Problem-Based Learning: An Ideal Model for Enhance Students' Critical Thinking Skills in Higher Education

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Abstract. This study aims to analyze the effect of online problem-based learning (OPBL) on students' critical thinking skills. This research is quasi-experimental research with a sample of 59 students who are taking research methodology courses. There are two classes that are used as research subjects, where the experimental class is 28 students, and the control class is 31 students. The data analysis method used two-way ANOVA. The results of this study indicate that (1) students who learn to use OPBL in the research methodology course have higher critical thinking skills than students who learn to use SyLearn; (2) students with high initial abilities have higher critical thinking skills than those with low initial abilities; and (3) there is an interaction between learning media and the initial ability of students' critical thinking skills.

Keywords: Problem-Based Learning · Ideal Model · Enhance Students' · Critical Thinking Skills · Higher Education

1 Introduction

Problem-based learning (PBL) is a learner-centered learning model that focuses on the process of finding solutions to real problems. As seen by the research of Hidayatullah, students are able to develop thinking strategies and problem-solving skills [1]. In addition, several studies also recommend that students learn through problem-solving experiences that allow them to develop new thinking strategies. PBL is also an effective way to help students learn basic problem-solving skills and gain additional knowledge through interaction with others [2]. The implementation of PBL learning can be designed through the formation of small groups to carry out specific tasks independently, both life-based real or study. In his book, Loyens et al., 2012 explain that currently, PBL has a major role in the development of educational practice throughout the world [3].

Technological developments and the Covid-19 pandemic have changed the direction and method of traditional education into a way of learning in the modern era [4]. Several

educational institutions, especially higher education have accustomed to the implementation of learning through hybrid learning methods and even full online learning [5]. Online learning itself is not only limited to the term technology-based, but rather using existing facilities digitally such as websites, learning portals, video conferencing, OPBL, mobile applications, and thousands of types of free websites available. These facilities, if they can be utilized optimally, will certainly have a major impact on the development of student knowledge. A lot of information can be accessed and obtained easily anytime and anywhere [6]. This certainly supports the development of key 21st Century skills, such as (1) critical thinking and problem-solving; (2) creativity and innovation; (3) communication; and (4) collaboration [7].

Critical thinking is the first skill mentioned in the four 21st Century skills. These skills are also often known as high-level skills that require assessment, reflection, analysis, synthesis, and attention to context [8]. Complexity in critical thinking often stems from the existence of multidimensional problems. Such as problems that must be resolved immediately or the need for decision-making in a short time. The implementation of education with critical thinking has several concepts in common. In line with critical thinking, the implementation of education ideally also involves several approaches that are carried out in stages such as problem identification, planning, implementation, evaluation, and reflection [9]. The concept of critical thinking is basically in line with the objectives of implementing PBL. This certainly makes it possible to further strengthen the development of key 21st Century skills.

However, the problem is how to develop critical thinking skills through online PBL? To answer this question, further research is needed through the implementation of problem-based learning models combined with online learning to improve student's critical thinking skills. It aims to analyze the effect of the implementation of problem-based learning online teaching on improving the critical thinking of higher education students. The urgency of the research is based on the fact that there is a lot of knowledge that students can easily learn online. However, classic problems such as the lack of interest and the role of students in learning continue to be a scourge that makes the learning system unable to work properly. Therefore, with the implementation of online problem-based learning, students are expected to be able to improve their critical thinking skills to the maximum with the aim of making learning more meaningful and useful.

2   Research Method

This research is an experimental type that discusses the effect of implementing problem-based learning online teaching on improving students' critical thinking. Experimental research is a quantitative research model that explains cause-and-effect relationships; in other words, the effect of one variable on another is examined. The research subjects were students of the Mechanical Engineering Department, Faculty of Engineering, Universitas Negeri Surabaya who programmed research methodology courses, the energy conversion class (2018K) with 28 students, and the manufacturing class (2018M) with 31 students. This study uses two classes as research samples, both classes use the Google Meet platform to carry out online learning. The difference between the two classes is that the experimental group is taught online problem-based learning (OPBL) with the concept

of preparing a thesis proposal, where the research topics discussed are obtained through independent field surveys or based on problems in the industry. Meanwhile, the control group (SyLearn) got research topics from relevant literature such as journals, libraries, or relevant literature. These groups were formed using a random sampling technique through the SPSS 16 program.

Data were collected using two instruments, namely test and performance instruments. The test instrument was used to measure students' cognitive abilities. Then the performance instrument is used to measure students' critical thinking skills. After the research data is obtained, then proceed with conducting the analysis prerequisite test. Prerequisite tests include normality and homogeneity tests. The normality test was carried out using the one-sample Kolmogorov-Smirnov test with test criteria, the data is said to be normally distributed if the significance value is > 0.05, while if the significance value is < 0.05, it can be said that the data is not normally distributed [10]. [10, p. 369] After the normality test is completed, then proceed. With homogeneity test. The homogeneity test was carried out through Levene's with test criteria referring to the significance value > 0.05 [10]. [10] After the data was declared to be normally distributed and homogeneous, then proceed with testing the hypothesis through Two-Way Anova.

3   Result and Discussion

3.1   Data Distribution Normality Test

The distribution normality test was conducted to identify the level of normality of the student's critical thinking skills data. The distribution normality test with Kolmogorov-Smirnov analysis has the acceptance criteria H0 if the significance value obtained is greater than 0.05 [11]. The data from the Kolmogorov-Smirnov analysis in more detail can be seen in Table 1. Based on the results of the distribution normality test in Table 1, it is known that the SyLearn class had a significance value of 0.200, while the OPBL class got a significance value of 0.112. Because the significance value is more than 0.05, it is stated that H0 is accepted. Thus, it is concluded that critical thinking skills

Table 1. Distribution Normality Test Results

Kolmogorov-Smirnov Test		SyLearn	OPBL
N		28	31
Normal Parameters[a,b]	Mean	78.4857	77.5774
	Std. Deviation	2.90003	3.11541
Most Extreme Differences	Absolute	0.103	0.142
	Positive	0.103	0,142
	Negative	−0.079	−0.071
Test Statistic		0.103	0.142
Asymp. Sig. (2-tailed)		0.200	0.112

Table 2. Variance Homogeneity Test Results

Test of Homogeneity of Variances			
Critical Thinking Skill			
Levene Statistic	df1	df2	Sig.
0.289	1	57	0.593

in both study groups in the research methodology course are normally distributed. In this case, the normality test is an important thing that needs to be done because the data will be considered representative of the research population if it is normally distributed [12]. In addition, Frey (2018) states that in the case of two samples, the Kolmogorov-Smirnov analysis was carried out to test whether the two data samples have the same basic distribution [13].

3.2   Variance Homogeneity Test

The homogeneity of variance test is carried out to ensure that the variance in each population is the same for all populations [14]. The homogeneity of variance test with Levene analysis has the acceptance criteria H0 if the significance value obtained is greater than 0.05 [15]. The data from the Kolmogorov-Smirnov analysis in more detail can be seen in Table 2.

Based on the results of the distribution normality test in Table 2, a significance value greater than 0.05 was obtained. Because the significance value is more than 0.05, it is stated that H0 is accepted. Thus, it is concluded that the two samples have homogeneous variance. These results are in line with the theory proposed by Sugiyono (2010) which explains that the homogeneity test is used by researchers to determine whether or not the data variance is homogeneous between the two study groups [16].

3.3   Hypothesis Test

The two-way ANOVA test aims to measure the effectiveness of the learning model and initial abilities and to analyze whether there is an interaction with critical thinking skills. In more detail, the results of the two-way Anova test using the SPSS 16 program are shown in Table 3.

The first hypothesis test in the ANOVA calculation (Table 3) obtained F-statistics 1.576 with Sig $0.215 > 0.05$, it is concluded that H0 is accepted. This means that there is no difference in critical thinking skills between students who learn to use OPBL in research methodology courses compared to SyLearn. The second hypothesis test in the ANOVA calculation is obtained by F-statistics of 5.038 with Sig $0.029 < 0.05$, it is concluded that H1 is accepted. This means that there are differences in critical thinking skills between students with high initial abilities compared to low ones. Students with high initial abilities have higher critical thinking skills than those with low initial abilities. The third hypothesis test in the ANOVA calculation obtained F-statistics 9.384 with Sig $0.003 < 0.05$, it is concluded that H1 is accepted. This means that there is an interaction

Table 3. Two Paths Anova Test Results

Tests of Between-Subjects Effects

Dependent Variable: Critical Thinking Skill

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	115.878	3	38.626	5.125	0.003
Intercept	358184.134	1	358184.134	47526.570	0.000
Learning_Model	11.880	1	11.880	1.576	0.215
Initial_Ability	37.968	1	37.968	5.038	0.029
Learning_Model * Initial_Ability	70.726	1	70.726	9.384	0.003
Error	414.508	55	7.537		
Total	359564.390	59			
Corrected Total	530.386	58			

[a]R Squared =,218 (Adjusted R Squared =,176)
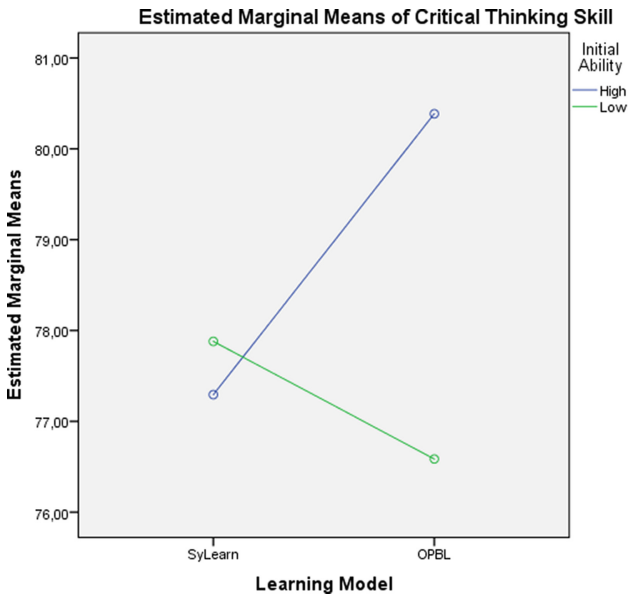
Fig. 1. Interaction Between Learning Models and Initial Ability to Students' Critical Thinking Skills

between the learning model and the initial ability of students' critical thinking skills. Thus, there are differences in students' critical thinking skills in the two learning models, both for students with high and low initial abilities. To see and confirm whether there is an interaction effect between the learning model and initial abilities on student achievement, it can be seen in Fig. 1.

4   Conclusion

Based on the results and discussion, it can be concluded that there are differences in critical thinking skills between students who learn to use OPBL compared to SyLearn. Students who learn to use OPBL in the research methodology course have higher critical thinking skills than students who learn to use SyLearn. Then, there are differences in critical thinking skills between students with high initial abilities compared with low. Students with high initial abilities have higher critical thinking skills than those with low initial abilities. In addition, there is an interaction between learning media and the initial ability of students' critical thinking skills. Thus, there are differences in students' critical thinking skills in the two-learning media, both for students with high and low initial abilities.

References

1. R. S. Hidayatullah, S. R. Ariyanto, Muhaji, H. Mubarok, and A. Yohannes, "Collaborative Problem-based Learning: An Analysis of Problem-Solving Skills in Vocational Schools," *IJORER : International Journal of Recent Educational Research*, vol. 1, no. 3, pp. 209–217, Oct. 2020, https://doi.org/10.46245/ijorer.v1i3.62.
2. L. Deligiannidis, C. Wiseman, M. Yun, and H. R. Arabnia, "Security Projects for Systems and Networking Professionals," in *Emerging Trends in ICT Security*, Elsevier, 2014, pp. 111–122. https://doi.org/10.1016/B978-0-12-411474-6.00007-4.
3. S. M. M. Loyens, P. A. Kirschner, and F. Paas, "Problem-based learning," in *APA educational psychology handbook, Vol 3: Application to learning and teaching.*, Washington: American Psychological Association, 2012, pp. 403–425. https://doi.org/10.1037/13275-016.
4. L. Cai and Y. Zhu, "The Challenges of Data Quality and Data Quality Assessment in the Big Data Era," *Data Science Journal*, vol. 14, p. 2, May 2015, https://doi.org/10.5334/dsj-2015-002.
5. A. Shahzad, H. K. Chin, M. Altaf, and F. A. Bajwa, "Malaysian SME's performance and the use of e-commerce: A multi-group analysis of click-and-mortar and pure-play e-retailers," *Pakistan Journal of Commerce and Social Sciences (PJCSS)*, vol. 14, no. 1, pp. 1–33, 2020.
6. G. Chopra, P. Madan, P. Jaisingh, and P. Bhaskar, "Effectiveness of e-learning portal from students' perspective," *Interactive Technology and Smart Education*, vol. 16, no. 2, pp. 94–116, Jun. 2019, https://doi.org/10.1108/ITSE-05-2018-0027.
7. T. Tang, V. Vezzani, and V. Eriksson, "Developing critical thinking, collective creativity skills and problem solving through playful design jams," *Thinking Skills and Creativity*, vol. 37, p. 100696, Sep. 2020, https://doi.org/10.1016/j.tsc.2020.100696.
8. D. F. Halpern, "Critical Thinking, Cognitive Psychology of," in *International Encyclopedia of the Social & Behavioral Sciences*, Elsevier, 2001, pp. 2990–2994. https://doi.org/10.1016/B0-08-043076-7/01586-2.

9. P. V. Peaks, "Developing Critical Thinking in Perioperative Staff Members," *AORN Journal*, vol. 108, no. 1, pp. 81–85, Jul. 2018, https://doi.org/10.1002/aorn.12295.

10. M. Nazir, *Metode penelitian*, 11th ed. Bogor: Ghalia Indonesia, 2014.

11. Z. Drezner, O. Turel, and D. Zerom, "A modified kolmogorov-smirnov test for normality," *Communications in Statistics: Simulation and Computation*, vol. 39, no. 4, pp. 693–704, 2010, https://doi.org/10.1080/03610911003615816.

12. P. Mishra, C. Pandey, U. Singh, A. Gupta, C. Sahu, and A. Keshri, "Descriptive statistics and normality tests for statistical data," *Annals of Cardiac Anaesthesia*, vol. 22, no. 1, p. 67, 2019, https://doi.org/10.4103/aca.ACA_157_18.

13. 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. https://doi.org/10.4135/9781506326139.n392.

14. N. Erjavec, "Tests for Homogeneity of Variance," in *International Encyclopedia of Statistical Science*, Berlin, Heidelberg: Springer Berlin Heidelberg, 2011, pp. 1595–1596. https://doi.org/10.1007/978-3-642-04898-2_590.

15. O. Chukwudi, O. Idochi, and I. O. Sylvia, "Effect Of Sample Sizes On The Empirical Power Of Some Tests Of Homogeneity Of Variances," *International Journal of Mathematics Trends and Technology*, vol. 65, no. 6, pp. 119–134, 2019, https://doi.org/10.14445/22315373/ijmtt-v65i6p518.

16. Sugiyono, *Statistika untuk penelitian*, 17th ed. Bandung: Alfabeta, 2010.