problem-based learning model that is integrated with collaboration skills (Ariyanto et al., 2019). Through this model, students are not only directed to increase their learning independence and creativity but also improve collaborative problem-solving skills (Mühlfelder & Chandrasekaran, 2015). Jonassen & Hung (2012) defined problem-solving as a process for constructing and implementing a mental representation of a problem. Its function was to find solutions to the problems at hand. Based on the background description above, the hypotheses of the study were formulated as follows:

1. There was a difference in learners' problem-solving skills between the experimental group, who learned via CPBL versus the control group, who learned via DI.
2. There was a difference in problem-solving skills between students with high initial skills and low initial skills.
3. There was an interaction effect of learning models and initial skills on problem-solving skills.

RESEARCH METHOD

The study used an experimental design intending to analyze the effect of CPBL on the competence of the internal combustion motor at First Vocational Schools Jetis Mojokerto, Indonesia. This study used a 2x2 factorial design, in which the selection of experimental and control groups was determined with convenience sampling (Creswell, 2009). More details on the experimental design in this study are shown in Figure 1 (Tuckman & Harper, 2012).

Experiment	O_{1A}	X_1	Y_1	O_{2A}
		-	Y_2	O_{2B}
Control	O_{1B}	X_2	Y_1	O_{2C}
		-	Y_2	O_{2D}

Figure 1. 2x2 factorial design of experimental and control groups.

$O_{1A, 1B}$ are pre-test results, while $O_{2A, 2B, 2C, 2D}$ are problem-solving skills. Symbols X_1 and X_2 respectively indicate the treatment of the experimental and control groups. Meanwhile, Y_1 and Y_2 respectively show the value of the students' initial skills. Based on the experimental design above, the research analysis design is shown in Table 1.

Table 1. Research analysis design.

Learning model	Initial Skills	
	High (Is_1)	Low (Is_2)
CPBL (M_1)	M_1Is_1	M_1Is_2
DI (M_2)	M_2Is_1	M_2Is_2

Information:

M_1Is_1 : The problem-solving skills of students who learn to use CPBL in the high initial skill group.
M_1Is_2 : The problem-solving skills of students who learn to use CPBL in the low initial skill group.
M_2Is_1 : The problem-solving skills of students who learn to use DI in the high initial skill group.
M_2Is_2 : The problem-solving skills of students who learn to use DI in the low initial skill group.

The sample of this study was students in eleventh grade, group 1 and group 2 at First Vocational Schools Jetis Mojokerto, with a total of 34 students in each group. Group 1 was an experimental group that taught using the Collaborative Problem-Based Learning (CPBL) model and group 2 was a control group that taught using the Direct Instruction (DI) model. In this study, the separation of students' initial skill levels was pseudo. Determination of students' initial skills was done by giving a test, where the test was carried out before the research activity. Initial skills indicators that are used as references in this study include: (1) having a memory of previously studied subject matter; (2) able to understand the meaning of the material being studied; and (3) able to connect new material with other previously studied material (Olson et al., 2019).

Students with ratings 1 to 17 were into the category of the high initial skill group. Meanwhile, students with ratings 18 to 34 entered the low initial skill group. The data analysis technique of this research was divided into two types, namely the prerequisite analysis test and hypothesis testing. The prerequisite analysis test was divided into two stages, namely the normality test using the one-sample Kolmogorov-Smirnov test and the homogeneity test using the Levene's test. After the analysis prerequisite test was fulfilled, and then followed by hypothesis testing using the two-way ANOVA test.

RESULTS AND DISCUSSION

Analysis of Prerequisite Test

The data from the research results were first tested for prerequisites before proceeding to hypothesis testing. The first stage of the prerequisite test is the normality test. The distribution normality test was carried out to analyze the level of normality of the data. This study conducted a distribution normality test using the Kolmogorov-Smirnov test with a significance value of 0.05. The data of the distribution normality test results can be seen in Table 2.

Table 2. Result of the normality test of problem-solving skills.

One-Sample Kolmogorov-Smirnov Test			
		Experimental	**Control**
N		34	34
Normal Parameters[a]	*Mean*	81.2294	76.2588
	Std. Deviation	7.99650	7.34889
Most Extreme Differences	*Absolute*	0.094	0.108
	Positive	0.084	0.108
	Negative	-0.094	-0.072
Kolmogorov-Smirnov Z		0.550	0.628
Asymp. Sig. (2-tailed)		0.923	0.825

a, Test distribution is Normal.

Based on the data in Table 2, it is known that students' problem-solving skills in both the experimental and control groups were equally tested for normality using the Kolmogorov-Smirnov test with a significance value of 0.05. Data is categorized as normally distributed if the significance value is more than 0.05 and otherwise (Sanaie et al., 2019). From the Kolmogorov-Smirnov test output, it can be seen that the experimental group got a significance value of 0.923, while the control group got a significance value of 0.825. Because the significant value in both the experimental group

and the control group was more than 0.05, it was stated that H_0 was accepted. So, it can be concluded that the normality of the data distribution of problem-solving skills was normal.

The variance homogeneity test was carried out to test the variance equation of the data population. The decision-making criterion is if the significance value is more than 0.05, it can be said that the data variants from two or more groups are the same (Chukwudi et al., 2019). This study conducted a homogeneity test of variance using the Levene's test with a significance level of 0.05 (Frey, 2018). The results of the variance homogeneity test are shown in Tables 3, 4, and 5.

Table 3. The homogeneity test of problem-solving skills between students using CPBL and DI.

Test of Homogeneity of Variances			
Problem-solving skills between students learning to use CPBL and DI			
Levene Statistic	df1	df2	*Sig.*
1.579	1	66	0.213

Table 4. The homogeneity test of problem-solving skills between students with high and low initial skills.

Test of Homogeneity of Variances			
Problem-solving skills between students with high and low initial skills			
Levene Statistic	df1	df2	*Sig.*
5.066	1	66	0.058

Table 5. The homogeneity test of the interaction between learning models, and initial skills on problem-solving skills.

Levene's Test of Equality of Error Variances[a]			
Dependent Variable: Problem-Solving Skills			
F	df1	df2	*Sig.*
2.345	3	64	0.081

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

*a,Design: Intercept + Model + Initial Skills + Model *Initial Skills*

The results of the variance homogeneity test in the formulation of the first problem can be seen in Table 3. From the output of the Levene's test, it can be seen that the formulation of the first problem gets a significance value of 0.213, because the significance value of 0.05 (0.213>0.05), it was concluded that accept H_0. This means that problem-solving skills between students who learn to use CPBL and DI have homogeneous variances. Furthermore, from Levene's test output, it can be seen that the formulation of the second problem in Table 4 shows a significance value of 0.058, because the significance value of 0.05 (0.058>0.05), it was concluded that accept H_0. This means that problem-solving skills between students with high and low initial skills have a homogeneous variance. Then, from the output of the Levene's test it can be seen that the formulation of the third problem in Table 5 shows a significance value of 0.081,

because the significance value of 0.05 (0.081>0.05), it was concluded that accept H_0. This means that the interaction between learning models and initial skills against problem-solving skills shows homogeneous variance.

Research Hypothesis Test

After the prerequisite test has been fulfilled, it was continued to test the research hypothesis. Hypothesis testing was carried out using two-way ANOVA assisted by SPSS 16 software. The significance value required in hypothesis testing is 0.05. The research hypothesis is stated to accept H_0 if the significance value is greater than 0.05. More specifically, the output of hypothesis testing is shown in Table 6.

Table 6. Two-way ANOVA test results.

Tests of Between-Subjects Effects					
Dependent Variable: Problem-Solving Skills					
Source	***Type III Sum of Squares***	***df***	***Mean Square***	***F***	***Sig.***
Corrected Model	2069,089[a]	3	689,696	19,677	0,000
Intercept	421643,252	1	421643,252	1,203E4	0,000
Model	420,015	1	420,015	11,983	0,001
Initial Skills	647,295	1	647,295	18,467	0,000
Model * Initial Skills	1001,779	1	1001,779	28,580	0,000
Error	2243,279	64	35,051		
Total	425955,620	68			
Corrected Total	4312,368	67			

Based on Table 6, it can be seen that the significance value of the learning model was 0.001. The significance value was less than 0.05 (0.001<0.05), it was concluded that H_1 was accepted. This means that there were significant differences in problem-solving skills between students learning to use CPBL and students learning to use DI. In line with this study, Koroneou et al. (2013) explain that by using PBL students can participate actively in the problem-solving process from unstructured problems to strengthening 21st Century skills. Meanwhile, Win et al. (2015) stated that the implementation of PBL in active collaborative groups can also increase student motivation, cognitive skills, and problem-solving skills.

The results of the second hypothesis test showed that the significance value of collaboration skills was 0.000. The significance value was less than 0.05 (0.000<0.05), it was concluded that H_1 was accepted. This means that there were significant differences in problem-solving skills between students with high initial skills and students with low initial skills. The results of this study were in line with the research of Latif & Akib (2016) which explains that students with good initial skills will certainly understand learning material faster. This was supported by the fact that students with high initial skills find it easier to analyze ideas to convert them into problem solutions.

Initial skills are skills that must be possessed by students at the beginning of learning. In other words, initial skills are a prerequisite that students must have before carrying out the learning process (Widodo et al., 2017). Purwaningrum & Sumardi (2016) which explains that students with good initial skills tend to get better learning outcomes than students with low initial skills. The same thing was also conveyed by Elmiwati et al. (2020) that during the problem-solving process, students with good

initial skills found it easier to build knowledge and develop solving skills and independent learning skills.

The results of the third hypothesis test were about the interaction between learning models and initial skills on problem-solving skills, in this case, the significance value obtained was 0.000. The significance value shows that it was smaller than 0.05 (0.000<0.05), it was concluded that H_1 was accepted. This means that there was a significant interaction between the learning model and initial skills on students' problem-solving skills in internal combustion motor competencies as shown in Figure 2.

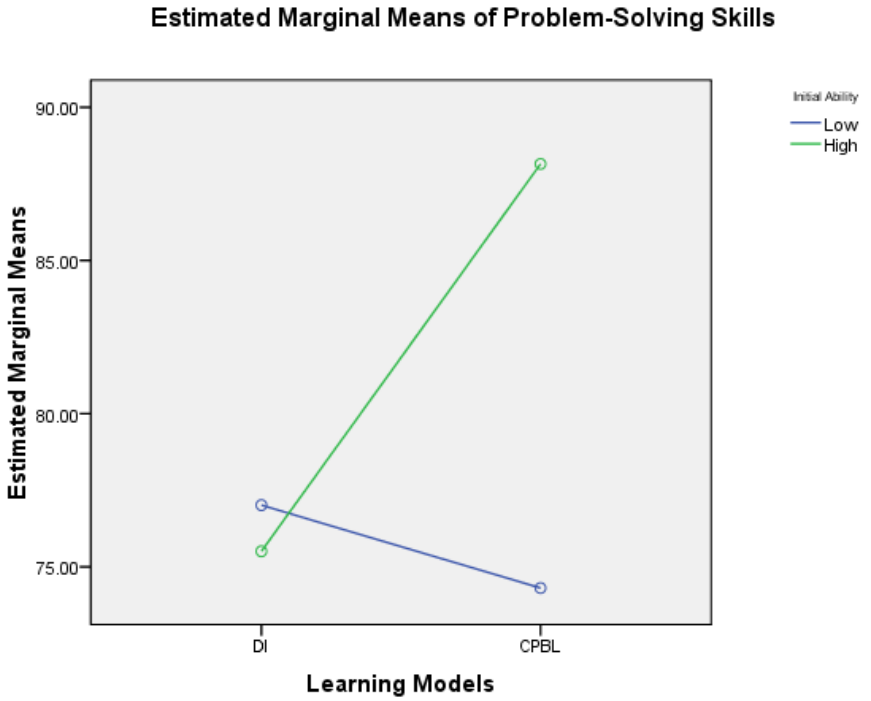

Figure 1. The interaction between learning models and initial skills in problem-solving skills.

The results of this study were in line with the statement of Yew & Goh (2016), where the implementation of problem-based learning (PBL) was closely related to collaboration skills in various fields and educational contexts. This model was generally used to promote critical thinking and problem-solving in authentic learning situations. The same thing with Kadir et al. (2016) statement, this model has been widely used in various disciplines because it was claimed to improve student soft skills. However, empirical support leads to the achievement of problem-solving skills (Arsana et al., 2019). Problem-solving skills are very important in the learning process. To complete the project, students need to overcome all difficulties, and their problem-solving skills will gradually become better and more meaningful (Chiang & Lee, 2016). This finding was consistent with Rustam et al. (2017) which explains that problem-solving ability itself was not only a goal in learning, but also very meaningful in everyday life, and in the world of work being a problem-solving can provide many benefits.

The results of this study are also in line with the spirit of Presidential Instruction Number 9 of 2016 concerning the Revitalization of Vocational High Schools in Indonesia. This means that graduates of vocational schools in the future must be

equipped with 21st Century skills that can be fully utilized to meet the needs of the industrial world. Besides, the results of this study also support the Regulation of the Minister of Industry No. 3 of 2017. Through this regulation, vocational schools are expected to organize educational programs that "link and match" with industrial needs. Meanwhile, the company is expected to facilitate guidance to vocational schools to be able to produce a skilled and competent workforce by industrial conditions.

CONCLUSIONS

Based on the results of data analysis and discussion, it can be concluded that students learning with CPBL have significantly higher problem-solving skills than students learning with DI. Second, high problem-solving skills were generally owned by students with high initial skills. Meanwhile, the results of this study also showed a significant interaction between the learning model and initial skills on students' problem-solving skills in internal combustion motor competencies. Therefore, teachers also need to pay attention to students' initial skills, so that problem-solving skills can improve and facilitate the process of determining the solution to problems.

REFERENCES

Ariyanto, S.R., Munoto, Muslim, S., & Muhaji. (2019). Collaborative problem-based learning models implementation in vocational high schools. *Proceedings of the 1st Vocational Education International Conference (VEIC 2019)*. https://doi.org/10.2991/assehr.k.191217.039

Arsana, I.M., Susila, I.W., Hidayatullah, R.S., & Ariyanto, S.R. (2019). Implementation of troubleshooting teaching method to develop student's competency in conducting motorcycle tune-up. *International Conference on Education, Science and Technology 2019*. https://doi.org/10.1088/1742-6596/1387/1/012096

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

Chukwudi, O., Idochi, O., & Sylvia, I. O. (2019). Effect of sample sizes on the empirical power of some tests of homogeneity of variances. *International Journal of Mathematics Trends and Technology*, *65*(6), 119–134. https://doi.org/10.14445/22315373/ijmtt-v65i6p518

Creswell, J.W. (2009). Research design: Qualitative, quantitative and mixed approaches (3rd Edition). In *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (3rd ed.). SAGE Publications, Inc. https://doi.org/10.2307/1523157

Elmiwati, E., Kartini, K., & Zulkarnain, Z. (2020). Improvement of mathematical problem solving ability of high school students through problem based learning. *Journal of Educational Sciences*, *4*(3), 584. https://doi.org/10.31258/jes.4.3.p.584-593

Frey, B. (2018). Levene's homogeneity of variance test. In *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*. SAGE Publications, Inc. https://doi.org/10.4135/9781506326139.n392

Gokhale, A.A. (2012). Collaborative learning and critical thinking. In *Encyclopedia of the Sciences of Learning* (pp. 634–636). Springer US. https://doi.org/10.1007/978-1-4419-1428-6_910

Jonassen, D.H., & Hung, W. (2012). *Encyclopedia of the sciences of learning* (N. M. Seel

(ed.)). Springer US. https://doi.org/10.1007/978-1-4419-1428-6

Kadir, Z.A., Abdullah, N.H., Anthony, E., Salleh, B.M., & Kamarulzaman, R. (2016). Does problem-based learning improve problem solving skills?-A study among business undergraduates at malaysian premier technical university. *International Education Studies*, *9*(5), 166. https://doi.org/10.5539/ies.v9n5p166

Koroneou, L., Paraskeva, F., & Alexiou, A. (2013). Designing a framework based on problem-based learning for CSCL environments to enhance 21st Century Skills. *International Journal of Information and Education Technology*, *3*(2), 135–138. https://doi.org/10.7763/IJIET.2013.V3.250

Latif, S., & Akib, I. (2016). Mathematical connection ability in solving mathematics problems based on the initial abilities of students at SMPN 10 Bulukumba. *Jurnal Daya Mathematics*, *4*(2), 207–217.

Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education*, *48*(1), 103–122. https://doi.org/10.1080/0305764X.2016.1259389

Mühlfelder, M., & Chandrasekaran, S. (2015). Collaborative problem based learning in distance and mobile education. *International and Interdisciplinary Open Access Journal of Digital Universities: International Best Practices and Applications*, *2*(3), 3–10.

Olson, A.E., Kim, H.K., Bruce, J., & Fisher, P.A. (2019). General cognitive ability as an early indicator of problem behavior among toddlers in foster care. *Journal of Developmental & Behavioral Pediatrics*, *40*(2), 144–149. https://doi.org/10.1097/DBP.0000000000000632

Purwaningrum, D., & Sumardi, S. (2016). Efek Strategi Pembelajaran Ditinjau dari Kemampuan Awal Matematika terhadap Hasil Belajar Matematika Kelas XI IPS. *Manajemen Pendidikan*, *11*(2), 155. https://doi.org/10.23917/jmp.v11i2.2862

Rustam, E.S., Sidabutar, D.R., & Edy, S. (2017). Improving learning activity and students' problem-solving skill through Problem Based Learning (PBL) in junior high school. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, *33*(2), 321–331. http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Sanaie, N., Vasli, P., Sedighi, L., & Sadeghi, B. (2019). Comparing the effect of lecture and Jigsaw teaching strategies on the nursing students' self-regulated learning and academic motivation: A quasi-experimental study. *Nurse Education Today*, *79*, 35–40. https://doi.org/10.1016/j.nedt.2019.05.022

Scager, K., Boonstra, J., Peeters, T., Vulperhorst, J., & Wiegant, F. (2016). Collaborative learning in higher education: Evoking positive interdependence. *CBE Life Sciences Education*, *15*(4). https://doi.org/10.1187/cbe.16-07-0219

Siew, N.M., Chin, M.K., & Sombuling, A. (2017). The effects of problem based learning with cooperative learning on preschoolers' scientific creativity. *Journal of Baltic Science Education*, *16*(1), 100–112.

Tuckman, B.W., & Harper, B.E. (2012). *Conducting educational research* (6th ed.). Rowman & Littlefi eld Publishers, Inc. http://dl4.libgen.io/get.php?md5=706D56613F679502BCBB6F1E1587CF3A&key=QY95UQT2LYREVQXP

Widodo, S.A., Purnami, A.S., & Prahmana, R.C.I. (2017). Team Accelerated Instruction, Initials And Problem-Solves Ability In Junior High School. *International Journal on Emerging Mathematics Education*, *1*(2), 193. https://doi.org/10.12928/ijeme.v1i2.6683

Win, N.N., Nadarajah, V.D.V, & Win, D.K. (2015). The implementation of problem-based learning in collaborative groups in a chiropractic program in Malaysia. *Journal of Educational Evaluation for Health Professions*, *12*, 17. https://doi.org/10.3352/jeehp.2015.12.17

Yew, E.H.J., & Goh, K. (2016). Problem-based learning: An overview of its process and impact on learning. *Health Professions Education*, *2*(2), 75–79. https://doi.org/10.1016/j.hpe.2016.01.004

***Rachmad Syarifuddin Hidayatullah (Corresponding Author)**
Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Surabaya
Jl. Ketintang, Ketintang, Kec. Gayungan, Kota SBY, Jawa Timur 60231
Email: rachmadhidayatullah@unesa.ac.id

Sudirman Rizki Ariyanto
Automotive Technology Vocational Education, Faculty of Science and Technology, Universitas Bhinneka PGRI Tulungagung
Jl. Mayor Sujadi No.7, Manggisan, Plosokandang, Kec. Kedungwaru, Kab. Tulungagung, Jawa Timur 66229
Email: sudirmanrizki11@ubhi.ac.id

Muhaji
Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Surabaya
Jl. Ketintang, Ketintang, Kec. Gayungan, Kota SBY, Jawa Timur 60231
Email: muhaji61@unesa.ac.id

Husni Mubarok
Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology
No. 43號, Section 4, Keelung Rd, Da'an District, Taipei City, 106 Taiwan
Email: husnimubarok254@gmail.com

Abebayehu Yohannes
Department of Mathematics, College of Natural and Computational Science, Wolaita Sodo University
Wolaita Sodo, SNNP Region, 138 Ethiopia
Email: abex98@gmail.com