

# THE EFFECT OF LEARNING MODELS ON BIOLOGY CRITICAL THINKING SKILLS OF MULTIETHNIC STUDENTS AT SENIOR HIGH SCHOOLS IN INDONESIA

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## Abstract

*Teachers play an important role in the world of education, including in the process of planning the learning activities. A meaningful learning will be able to provide a good effect on students' thinking ability. One of the students' thinking skills that can be empowered is the critical thinking. Critical thinking skills can help a person to face the challenges of a globalized world. This research aimed at revealing the effect of PBL learning model on the critical thinking skills of multiethnic students. The design of this research was quasi experimental in non-equivalent pretest-posttest control group design. This research was conducted on multiethnic students of class XI Science in July-December 2016, in Samarinda, Indonesia. The results of the data analysis showed that learning model had an effect on students' critical thinking skills. PBL model had a mean score of students' critical thinking skill 73.81% higher than that of the conventional learning. Ethnicity had an effect on students' critical thinking skills. The mean score of students' critical thinking skills of Javanese was 11.94% higher than that of the Kutai ethnic, and 13.17% higher than that of the Banjar ethnic.*

**Keywords:** *learning model, problem based learning, critical thinking skills, multiethnic students.*

## Introduction

To face the global demand, including the demand of 21st century, requires the preparedness in many aspects, including education. Runco (2014) stated that the trend in the current education was not only about teaching reading, writing and arithmetic but also about teaching how to develop and use thinking skills. Problem solving ability and some other skills of science literacy and technology should also be optimally empowered in education (Segal, Chipman & Glaser, 1985; Lawless & Brown, 2015).

Alismail and McGuire (2015) stated that life today is exponentially more complicated and more complex than that of fifty years ago. In the 21st century everyone needs high level of information and technology literacy that goes far beyond the basic knowledge which was sufficient in the past. Furthermore, it was explained that there were four important skills that should be possessed and empowered in the 21st century. Those skills include critical thinking and problem solving, communication, collaboration, and creativity and innovation.

One of the skills that are essential to be empowered is the thinking skill, including the critical thinking skill. To date, researchers have not found a way to measure the other skills, so that this research only measures the critical thinking skills. Paul (1988) defined the critical

thinking skills as something that were done to obtain a conclusion in accordance with the goal and the knowledge already existed. Seferoglu & Akbiyik (2006) explained that critical thinking skills were the ability to see an event or condition and give a comment, a decision based on a person's knowledge and thoughts. Howard, Tang & Austion (2015) explained that high order thinking skills provided an opportunity to correct any errors or ability to solve a problem appropriately and in accordance with the existing conditions. Critical thinking skills basically involve identifying and analyzing the sources of information for credibility, demonstrating the prior knowledge and making connections as well as making a conclusion (Thurman, 2009). Based on some sources related to critical thinking skills over time, it can be concluded that the critical thinking skills are the skills owned by a person to solve a problem based on their knowledge.

### *Problem of Research*

Related to the students' critical thinking skills in biology, the results of surveys and interviews (May, 2012) to forty Biology teachers of Senior high schools in Samarinda, about students' critical thinking skills in biology, revealed that there were still many students of class XI who were not able to express their opinions in a structured and logical manner. Eight teachers (20.0%) said that it was not satisfactory, 15 teachers (37.5%) said that it was quite satisfactory, ten teachers (25.0%) said that it was satisfactory, and seven teachers (17.5%) said it was very satisfactory. Likewise, there were still many students who were not able to express their arguments in explaining a problem related to biology learning. The results of the survey also showed that teachers still used conventional learning technique in teaching biology in class XI of science of senior high school.

Teachers have an important role in empowering the critical thinking skills. It can be started from the process of making the lesson plan. The scenario developed needs to pay attention to the various components that affect the students' learning process, starting from the learning model used in the learning process until some other things that teachers need to consider. One of the learning models that can be implemented to empower students' thinking skills is PBL model. There have been many research on PBL related to the empowerment of students' high order thinking skills (Savery, 2006). Previous research has revealed that PBL has become the domain of learning aimed at improving students' thinking skills (Sendaq & Odabas, 2009; Iwaoka et al., 2010). The problem of this research is related to the fact that there was not any information yet about the effect of PBL learning model on multiethnic students' critical thinking skills in Samarinda, East Kalimantan, Indonesia. Thus, this research is carried out to reveal the effect of PBL learning model on the students' critical thinking skills.

### *Research Focus*

In this research, the critical thinking skills of the students taught by using PBL learning model were compared with those of the students taught by using conventional learning (The type of learning that was usually implemented everyday by the teachers). The comparison was done on multi-ethnic students in Samarinda, East Borneo, Indonesia. From this research, it will be revealed the effect of PBL learning model on the critical thinking skills of multiethnic students.

Yuan et al. (2008) stated that PBL was a student-centered learning, and it enabled the students to participate actively in group work activities. Rideout and Carpio (2001) also explained that in PBL, the students would be trained in solving problems both individually and in groups, and the students' critical thinking skills can be empowered during the group discussions. This is supported by Williams' statement (1999) explaining that PBL provided the opportunities for students to improve their critical thinking skills, made students become independent learners, and involved students in the process of problem solving.

The research by Biley and Smith (1999) revealed that every activity in PBL was able to empower students' critical thinking skills. PBL provides the opportunities for students to develop their critical thinking skills and to evaluate their skills by analyzing real situations/problems (Smith, 1995). In addition, PBL challenges the students to solve authentic problems and to make their own solution (Brigili, 2015).

Another component that may affect the learning in the classroom is ethnic. In relation to the ethnic condition of senior high school students in class XI of science in Samarinda, the results of the survey conducted by Boleng (2012) to 1.778 students of class XI of science in 2012/2013 academic year found that there were four major ethnic groups having the largest number of students, namely Javanese ethnic 41.7%, Banjar ethnic 15.1%, Bugis ethnic 14.7%, and Kutai ethnic 6.2%. Some other ethnic groups (22.3%) comprised of relatively small numbers of students, but almost distributed in most of class XI of science in Samarinda. In relation with the students' ethnic, the learning process should be planned to accommodate the character of students having diverse ethnic backgrounds. Thus, the learning objectives, both related to the cognitive learning results, social attitudes, critical thinking skills, creative thinking skills, as well as some others can be achieved. Therefore, it is necessary to conduct a research which aims at revealing the effect of learning models and ethnic on students' critical thinking skills.

## **Methodology of Research**

### *General Background of Research*

This is a quantitative research classified as a quasi-experiment using Pre-test; post-test Nonequivalent Control Group Design. This research was conducted during the odd semester in the 2016/2017 academic year. The independent variables of this research were learning models consisting of two levels (Problem Based Learning Model and Conventional Learning) and the ethnics of the students consisting of four different levels (Java, Banjar, Bugis, and Kutai). The dependent variable of this research was the students' critical thinking skills.

### *Sample of Research*

The population in this research was all senior high school students from 21 senior high schools in Samarinda, East Kalimantan, Indonesia. The samples of this research were the science class XI students of state senior high school 1 Samarinda as well as of state senior high school 8 Samarinda. The samples were selected based on the equality test carried out in all senior high schools. The senior high schools, which met the criteria of data collection in this research, were two senior high schools.

### *Instrument and Procedures*

Critical thinking skills were measured by using a rubric of critical thinking skill which was developed by referring to Hard (1994). The test instrument was initially tested for the validity and reliability. The data were taken during the pre-test; post-test.

### *Data Analysis*

The data of this research were analyzed by using two-way ANCOVA with the significance level of 0.05 ( $p < 0.05$ ). Pre-test was used as the covariate. Before the ANCOVA test was performed, the pre-requisite tests, namely the data normality test using Kolmogorov-Smirnov test and data homogeneity test using Levene test were conducted. The data were analyzed using IBM SPSS Statistics 23 for Windows.

## Results of Research

The summary of the results of ANCOVA on the effect of learning models and ethnic, and the interaction of both learning models and ethnic on students' critical thinking skills can be seen in Table 1.

**Table 1. The results of ANCOVA on the critical thinking skills of multiethnic students.**

Source	Type III Sum of Squares	df	Mean Square	F	Sig. ( $p$ level)
Corrected Model	12365.962 <sup>a</sup>	8	1545.745	31.831	.001
Intercept	20183.617	1	20183.617	415.631	.001
XKKBK	17.587	1	17.587	.362	.551
Model	11353.136	1	11353.136	233.790	.001
Ethnic	423.752	3	141.251	2.909	.046
Model * Ethnic	83.539	3	27.846	.573	.636
Error	2039.577	42	48.561		
Total	191111.500	51			
Corrected Total	14405.539	50			

a. R Squared = .858 (Adjusted R Squared = .831)

### *The Effect of Learning Model on Students' Critical Thinking Skills*

The results of ANCOVA analysis show related to the effect of learning model and the significance value is 0.0001 ( $p < .001$ ). It means that there is a difference in critical thinking skills between the students who are taught by using PBL and those taught by using conventional learning. PBL model gave a mean score of students' critical thinking skills as much as 72.068, which is 73.81% higher than students' critical thinking skills in conventional learning as much as 41.462.

### *The Effect of Ethnic on Students' Critical Thinking Skills*

The results of ANCOVA analysis related to the effect of ethnic show that the significance value is 0.046  $< 0.05$ . The results of the analysis can be interpreted that there is a difference in students' critical thinking skills among ethnics. The results of post hoc test on the effect of ethnic on students' critical thinking skills are presented in Table 2.

**Table 2. The LSD notation related to the students' critical thinking skills.**

No	Ethnics	Xcritical	Ycritical	Difference	Corrected Critical	LSD Notation
1	Banjar	15.892	54.607	38.715	54.345	a
2	Kutai	13.461	58.461	45	54.940	a
3	Bugis	11.750	59.000	47.25	56.270	a b
4	Jawa	12.678	63.392	50.714	61.505	b

The results of LSD test show that Javanese ethnic has the mean score of students' critical thinking skills 11.94% higher than that of Kutai ethnic, and 13.17% higher than that of Banjar ethnic.

*The Effect of Interaction between Learning Models and Ethnic on Students' Critical Thinking Skills*

The results of ANCOVA analysis related to the effect of the interaction between learning models and ethnic on students' critical thinking skills showed that the interaction does not have any effect on students' critical thinking skills. Although the results of the analysis of the interaction are not significant, to obtain the information about the position of each combination group, the post hoc LSD test was performed too. The results of post hoc test related to the effect of the interaction between learning model and ethnic on students' critical thinking skill can be seen in Table 4.

**Table 4. The results of LSD test related to the critical thinking skills of the interaction between learning model and ethnic groups.**

No.	Model	Ethnic	XCritical	YCritical	Difference	Corrected Critical	LSD Notation
1	Control	Banjar	16.785	37.428	20.643	37.065	a
2	Control	Kutai	12.500	39.500	27	39.622	a b
3	Control	Bugis	10.625	41.250	30.625	41.585	a b
4	Control	Javanese	12.916	47.500	34.584	47.575	b
5	PBL	Kutai	14.062	70.312	56.25	70.258	c
6	PBL	Bugis	12.500	70.833	58.333	70.956	c
7	PBL	Banjar	15.000	71.785	56.785	71.625	c
8	PBL	Javanese	12.500	75.312	62.812	75.435	c

The results of the post hoc test show that the critical thinking skills of the students in PBL multiethnic class were not significantly different between one another. Thus, the implementation of PBL has the potential to empower students' critical thinking skills in a wide range of ethnicities.

**Discussion**

The results of data analysis shows that learning model has a significant effect on students' critical thinking skills. PBL learning model is proven to give good effect on students' critical thinking skills. The syntax of PBL model provides the students with the learning atmosphere appropriate to the principles of scientific approach. The syntax of PBL learning, in its implementation in the classroom, allows the students to formulate problems, to make strategies to solve the problems, to gather data, to discuss the obtained data, to prepare materials for presentation, and finally to do a presentation in front of the class. The work patterns in the syntax of PBL require the students to be able to work individually and in groups. Yuan et al. (2008) suggested that PBL model facilitated the students in sharing opinions, provided an opportunity for the students to analyze a situation in different ways, and trained students' thinking skills, especially in terms of problem solving.

The implementation of the syntax of PBL learning allows the students to select the ways in collecting data, the way that suits their needs in the process of collecting data. Students are able to determine a certain way, which they think can be used to solve the problems that have been formerly formulated. This learning situation is different from the traditional learning, where teachers are more dominant in the learning process and the students are limited in the process of obtaining information. Yuan et al. (2008) stated that PBL was a learning activity that challenged students to find the solutions to real-world problems based on group work. Furthermore, it was explained that the group work activity in PBL would encourage the students to demonstrate their critical thinking in group discussion activities. They analyzed and



synthesized data, developed hypotheses, applied deductive reasoning, and drew conclusions. In addition, they would develop appropriate strategies and found solutions to the problems they faced. Those activities are based on their thinking process (Ryan & Quinn, 1995).

Yuan et al. (2008) revealed that, in his research, he found an empirical evidence that the critical thinking skills of nursing undergraduate students in China could be empowered by implementing PBL model. Batdı (2014) conducting a meta-analysis study of 90 research findings on the effectiveness of PBL, found that the PBL model was more effective than the traditional learning. Thus, the PBL model has potential in empowering the students' critical thinking. Teachers should continuously train the students in learning biology to find and formulate problems, and determine their own way to collect data in the process of solving their problems.

The results of data analysis showed that ethnic had an effect on students' critical thinking skills. Students of particular ethnic tend to have a distinctive character, and different from the characters of the other ethnic groups. Boleng (2014) stated that the syntax of a learning model gave a unique and specific experience to the students. It could affect a person's thinking ability.

Related to the student's ability to formulate problems and to determine the ways of solving the problem, each ethnic will have some differences. What causes the difference is caused by different desires and philosophy of life of each ethnic. Mustapha et al. (2009) concerned that with the absence of inter-racial policy, racial tensions might grow. Therefore, there should be positive interaction in the learning activities in classroom, that is, among the students having different ethnic backgrounds.

The results of the data analysis show that the interaction between learning models and ethnic does not have any effect on students' critical thinking skills. It means that the implementation of learning models in all ethnic groups of students has an equal effect on students' critical thinking skills. To reveal the information related to the combination of learning model and ethnic, post hoc LSD test is performed. The results of post hoc show that in PBL model there is not significant difference of student critical thinking skills among each ethnic. It means that PBL model is proven having potential to empower and equalize students' critical thinking skills of all ethnicities, on the other hand conventional learning does not have such potential. Savery (2006) explained that the implementation of PBL could engage the students in an active learning. Furthermore, it was explained that PBL will be able to empower the students to do research, to integrate theory into practice, and to implement their knowledge and skills to develop the best solution to a problem. Thus, the students will become independent learners and critical thinkers when they analyze, evaluate and synthesize information from various sources.

## Conclusions

Based on the data analysis and discussion, it can be concluded that learning models have an effect on students' critical thinking skills. PBL model gives a mean score of students' critical thinking skills 73.81% higher than that of the conventional learning. Ethnic has an effect on students' critical thinking skills. The Javanese ethnic has a mean score of students' critical thinking skills 11.94% higher than that of the Kutai ethnic, and 13.17% higher than that of the Banjar ethnic. The interaction between learning model and ethnic does not have any effect on the critical thinking skills of class XI students of Senior High Schools in Samarinda, Indonesia. Furthermore, PBL is proven having potential to empower and equalize students' critical thinking skills, that cannot be done by conventional learning.

Based on the research results there are some suggestions that will be described. The results of this research need to be confirmed further by other studies in the future. Biology teachers should understand the syntax of PBL better and implement it in biology learning in the classroom. On the other hand the school principal should monitor the teachers' learning media, especially Biology teachers, as an effort to improve students' critical thinking skills. Furthermore training activities on learning models/approach should be carried out more frequently, especially related to biological materials.

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## References

- Alismail, H.A. & McGuire, P. (2015). 21st century standards and curriculum: Current research and practice. *Journal of Education and Practice*, 6 (6), 150-155.
- Batdi, V. (2014). The effects of a problem-based learning approach on students' attitude levels: A meta-analysis. *Educational Research and Reviews*, 9 (9), 272-276.
- Biley, F., & Smith, K. (1999). Making sense of problem based learning: the perceptions and expectations of undergraduate nursing students. *Journal of Advanced Nursing*, 30 (5), 1205-1212.
- Birgili, B. (2015). Creative and critical thinking skills in problem-based learning environments. *Journal of Gifted Education and Creativity*, 2 (2), 71-80.
- Boleng, D. T. (2014). Pengaruh Model Pembelajaran Cooperative Script dan Think-Pair-Share terhadap Keterampilan Berpikir Kritis, Sikap Sosial, dan Hasil Belajar Kognitif Biologi Siswa SMA Multietnis [The effect of cooperative script and think-pair-share learning models on the critical thinking skills, social attitude and biology cognitive learning results of multiethnic students of senior high schools]. *Jurnal Pendidikan Sains*, 2 (2), 76-84.
- Howard, L. W., Tang, T., & Austin, M. J. (2015). Teaching critical thinking skills: Ability, motivation, intervention, and the Pygmalion effect. *Journal of Business Ethics*, 128, 133-147.
- Iwaoka, W. T., Li, Y., Rhee, W. Y. (2010). Measuring gains in critical thinking in Food Science and Human Nutrition course: The Cornell Critical Thinking Test, problem based learning activities, and student journal entries. *Journal of Food Science Education*, 9 (3), 68-75.
- Lawless, K. A., & Brown, S. W. (2015). Developing scientific literacy skills through interdisciplinary, technology based global simulations: GlobalEd 2. *The Curriculum Journal*, 26 (2), 268-289.
- Paul, R., & Elder, L. (2012). *Critical thinking: Tools for taking charge of your learning and your life*. Upple Saddle River, NJ: Prentice Hall.
- Mustapha, R., Azman, N. Karim, F. Ahmad, A. R. & Lubis, M. A. (2009). Social integration among multi-ethnic students at selected Malaysian universities in Peninsular Malaysia: A survey of campus social climate. *AJTLHE: ASEAN Journal of Teaching and Learning in Higher Education*, 1 (1), 35-44.
- Rideout, W., & Carpio, B. (2001). The problem-based learning model of nursing education. In E. Rideout (Ed.), *Transforming nursing education through problem-based learning* (p.21-49). Jones and Bartlett Publishers, Mississauga.
- Runco, M. A. (2014). *Creativity theories and themes: Research, development and practice*. (2nd Ed.) USA: Elsevier Inc.
- Ryan, G. L., & Quinn, C. N. (1995). *Cognitive apprenticeship and problem based learning*. In S. E. Chen, R. M. Cowdroy, A. J. Kingsland & M. J. Ostwald (Eds), *Reflections on problem-based learning. The Australian problem-based learning network* (p.57-72). Sydney.
- Savery, J. R. (2006). Overview of problem-based learning: Definitions distinctions. *Interdisciplinary Journal of Problem-Based Learning*, 1 (1), 9-20. Retrieved from <http://dx.doi.org/10.7771/1541-5015.100>.
- Seferoglu, S. S., & Akbıyık, C. (2006). Teaching critical thinking. *Hacettepe University Journal of Education*, 30, 193-200.
- Segal, J. W., Chipman, S.F., & Galser, R. (1985). *Thinking and learning skills: Relating instruction to research*. New York: Routledge.
- Sendaq, S., & Odabas, H. F. 2009. Effect of problem based learning course on content knowledge acquisition and critical thinking skills. *Computers & Education*, 53 (1), 132-141.
- Smith, C. A. (1995). Features section: Problem-based learning. *Biochemistry and Molecular Biology Education*, 23 (3), 149-152.

- Thurman, A. B. (2009). *Teaching of critical thinking skills in the English content area in South Dakota public high schools and college*. Doctor of Philosophy Dissertation, University of South Dakota, USA.
- Williams, A. F. (1999). An Antipodean evaluation of problem-based learning by clinical educators. *Nurse Education Today*, 19, 659-667.
- Yuan, H., Kunaviktikul, W., Klunklin, A., & Williams B.A. (2008). Improvement of nursing students' critical thinking skills through problem-based learning in the People's Republic of China: A quasi-experimental study. *Nursing and Health Sciences*, 10 (1), 70-6.

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