

# **Integrated PBL Approach: Findings towards Physics Students' Critical Thinking**

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## **ABSTRACT**

*This paper presents the findings of second phase of study on physics students' critical thinking. This study was performed on a cohort of 25 (i.e., 13 females and 12 males) Physics with Electronics students from School of Science and Technology at University Malaysia Sabah. The sample was trained by an integrated Problem-Based Learning (PBL) method for 1 semester (i.e., 14 weeks). Participants' critical thinking was evaluated using a previously validated instrument, the Watson Glaser Critical Thinking Appraisal (WGCTA) (i.e., inference; assumption; deduction; interpretation; evaluation arguments). The result shows that there is significant different in inference criteria (sig2-tailed,  $t=5.57$ ,  $p=.00 < *.05$ ) favor to the first post test.*

**Keywords** *Critical thinking, problem-based learning*

## **1. INTRODUCTION**

Criticism about Malaysian graduates lack of scientific and technical knowledge, critical and creative thinking skills, competency based and communication skills been a keen issue nowadays (Malaysian, 2012). Complaint from industrial employer about Malaysian graduates rose up and this indirectly contributed in persistency concern of unemployment among graduates each other (Bagayah *et al.*, 2005; Lim, 2005) as mentioned by Lim (2011) and the unemployment among Malaysian graduates also in critical state (Lai, 2011). This study as also the earlier purposes of problem-based learning (PBL) exist was formed as a result for alternative solution of this criticism. Meanwhile, the deficiencies of information about the effectiveness of PBL in physics field also encourage the formation of this study.

Problem-based learning (PBL) was known as method of teaching which active learning and learner centered approach (Tan, 2011), where it was very different with traditional teaching method. PBL known as "guiding rather than directive" and it also "process oriented" (Kemp, 2011) where students independently become a problem solver. PBL started in Malaysia at 1981 when Medical Department of University Sains Malaysia adopted it first (Ibrahim, 2009). Although, PBL defined in various understanding by researchers but the cycle process of the implementation mostly start with students meet the problem, identify problem, independent study, tutorial and integration of learning (Hung *et al.*, 2007; Arzuman, 2005; Barrett, 2005).

The focus of this study is the use of PBL online in Physics course and links to students' critical thinking. Tons of literature review regarding PBL online, but the study concerning the implementation of PBL and

implication on Physics students' critical thinking very rare specifically in Malaysia education system (Sulaiman, 2011; Masek, 2011).

This paper presents the findings on second phase of implementation PBL integrated on Physics students.

## **2. METHODOLOGY**

In this study, the implementation of integrated PBL was to investigate the effects of the independent variable (integrated PBL) on dependent variable (WGCTA score).

### **2.1 Subjects**

This study was performed on 25 (i.e., 13 females and 12 males) students from second year of Physics with Electronics program who attended Thermodynamics Physics course in Semester 1 Session 2012/2013 at University Malaysia Sabah. The course was a compulsory course under the programme. They had been exposed by PBL method for 2 semesters (28 weeks). The course led by a lecturer who had 10 years of experienced in PBL.

### **2.2 Instruments**

Data gathered via Watson Glaser Critical Thinking Appraisal 1980 (WGCTA) test which adapted to Malaysia context by Sulaiman (2011). WGCTA was widely used by researchers represents by 5 tests in total: *inference, recognition of assumptions, deduction, interpretation and evaluations of arguments* was implemented before and after the PBL method. Additionally, for creative-critical thinking skill, data was collected by using The YanPiaw Creative Critical Thinking (YCreative-Critical Thinking) Test developed by Chua (2004) to identify student level of thinking styles. In this particular test there were 4 level of thinking that being stated which are: *superior creative thinking, creative thinking, balanced thinking, critical thinking and superior critical thinking*.

The Cronbach's alpha coefficient value for WGCTA test revealed a range of .76 to .85 accordingly while for YCreative-Critical Thinking Test is .90 (total score), .81(critical thinking style) and .85 (creative thinking style).

Data was analyzed using SPSS Windows version 20.

### **2.3 Procedure**

#### **2.3.1 The Online Platform**

In order to implement the online activities, Facebook (FB) chat room was used. As widely known, FB is a freely accessible social network on the Internet which would work for anyone (Collier *et al.*, 2012). FB was developed in 2004 by Mark Zuckerberg accessed by using either on computers or mobile phone and this makes students easy to use everywhere and anywhere they are (Collier *et al.*, 2012). This also make student's easy to share document or photo related to their problem anytime they want and each member or facilitator still can view it anytime they use FB not limited to their timetable.

#### **2.3.3 PBL Procedures**

The PBL process used in this implementation was summarized as shown in Fig. 1.

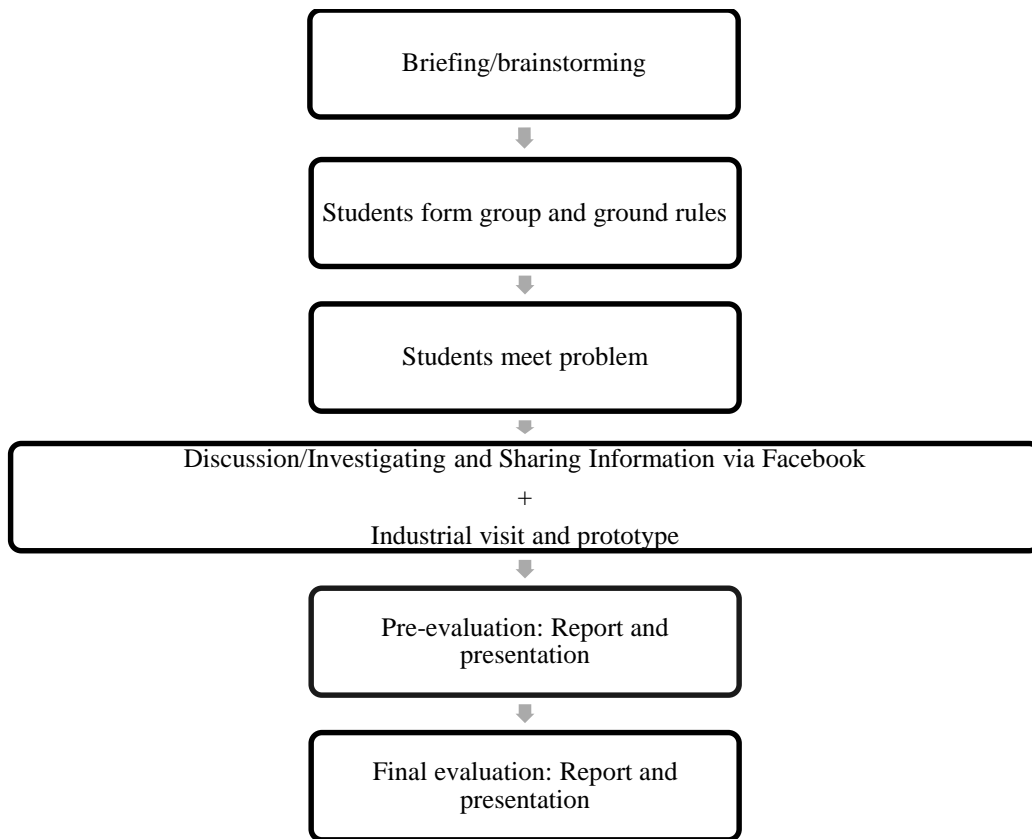


Figure 1: Summary of PBL model used

During the first and second week before PBL implementation, students briefly introduced about course outline. Meanwhile, students formed group about 5 to 6 people in a group and set ground rules. Students were provided with lecture note and act as their main guideline to identify their own problem statement. After brainstorming, students decided their slot time for online chatting: 1 hour per week for every group as this online PBL implementation held almost 3/4 using online chatting.

Students find their own problem statement with the guideline from lecture note and facilitator. During discussions, students were suggested their own idea and also shared the information they gathered during the independent learning. These activities had been monitored by a facilitator via online. Students normally were given with 1 week to settle on and decide their final problem statement and main objective which they will solve throughout the period of PBL implementation. Students usually gathered information from their surroundings, technology (internet), book and journal reading to come up with their problem statement.

The processed of intervention start with students brainstorm and brief about the problem with each other. After that students provide what they know and what they do not know about the problem and objective of problem. Students searched relevant information including book, journal, magazine, notes, manual, internet

and other kind of resources. All this give and take or sharing information and idea processed held via Facebook facilitated by lecturer and researcher as facilitator.

Additional compulsory activity that the group need to do was to visit to any government or private agencies related to their problem respectively for interviewing in a way for students understand more and get useful information. This is critical extra-curricular such as interview and observation will make students understand more and get useful information. Some of students even make a simple laboratory experiment or prototype after the visit to gain more idea and provide deeper understanding with the member group and other classmates.

To make this implementation more effective, after every 2 to 3 weeks of online class in chatting room (Facebook), students compulsory meet face to face with facilitators to exchange their confusing or dilemma. On the other hand, students also need to provide pre-report and pre-presentation at week 7 or 8 in front of their classmates and facilitator. This pre-evaluation provide them with experience for better communication skills and presenting in front of many people. Final report and presentation also held at the end of implementation in week 14 for final evaluation.

### 2.3.2 Face-to-face Discussion

Face-to-face discussion in this study held as usual lecture, sit in a class for 1 to 2 hours and facilitator discuss the progress of each group in term of their solution. This discussion held about 2 or 3 weeks after online class. This is important as to provide students with a solid discussion in every chat and they had time to ask facilitator question they found hard to explain during the online chat class. This discussion also provide time between facilitator and students to be little closer and realize the role of facilitator in their online chat class as guide which help students to more open to ask, share their opinion and widen their rationale during online chat. In addition, this discussion also helps each member to solve their misunderstanding and misinterpretation between each other's.

At the end of every face-to-face discussion, facilitator provides some feedback to almost every group member regarding to their level of participations, contributions of opinion or comment and alternative of solving the problem. This was important in helping the students to be to more confidence with the information that they want to share.

## 3. FINDINGS

As described earlier this paper presents the findings of second phase of study on physics students' critical thinking. Form B and C in this second phase was distributed on week 1 and week 14 accordingly. Table 1 shows the report of students' critical thinking for post- test 1 to post-test 2 by criterion.

These data show that students performed better before (mean=44.12, SD=11.01) rather than after (mean = 41.84, SD = 8.12) the implementation of PBL on second phase. However, the Independent Sample t-test analyses shows there are statistically significant for *inference* (sig 2-tailed,  $t = 5.57$ ,  $p = .00 < * .05$ ) favor to post-test 1, while there is no statistically significant for other criterion. Meanwhile, *inference* also appear statistically significant ( $z = -4.67$ , asym. sig = 0.00) when data analyses with the more non-parametric Mann-Whitney U-Test. Nevertheless, *inference* (mean difference = +0.48, SD difference = 1.20) and *evaluations of arguments* (mean difference = +0.72, SD difference = 0.17).

This study, as it was purposed to provide continuation of results of students' critical thinking after being intervened with integrated PBL approach. The result on second phase of PBL implementation show there is significant in one of critical thinking elements *inference*.

Table 1: Report of students' mean marks for critical thinking post-test 1 and post-test 2 by criterion

Critical Thinking Criterion		Post-test 1 (form B)	Post –test 2 (form C)		Difference in post test
			Mann-Whitney U Test	Independent sample t-test	
Inference	Mean	6.28	3.60		2.68
			z= -4.67 Asymp. Sig = 0.00	t= 5.57 p= 0.00*	
	SD	2.15	1.08		1.07
Assumption	Mean	9.64	9.24		0.40
			z= -0.75 Asymp. Sig = 0.46	t= 0.71 p= 0.42	
	SD	1.82	2.13		- 0.31
Deduction	Mean	10.00	10.48		- 0.48
			z= -0.51 Asymp. Sig = 0.61	t= -0.82 p= 0.42	
	SD	2.59	1.39		1.20
Interpretation	Mean	10.16	9.72		0.44
			z= - 0.69 Asymp. Sig = 0.49	t= 0.73 p= 0.47	
	SD	2.48	1.72		0.76
Evaluation of Arguments	Mean	8.04	8.80		- 0.72
			z= -1.44 Asymp. Sig = 0.15	t= -1.42 p= 0.16	
	SD	1.97	1.80		0.17
Overall	Mean	44.12	41.84		2.28
			z= -8.06 Asymp. Sig = 1.71	t= 4.77 p=1.47	
	SD	11.01	8.12		2.89

#### 4. DISCUSSION AND CONCLUSION

As the purpose of this paper was to report the findings of second phase of study on physics students' critical thinking after implemented with integrated PBL. Based from previous findings (Elnetthra et al., 2013) results shows that PBL implementation enhanced positive development on critical thinking style students, meanwhile for second phase of PBL implementation, reports shows there is no development in any criterion from the test.

Based from students' feedback at the end of PBL implementation, most students feel that it is difficult for them to adapted the PBL method teaching in Statistical Physics course. Statistical Physics as described by Galperin *et al.* (2004) was about a rational understanding of Thermodynamics in terms of microscopic particles and their interactions. Rather than just a theory compared to Thermodynamics Physics, Statistical Physics allows not only calculation but also the theory itself (Galperin *et al.*, 2004), this is one of the factor that makes students respond that PBL online was quiet hard to applied in Statistical Physics. Some students said the typical lecture (students being described and understood about the calculation and theory by facilitator and lecturer) was needed at least half of duration in this course before they introduced to PBL online.

Even so, students demonstrate their critical thinking ability on same criteria which is *inference* throughout the integrated PBL implementation, when students show statistically significant on this criterion on both phase of implementation.

This study, as its purpose was to provide continuation on second phase of implementation PBL integrated, results shows the significantly on inference criterion on second phase and this shows how students seems strong on this element in their study.

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