

Improving the Critical Thinking Skills of Secondary School Students using Problem-Based Learning

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Abstract: Problem-based learning (PBL) is a pedagogy where students gain knowledge about a subject through solving an ill-structured problem. Critical thinking skills (CTS) are the capacity to think about what to do or what to consider by an individual. This study sought to decide if using Problem-based Learning (PBL) improves the critical thinking skills (CTS) of the students in a secondary school in the subject of economics. This research used an experimental design. Twenty-seven (27) students were purposively selected from a secondary school in Zambales, Philippines for the school year 2017-2018. Results proved that there was a significant difference in the test scores before and after the intervention. We found PBL to be effective in improving the critical thinking skills of the students based on the result of the mean analysis, standard deviation, and t-test. The researchers recommend that problem-based learning may improve the level of critical thinking skills of the students and improve the teaching-learning process.

Keywords— Critical thinking skills, Descriptive action research, Grade 9 students, Problem-based learning

1. INTRODUCTION

Faculty, teachers, instructors, and professors always deal with the correct methods in giving educational preparations for the students in the academic field. Asio & Riego de Dios (2019) showed what makes an educator well-qualified, it is an essential aspect of educators to possess an innovative way to teach students. Teaching students nowadays differs from decades ago. The students can subject teachers into different degradation. Literatures emphasized the proliferation of teacher bullying by students (Asio & Gadia, 2019; Asio, 2018) and it is alarming to know. Thus, it is important to provide a sound and critical way of delivering knowledge to students.

Whether our focus on the field is on language, history, math, geography or economics, the aim of educators is to convey students to think. Critical thinking dates back to the early times of the Greek philosophers Plato and Aristotle. Dewey also put premiums on the importance of critical thinking.

Literatures that show relationships between critical thinking skills and problem-based learning researches from those of Burris (2005) and Masek and Yamin (2011) which yielded a positive attribute on the students. As Stentoft (2017) characterized problem-based learning as an approach to interdisciplinary learning.

1.1 Problem-based Learning

Problem-based Learning can derive a variety of effects and impacts on both students and teachers. PBL can be an efficient learning strategy (Gorghiu, Draghicescu, Cristea, Petrescu & Gorghiu, 2014; Fatade, Mogari, and

Arigbabu, 2013; Mustafa, 2016; Sindelar, 2010); has positive effects on teaching (Padmavathy & Mareesh, 2013); problem-solving skills and self-efficacy (Rokhmawati, Djatmika, and Wardana, 2016; Padmavathy & Mareesh, 2013); enhanced student performance (Polanco, Calderon, and Delgado, 2004); and an effective instructional approach (Mergendoller, Maxwell, and Bellisimo, 2000).

Further, in the research of Sungur and Tekkaya (2006), they stated that class learning with problem-based learning has high intrinsic motivation, influences meaning in doing the job, increases the ability to think and, has meta-cognitive and self-regulated learning, if compared with the class applying conventional learning. In addition, according to Salandanan (2012), when students solve the task or problem the learning becomes permanent because it develops critical-mindedness, likewise inculcates systematic habits of work through their adulthood and students develop a high sense of responsibility, originality, and resourcefulness.

Contradicting to other researches, Sahin and Yorek (2009) suggest that the PBL approach has no positive influence on students' achievement and expectations about physics and physics learning for this group of students. Corroboratively, Demirel and Dagyar (2016) found a low-positive effect of PBL on a student's attitudes. Anazifa and Djukri observed the same idea (2017) that there is no differential effect of PBL on the student's critical thinking. In the study of Dochy, Segers, van den Bossche, and Gijbels (2003), results show that there is a difference in the reported effects of PBL between each of the three levels in the knowledge structure. The team of Argaw, Haile, Ayalew and Kuma (2017) also argued that there was no significant difference in motivating students when they used PBL instruction.

1.2 Critical Thinking Skills

Education is the tip of the spear in improving the quality of human resources. The change of education with the needs of the days should be one-step taken by educators to improve the quality of human resources. It reflected the concept of critical thinking in Greek philosophers' teaching such as Socrates, Plato and Aristotle (Staib, 2003; Burbach, Matkin, & Fritz, 2004). According to Utami, Saputro, Ashadi, Masykuri, and Widoretno (2017), critical thinking skills are the priority in the goals of education. Whitten and Brahmasrene (2011) found out that there significant differences and relationships in the critical thinking scores and its components when grouped according to college classification, high school GPA, high school rank, SAT verbal scores, SAT mathematical scores, gender, race and major. Organizational learning culture affects the critical thinking skills of female higher education female teachers (Sabri, Ilyas & Amjad, 2015). On the study of Ozyurt (2015), there was a low level of a significant relationship between the critical thinking disposition and problem-solving skills of students.

However, Horenstein, and Niu (2011) revealed that the same instructional interventions could lead to different results depending on the intervention's implementation. In the study, these determined the characteristics of the students, which showed whether they manifest critical thinking skills based on the observation of the teacher.

The theoretical premises for PBL according to Solomon (2005) includes contextual learning, information-processing theory, and cooperative learning. It results in superior problem-solving skills.

In the work of Pagander and Read (2014), they showed that PBL anchors with constructivism as being a "student-centered". PBL involves negotiating with learners, focusing on the starting point that each student brings to the PBL process, and allowing greater control by the student in terms of the direction and content of learning. With this in mind, different tasks place different emphasis on these aspects. According to Orig (n.d.), problem-based learning via Socratic questioning can apply to a contemporary method of education. A problem comprises several questions that students encounter during class. A question will serve as a pivotal quandary around which other ideas and questions spring from.

2. METHODOLOGY

2.1 Research Design

This study used an experimental design. This involves a one-group pretest-posttest scheme. It includes a pretest measure followed by a treatment and a posttest for a single group (Creswell, 2014). The study describes the level of critical thinking of students before and after applying the technique using formative evaluation like quizzes, group/pair exercises, and tangible outputs.

The researcher would like to find out if there is a clear manifestation of a relationship between the two variables. Moreover, if there shows such, it would be of a great addition to the research a community for having a study that is done.

The findings of this study would be helpful to a variety of professionals that may find the article reliable to some extent either in their own field or even just for a simple discussion and citation in research.

2.2 Respondents

There were 27 respondents from a secondary school in Zambales, Philippines. These respondents were bona fide students and enrolled in their respective classes of the same academic year 2017-2018. The researchers used a purposive sampling technique for the study.

2.3 Research Instrument

To determine the impact of Problem-based Learning among grade nine students, the researchers used a unit plan and a teaching plan in Economics subject, for the tool or instrument. Three teachers validated the table of specification for the pre-test and post-test. They put their remarks and corrections before the researchers used it. Then an item analysis was done to check the reliability of the pre-test and post-test.

2.4 Data Analysis

To determine the impact of PBL, the researchers used item analysis, frequency and percentage distribution, dependent *t*-test and standard deviation. There is also a comparison of the pre-test and post-test results to determine the improvement of critical thinking before and after using PBL. We used frequency and percentage for the scores of the students on their pre-test and post-test. The researchers also used a dependent *t*-test for the significant difference in the average score of the students before and after the study. Then the standard deviation measured the class distribution. The Researchers used Statistical Package for Social Sciences (SPSS) version 22 for statistical computation.

3. RESULTS

3.1 Student's Level of Critical Thinking Skills before the Intervention

The result of their diagnostic/ pre-test reflected the level of critical thinking skills of the Grade 9 students in the Economics subject.

Table 3 shows the frequency and percent distribution of the students' performance in the 30-item test given by the teacher.

Table 3. Frequency and Percent Distribution of the Students' Score in the Pre-test

Class	Frequency	Percent	Descriptive
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Interval			Rating
13-18	3	11.11	Average
7-12	23	85.19	Fair
1-6	1	3.70	Poor
Total	27	100	WM: 9.52 (Fair)

Twenty-three students or 85.19 percent of the class were considered fair, three students or 11.11 percent were considered average and one student was considered poor. In summary, before using the technique, most of the students had fair level of critical thinking skills and still needed a lot of improvement.

Further, critical thinking skills involve structured processes. In Table 4, we presented the proficiency of students based from the domains of learning, such as analysis, evaluation and creation.

Table 4. Level of Students' Proficiency in the Pre-test

	A	E	C	Weighted Mean
Average Number of Students	9	8	9	9
Percent	30.83	26.19	28.44	28.47%

*Legend: A-Analysis, E-Evaluation, C-Creativity

It is seen that in the pre-test, nine or 30.83% students mustered most the domain of Analysis, while eight (26.19%) students performed the domain of Evaluation and nine (28.44%) students mustered the domain of Creativity.

3.2 Formative Assessment during the Intervention

Problem-based Learning Quiz was conducted at the end of the topic to test the level of the critical thinking skills of the students. Quizzes made by the researcher further tested the effect of problem-based learning on the level of the critical thinking skills of the students in their Economics subject. Table 5 shows the score of the students in their three PBL quizzes.

Table 5. Mean and Standard Deviation of Students' Scores in their Three Problem-based Learning Quizzes

Score	Problem-based Learning Quizzes		
	1	2	3
11-15	19	16	24
6-10	6	10	3
1-5	2	1	0
Mean	11.07	10.78	12.3
SD	2.32	2.17	1.32

Results of the quizzes showed that there had been an increase in the level of the critical thinking skills of the students. The mean of the first quiz is 11.07 then it increased to 10.78 in the second quiz, it increased to 12.3 with a significant increase of 1.52 points. The standard deviation of

the scores in the first quiz was 2.32; in the second quiz, it was 2.17 and 1.32 in the final quiz. We have shown that problem-based learning helps improve the level of critical thinking skills of the students.

To strengthen the effects of the use of the strategy in between the quizzes, two performance tasks were administered for the students to accomplish. The first was creating a semantic web with thirty-five points, and the second one is role-playing with thirty points. These were all collaborative activities that integrated problem-based learning (PBL).

Table 6 exhibits percent of correct answers the mean scores in the two performance tasks.

Table 6. Students' Performances in the Task

	Task	Task 2
Items	35	30
Mean	30.41	28.48
Percent of Correct Answers	86.89	94.93

We can observe an increase of 8.04% from Task 1 to Task 2. This shows that more than the half of the class can perform based from the mean scores and the percent increase in the Performance Tasks. The performances of the students in the performance tasks were tested and assessed using holistic rubrics.

3.3 Students' Level of Critical Thinking Skills after the Intervention

The result of their Post-test mirrored the level of Critical Thinking Skills of Grade 9 students in Economics after using Problem-based learning.

Table 7 shows the frequency and percent distribution of the students' scores in post-test to find out whether there was a significant change in the level of the critical thinking skills of the students.

Table 7. Frequency and Percent Distribution of the Students' Scores in Post-test

Class Interval	Frequency	Percent	Descriptive Rating
19-24	8	29.63	Above Average
13-18	16	59.26	Average
7-12	3	11.11	Fair
Total	27	100	WM: 16.19 (Average)

The result of the post-test showed that sixteen or 59.26 percent of the students belonged to average, eight or 29.63 percent of the class belonged to above average and three of 11.11 percent of the students are considered fair.

With the calculated mean of 16.19 (SD=3.78), the class performance was average. It proves that Problem-based learning improves the critical thinking skills of the students.

In the post-test (Table 8), over half of the class, 16 (48.96%) students performed the domains of learning.

Table 8. Level of Students' Proficiency in the Post-test

	A	E	C	Weighted Mean
Average Number of Students	17	13	14	16
Percent	57.08	43.81	46.00	48.96%

*Legend: A-Analyzing, E-Evaluation, C-Creativity

There was an improvement in critical thinking skills. The learning domains belong to higher order thinking skills (HOTS) improved. They reflected this in performing students in the domain of Analysis as 17 or (57.08%) students got the test items 1, 2, 8, 9, 16, 17, 18 and 19 correct which showed that they mastered this learning domain. Meanwhile, test items 3, 4, 10, 11, 20, 21, and 22 were got by thirteen or (43.81%) students who performed the domain of evaluation. An average of 14 or 46% students mastered the domains of Creativity.

In the intervention's course, we saw a clear improvement in the levels of proficiency. Considering the learning domains mastered in the pre-test and post-test and as shown in the percentage increase of 20.49 in the post-test (Table 9).

Table 9. Level of students' proficiency in the Pre-test and Post-test

This was opposite with the result of the post-test (Table 9) where Analyzing was the most performed (mf=17; 57.08%), then Create with a mean frequency of 14 (46%) and Evaluating which is least performed with a mean frequency of 13 (43.81%).

Table 10 shows the comparison of the Mean and Standard Deviation of the Pre-test and Post-test.

Table 10. Frequency and Percent Distribution of Students' Score in Pre-test and Post-test

Class Interval	Pre-test		Post-test		Descriptive Rating
	F	%	F	%	
19-24	0	0	8	29.63	Above Average
13-18	3	11.11	16	59.26	Average
7-12	23	85.19	3	11.11	Fair
1-6	1	3.70	0	0	Poor
Total	27	100.0	27	100.0	

Mean	9.52	16.19
SD	2.47	3.78

From the 9.52 computed mean of the pre-test, the post-test has a result of 16.19. Therefore, it increased by 6.67 points. However, the standard deviation in the post-test is 3.78 that increased by 1.31, or can be interpreted that the scores in the post-test became more heterogeneous. The pre-test and the post-test show that there was an improvement in the students' level of critical thinking skills after applying the problem-based learning.

This showed that more students rose in their critical thinking skills. Students learn and respond during discussion if they know the answer and take part in classroom discussion.

Table 11 shows the difference of the two means of the critical thinking skills of Grade 9 in Economics before and after the use of Problem-based learning.

Table 11. Difference between the Pre-test and Post-test Mean Scores of the Students

Post-test Mean	Pre-test Mean	Mean Gain	t-value	Tabular value (a=0.05)	df
19.69	9.52	10.17	14.618*	2.06	26

*p < 0.05

We can view it on the table that the computed t-value 14.618 is greater than the critical t-value 2.06 at the 0.05 level of confidence. These figures show rejection of the null hypothesis on the level of the critical thinking skills of Grade 9 students before and after the intervention. This means that there is a significant difference in the level of the

Learning Domains	Pre-test		Post-test	
	Mf	(%)	Mf	(%)
Analyzing	9	30.83	17	57.08
Evaluating	8	26.19	13	43.81
Creating	9	28.44	14	46
Overall	9	28.47	16	48.96

critical thinking skills of Grade 9 students before and after using the intervention.

4. DISCUSSION

The aim of this study is to determine any relationship that exists between problem-based learning and the critical learning skills of secondary school students in an economics class. However, before going to that matter, let us first present the preliminary assessments of the students before we intervene with the concept.

We can infer from the preliminary presentation of tables that students, before applying the technique, had a fair level of critical thinking skills and needed improvement. Problem-based learning is an effective instructional activity for a

meaningful learning. (Fatade, Mogari, & Arigbabu, 2013) We also realize that critical thinking skills comprise a structured process like analysis, evaluation and creation and upon critical analysis. However, Wilder (2015) concurred that it is not possible to claim that problem-based learning is more effective in increasing a student's content knowledge. Upon the analysis, only one-third of the class could muster the three domains. As Utami, Saputro, Ashadi, Masykuri and Widoretno (2017) stipulated, critical thinking skills has a higher process which includes analysis, synthesis, evaluation, etc. which enables individuals to make a reasonable assessment.

During the formative assessment, the result showed a drastic change in the scores of the students based on their quizzes thus, an increase in the level of critical thinking skills of the students. With the significant increase in their scores during the students' quizzes, it only showed that problem-based learning has enhanced their performance. Wilder (2015) also involved that problem-based learning influences student academic achievement. The focus of the test was the understanding and application of the concepts rather than the recall of factual knowledge. (Polanco, Calderon, & Delgado, 2004)

For, the critical thinking skills of the students after the problem-based learning intervention reflect the results of their post-test results. From a fair level of critical thinking skills, it became an average. This only attests that problem-based learning increases the critical thinking skills of the students. As Tarhan and Ayyildiz (2015) and Schmidt, Rotgans and Yew (2011) argued that problem-based learning is an active learning approach and is very effective in creating knowledge. Even in the aspect of students' proficiency, from the original of one-third of the class to a significant, almost half of the class has mastery over the three domains (Analysis, Evaluation and Creation). This indicated that problem-based learning is more effective instructional method for teaching than traditional lecture-discussion (Mergendoller, Maxwell, & Bellisimo, 2000)

In the study's course, the pre-test and post-test scores delivered a substantial change in the scores in their proficiency. We can assume that problem-based learning has high intrinsic motivation, impacts meaning in doing the job, increases the capability to think, has meta-cognitive and self-regulated learning (Sungur & Tekkaya, 2006). They observed the same result on the study of Gholami, Moghadam, Mohammadipoor, Tarahi, Sak, Toulabi, and Pour (2016) wherein there is a significant increase in the overall critical thinking score.

To test if the scores were that substantial, we performed an independent *t*-test for the pre-test and post-test scores. There exists a significant difference in the scores since the computed *t*-value of 14.618 was greater than the tabular *t*-value, which is significant at 0.05 alpha level of confidence. This only means that problem-based learning is an effective instructional approach for teaching than the usual lecture-discussion. (Mergendoller, Maxwell, & Bellisimo, 2000) The

findings of Kang, Kim, Kim, Oh and Lee (2015) also reflects the same result and got a positive impact of problem-based learning in their study.

5. CONCLUSION

Based on the findings, we present the following conclusions:

- 1) Before using the technique, the level of critical thinking skills of the students was fair.
- 2) After using the technique, the level of critical thinking skills of the students was above average.
- 3) There is a significant difference before and after the use of Problem-based learning.

6. RECOMMENDATIONS

In the view of the findings and conclusions of the study, we hereby present the following recommendations for consideration.

- 1) Teachers may use problem-based learning to improve the level of critical thinking skills of the students and improve learning process.
- 2) Teachers can also try problem-based learning with other secondary school subjects to enhance the teaching-learning process.
- 3) The school administration may encourage using problem-based learning to teachers in their institution.
- 4) Provide seminars/ workshops on problem-based learning for teachers to re-equip them further with the technique and discover more about it,
- 5) Conduct further studies to validate the data gathered in this study and to advance the use of problem-based learning in the teaching-learning process.

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