

**INTEGRATED PROBLEM-BASED LEARNING APPROACH  
IN PHYSICS COURSES: A CASE STUDY OF  
STUDENTS' ACHIEVEMENT**

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**ABSTRACT:** The study was sets out to monitor students' achievement when exposed with two different approaches. The approaches that used were problem-based learning assessment (PBLa) and Conventional assessment (Ca). The study was carried out in Faculty of Science and Natural Resources, Universiti Malaysia Sabah involving students who registered under Physics with Electronic Programme. The main objective of this paper is to scrutiny on how PBLa and Ca might contribute to students' performance that leads to their final grade in total. Two physics courses (i.e., Waves and Optic (SF10603) and Thermodynamics (SF20503)) were chosen. Data was gathered from three (3) sequential different batches of students who registered for the courses. The courses were offered in every first (1<sup>st</sup>) and second (2<sup>nd</sup>) semester in each session (i.e., 2012/2013(N=28); 2013/2014 (N=57); and 2014/2015 (N=47)). In the first semester students were exposed with a course with mixed approach of PBLa and CBLa. The different of students' achievement between the two were gathered. As in the second semester, same students were undergone with the same PBLa assessment for the second course and the data was gathered in. From the data analysis, the different and the pattern outcome between these two semesters will be generalised. As a conclusion though in first semester some of students get higher CBLa marks as compare to PBLa (yet majority of students stated higher mark favour to PBLa), nevertheless they still maintain good grade as in the second semester as where the assessment were undergone PBLa totally. This paper also discussed type of assessments that carried out in PBLa and conventional approach.

**Keywords:** Problem-based learning assessment; Conventional assessment

## INTRODUCTION

### INTRODUCTION – Course Assessment

Parallel with the ten (10) shifts of Malaysian Education Blueprint (MEB) (2015) it is important for higher education institution to look back at their program structure that offered. One of the ten shifts that announced is to prepare graduates with holistic, entrepreneurship and balanced human capital (MEB, 2015). Thus it is vital for universities and colleges to focus on developing of more holistic and integrated curricula and enhancing the ecosystem for student development. Initiatives from the universities such as enhancing student learning experience by expanding industry collaboration in the design and delivery of programmes; increasing the use of experiential and service learning to develop 21<sup>st</sup> century skills, and leveraging technology-enabled models to enable more personalised learning are the key initiatives that suggests. Malaysian Qualification Agency or better known as MQA was a body in charge for quality assurance of higher education on both in public and private sectors in Malaysia (MQA, 2015). MQA department is responsible to sets standard for higher education institution (HEI) course assessment distribution according to the National Accreditation Board (*Lembaga Akreditasi Negara, LAN*). Thus, it is important for lecturers in both public and private college and university to fulfill MQA's requirement in particular pertaining students' performance (e.g., skills and academically) so it will reflect the credibility of program that offered. Universiti Malaysia Sabah (UMS) as well is not exempted, where one of the Faculty (i.e., Faculty of Science and Natural Resources (*Fakulti Sains dan Sumber Alam*) FSSA) is required to meet the standard.

**Table 1** MQA Course Marks Distribution Guideline (Centre for Academic and Strategic Management, 2014).

Type of Assessment	Marks distribution guideline Percentage (%)
Assignment	10-30
Progressive Assessment (Skill)	5-10
Test/Quiz	5-10
Presentation (Viva Voce)	5-20
Mid Term Exam	20-30
Lab/Clinical Report	20-30
Field Work	20-30
Final Exam	30-50

As for the MQA, though it has sets a guideline of a course marks distribution as shows in Table 1, it is up to lecturers to coordinate of their course marks requirement. Table 2 shows some of courses that offer in FSSA complete with marks distribution accordingly.

**Table 2** Course marks distribution in Faculty of Science and Natural Resources in several Courses selected.

Course	Assessment	Percentage (%)	Total
Geology	Field Work	15	100
	Assignment/Lab/Report	25	
	Mid Term Exam	20	
	Final Exam	40	
Aquaculture	Lab Report	10	100
	Assignment	10	
	Practical	10	
	Mid Term Exam	30	
	Final Exam	40	
Marine Science	Lab Report	15	100
	Assignment	15	
	Mid Term Exam	20	
	Final Exam	50	
Conservation Biology	Lab Report	15	100
	Assignment	20	
	Mid Term Exam	20	
	Final Exam	45	
Mathematics With Computer Grafic	Assignment 1	10	100
	Assignment 2	10	
	Mini Project	20	
	Mid Term Exam	20	
	Final Exam	40	

**Table 3** Course marks distribution in Faculty Science and Natural Resources in general

No.	Type of Assessment	Course Marks Percentage (%)	Total
1	Field Work	10 - 15	100
2	Assignment/ Lab/ Report	10 - 25	
3	Mid Term Examination	20 -30	
4	Final Exam	40 - 50	

It is clearly shows in Table 2 and Table 3 on weight of course assessment(s) in FSSA basically were pen and paper based evaluation (i.e., mid-term exam and final exam, contributes almost 80%). Though there were marks contribute from field work/assignment/lab report which is reflect to students' competencies in handling study case, experiment etc., it is relatively small contributions to the total marks. As stress by Astin *et al.*, (1996) assessment is most effective when it reflects an understanding as multidimensional, integrated, and revealed in performance over time. Astin *et al.*, adds learning is a complex process as it involves not only knowledge and abilities but values, attitudes, and habits of mind that affect both academic success and performance beyond the classroom. Assessment should reflect their understanding by employing a diverse array of methods (e.g., diverse actual performance; change and improve in their integration). These multiple diverse assessment is capable in improving students' learning experience. Additionally Affandi and Zanaton (2006) emphasis in order for students to complete their academic task,

constructivist learning (i.e., cooperative learning) active engagement in sharing and exchanging information and work supportively with each other is the key to an effective learning.

Hence, the present study was done to compare the difference between the constructivist assessments (i.e., Problem-based learning) and the conventional assessment which is more in traditional way. After that the comparison will be made with the second semester where PBLa will take totally in students' teaching and learning process.

## The Assessment

In this study two different approaches were taken into consideration as the independent variable, problem-based learning assessment (PBLa) and conventional assessment (Ca) as well in the first semester and PBLa in total in second semester

PBL is a student-centred instructional approach in which students collaboratively solve problems, and reflect on their experience and practical knowledge. Characteristics of PBL are where learning is driven by challenging and open-ended problems. Students work in small collaborative groups, and lecturers or teachers take on the role as 'facilitators' of learning. Accordingly, students are encouraged to take responsibility for their group, organize and direct the learning process with support from a tutor or instructor (Albanese & Mitchell, 1993; Colliver, 1993; Finucane, Johnson, & Prideaux, 1998; Gallagher, 1997; Lim, 2005). PBL approaches involve confronting situations where students are uncertain about information and solutions, and mastering the art of the instinctive leap in the process of resolving these situations (Boud & Felletti, 1991). Learning thus occurs through the application of knowledge and skills to the solution of authentic problems, often in the context of real practice (Bligh, 1995). PBL is a form of situated learning, and learning occurs through goal-directed activity situated in circumstances that are authentic in terms of intended application of the learnt knowledge. Advocates of PBL claim it can be used to enhance content knowledge and foster the development of communication, problem-solving, and self-directed learning skills. It is also an instructional method of hands-on, active, learning-centred education involving the investigation and resolution of messy, ill, loosely-structured problems, that one can find in real-world situations (Ahlfeldt, Mehta, & Sellnow, 2005; Paget, 2004).

In this study, a model based on a combination of three models was employed: model that used by McMaster University (Barrows & Tamblyn, 1980); the Torp and Sage Model (Illinois Mathematics and Science Academy (IMSA), 1998); and the model used by Pastirik (2006) The main purpose of choosing a hybrid model was to ensure students explores their own learning, especially in terms sharpening their analytical skills, improving their critical justification in making decision, being a creative observer, and practicing their communication skills. All of these characteristics can be sharpened through these established learning models. Thus these PBL models were modified to suit undergraduate students particularly in UMS itself.

There are five main stages that consist in this PBL which are: i. Problem presented; defined the problems which is ill-structure and complex situation; ii. Student recognises learning issues and potential sources of knowledge and information; iii. Engage in independent study by gathering and analysing essential scenario information; iv. Student then meet with the small group, they critically discuss the practical application of the information to the scenario; and v. Student then critically reflect on both the content learned and the process.

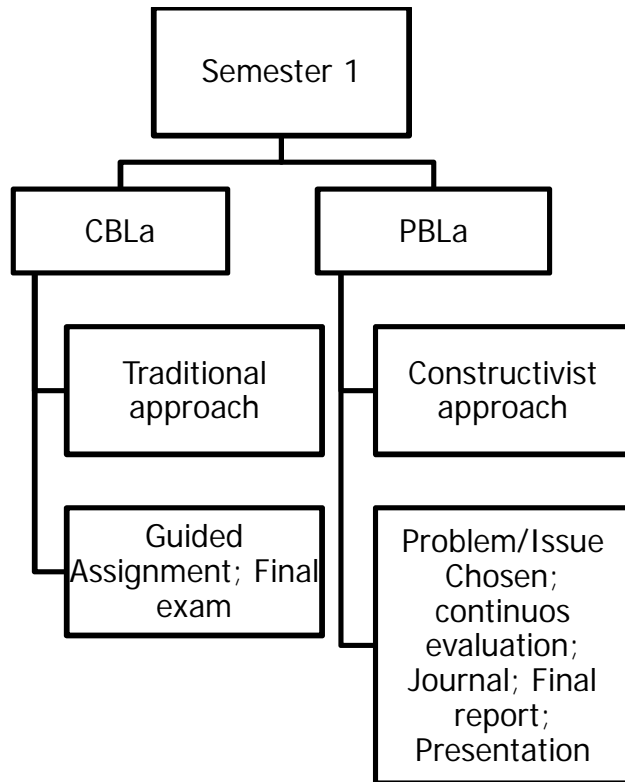
In PBLa, the choice of assessment(s) implemented within a PBL curriculum has a powerful impact on student learning – when used effectively, assessment can promote and optimise student capabilities; when used unsuccessfully it can disempower students, undervaluing them and their work (Pettigrew *et al.*, 2012). Pettigrew *et al.* (2012) suggests a varies of assessment can be done within PBL approach that will maximise students competency such as case-based essays, written examination, concept maps, *Viva voce*, Triple Jump, written examinations, written reports, role plays, online “chat” forum, independent study report, Reference list oral representation, reflective journal and portfolio. Thus in this study, assessment were rearranged from previous research and were to fit to local context.

As for the conventional, the assessment was following the normal teaching learning and activities as they need to fulfil the faculty's standard of contact hours of lecturer class and tutorial and written examination. Additionally guided group assessment was given to students as well, in order for them to accomplish the course.

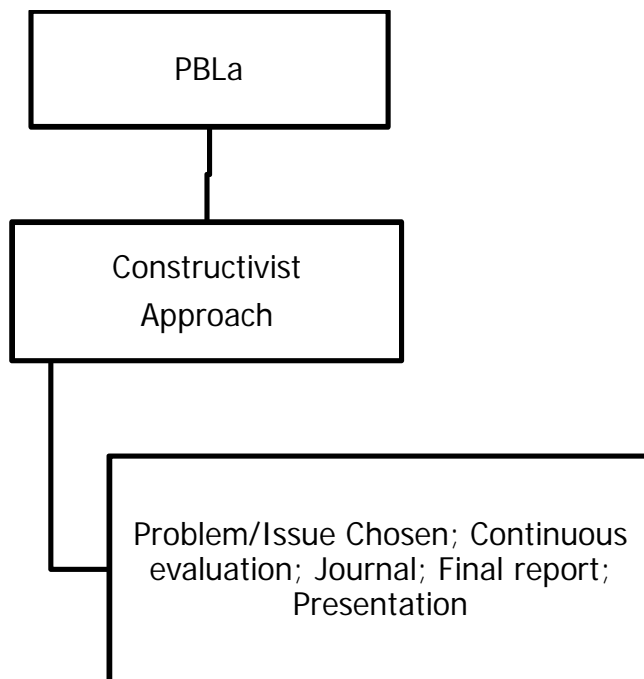
## METHODOLOGY

The data was gathered from three (3) consecutive batches starting from Session 2012/2013 (N=28); 2013/2014 (N=57); and 2014/2015 (N=47). The courses involve were Waves and Optic encoded with SF10603 and Thermodynamics encoded with SF20503 with three credit hours per semester accordingly. These courses were offered in Semester I and II of each session respectively to second year students of Physics with Electronic Programme.

Figure 1 and Figure 2 show the flowchart of learning process for each semester. In Semester I, students were exposed with two different leaning approaches which are Content-Based Learning Assessment (CBLa) and Problem-Based Learning assessment (PBLa) as well. In CBLa, the learning process undergone with a typical traditional teaching and learning approach including final exams and guided assignment. As for PBLa, assessments were varies starting from choosing their own issue, continuous evaluation, journal, discussion (online and offline), presentations and final report. All of these assessments were drop under constructivist approach. The different marks between these two approaches were gathered and those who get higher marks in CBLa compare to PBLa will be noted and will bring forward to the next semester. As in semester two the same set of students registered the second course, where the teaching and learning process totally in PBLa approach. After completing their assessment their marks will be gathered once again. Here the total marks of two semesters will be compared (i.e., Sem I and sem II) and be observed.

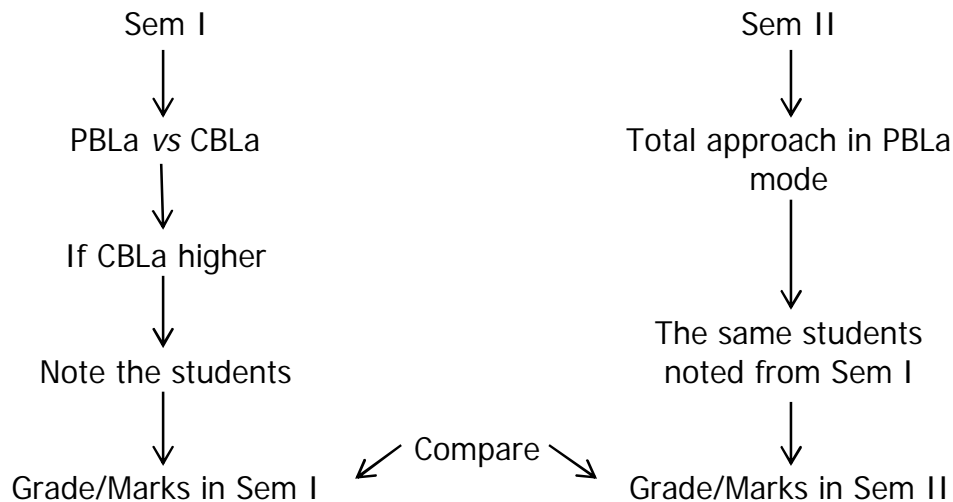


**Figure 1** Flow chart of learning process in Semester I for Waves and Optic Course (SF10603)



**Figure 2** Flow chart of learning process in Semester II for Thermodynamic Course (SF20403)

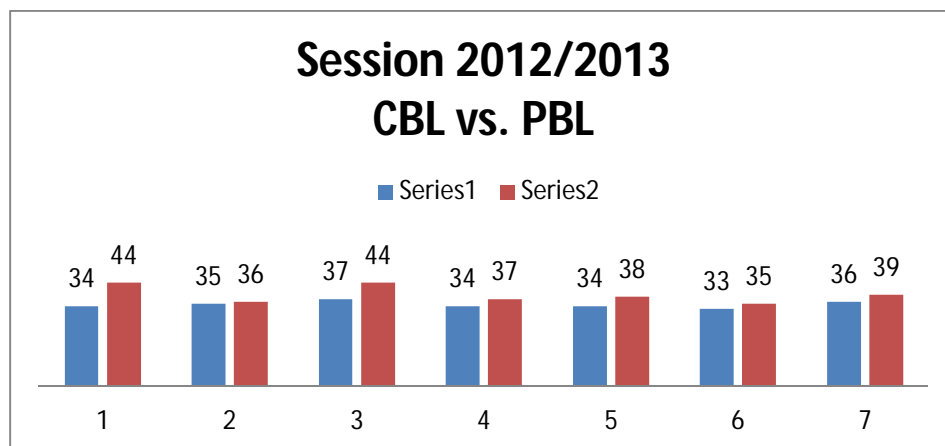
The main reason of monitoring students marks using this method is, the researcher would like to see the consistency of students' performance after getting higher CBLa marks compare to PBLa. Thus the grade analysis only counted for those who achieved CBLa higher compare to PBLa in the Semester I. After completing with Semester II, the very same students' grade will be compared with the Semester I's garde. The flow chart of the full methodology shows in Figure 3.



**Figure 3** The flow charts of the study data analysis

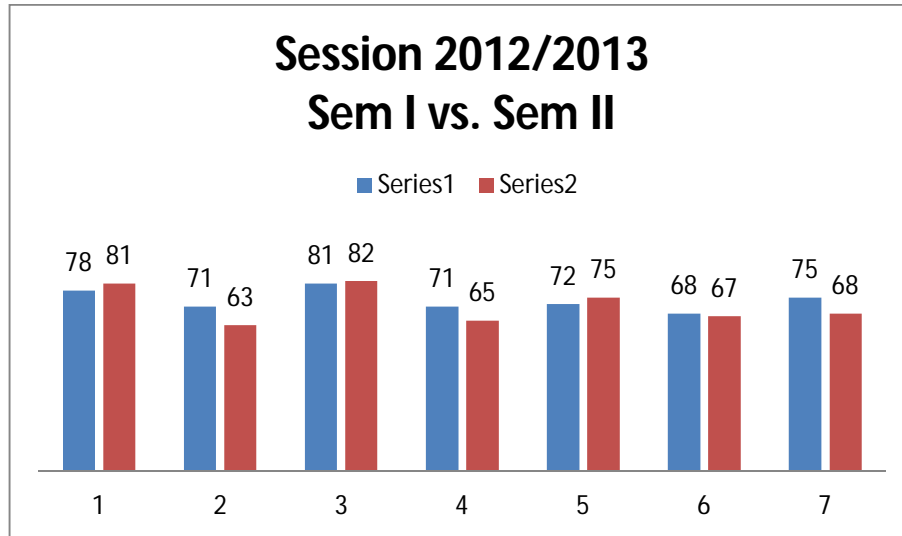
### FINDINGS

Figure 4 shows a bar chart where students stated higher CBLa compare to PBLa (Semester I). The total numbers of students are seven (7). At the beginning there were twenty eight (28) students that took part of this course however twenty one (21) of them stated higher PBLa compare to CBLa, thus it is not counted.



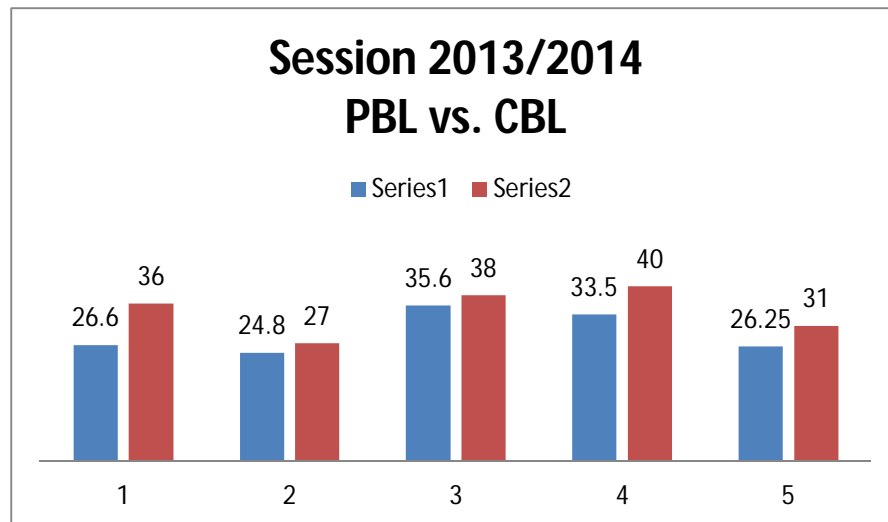
**Figure 4** PBLa (Series 1) vs. CBLa(Series 2) (where CBLa noted higher marks compare to PBLa in Session 2012/2013 (N= 28) in Semester I.

Figure 5 shows the comparison between marks from Semester I and Semester II. It is clearly states that three (3) out of seven (7) students stated higher marks for Sem II compare to Sem I. Series I represent marks from Sem I and Series 2 represent marks from Sem II.



**Figure 5** Semester I (Series 1) vs. Semester II (Series 2) (The difference between marks from two semesters for particular students).

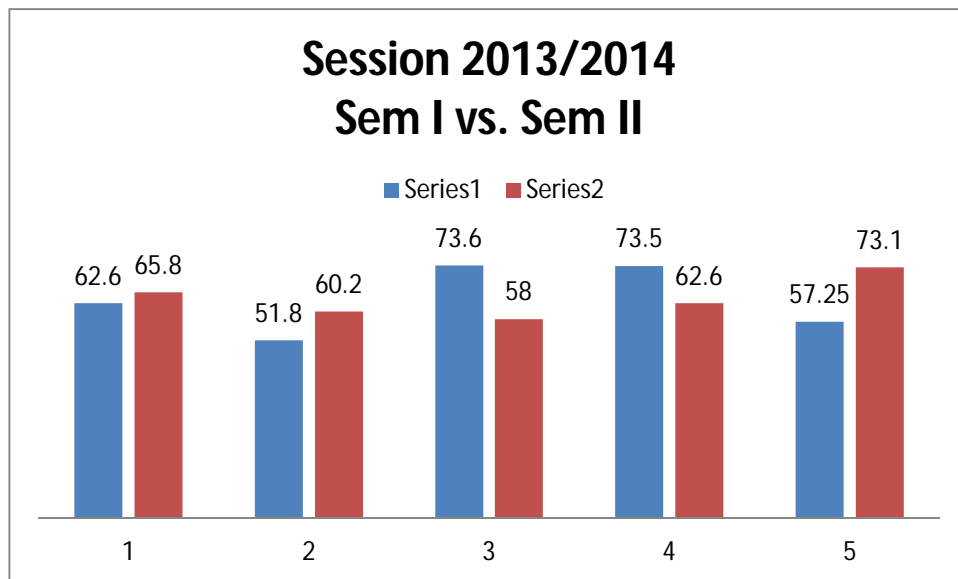
Figure 6 shows a bar chart where all students stated higher CBLa compare to PBLa. The total numbers of students are five (5). At the beginning there were fifty seven (57) students that took part of this course however fifty two (52) of them stated higher PBLa compare to CBLa, thus it is not counted.



**Figure 6** PBLa (Series 1) vs. CBLa (Series 2) (where CBLa noted higher marks compare to PBLa in Session 2013/2014 (N= 57) in Semester I.

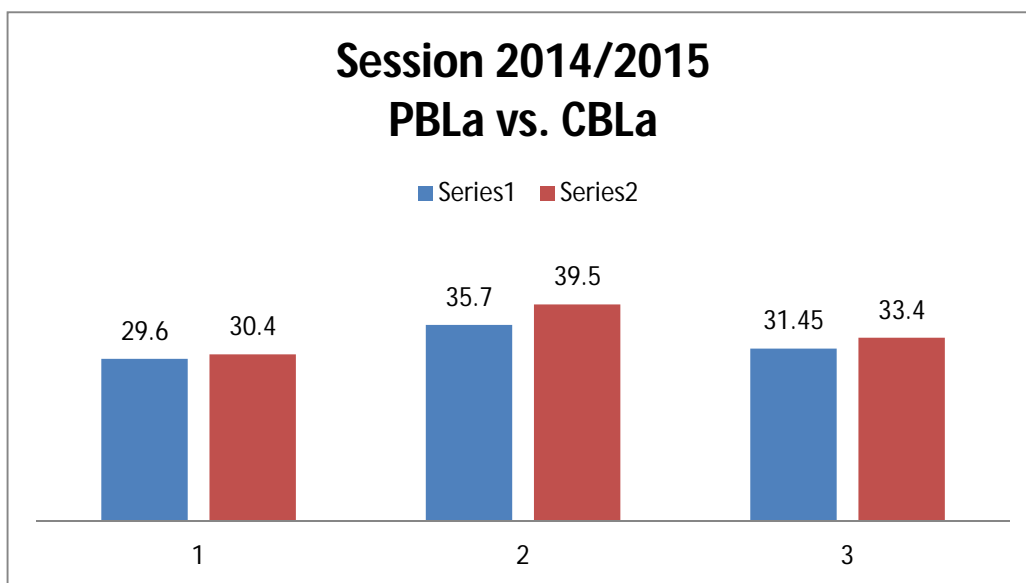


Figure 7 shows the mark comparison between Semester I and Semester II. It is clearly shows that three (3) out of five (5) students stated higher marks for Semester II compare to Semester I.



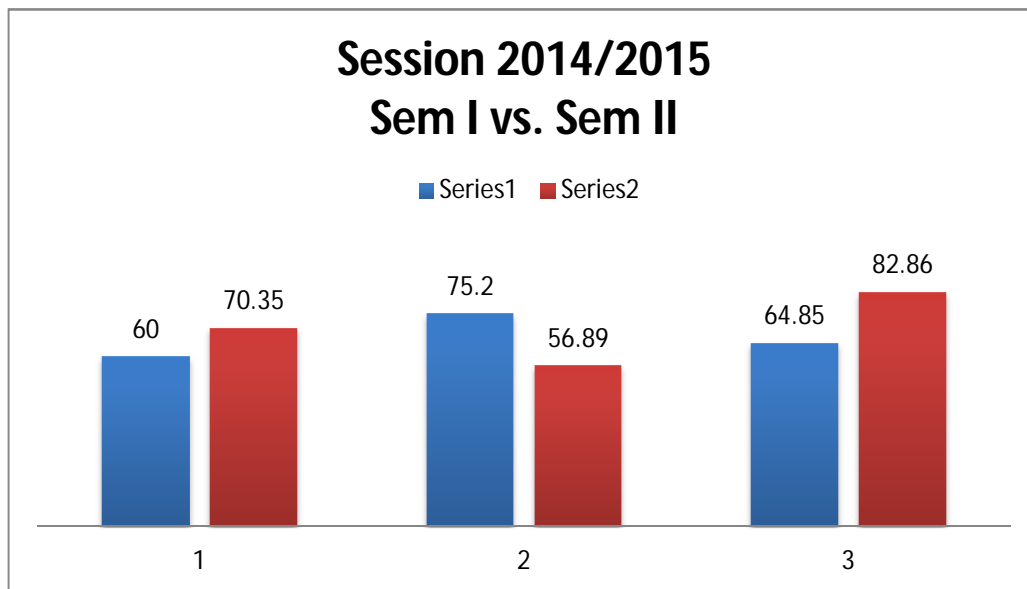
**Figure 7** Semester I (Series 1) vs. Semester II (Series 2) (The difference between marks from two semesters for particular students).

Figure 8 shows a bar chart where all students stated higher CBLa compare to PBLa. The total numbers of students are three (3). At the beginning there were forty seven (47) students that took part of this course however forty two (42) of them stated higher PBLa compare to CBLa, thus it is not counted.



**Figure 8** PBLa (Series 1) vs. CBL (Series 2) (where CBLa noted higher marks compare to PBLa in Session 2014/2015 (N= 47) in Semester I).

Figure 9 shows the comparison between marks from Semester I and Semester II. It is clearly states that two (2) out of three (3) students stated higher marks for Sem II compare to Sem I. Series I represent marks from Sem I and Series 2 represent marks from Sem II



**Figure 9** Semester I (Series 1) vs. Semester II (Series 2) (The difference between marks from two semesters for particular students).

## DISCUSSION AND CONCLUSION

The finding of the report reveals that students who get better marks for conventional approach may get good grade when deals in constructivist approach as well (i.e., Problem-Based Learning assessment). The idea of comparing marks between one course to another is to seek weather there is any loophole for those who are comfortable with the traditional conventional approach (i.e., CBLa). It appears that though these students favour CBLa approach during the first semester (Semester I) yet they were able coping with PBLa in the second semester where almost half of them get better marks compare to the Semester I or at least at the same grade. The activities arrangement in constructivist learning such as PBLa ensures students engaged and took responsibility with their learning outcome under facilitation of lecture in charged (Barret & Moore, 2012a). Moreover Barret and Moore (2012b) stress it is very important for lecture/tutor only intervene in students learning activities in terms of process interventions rather that content interventions, meaning that students need to really construct their own knowledge by experience and not getting it easily from lecturers. Therefore the researcher is planning to implement the assessment in another suitable science courses in the future. Though the result is very much promising, yet many factors may contribute to findings. Facilities and trained facilitators are very

critical that may contribute to the positive embracement of students' adaptations. PBLa demands of all three new knowledge, skills and behaviours thus it will reflect the positive change of attitudes as well (Shwartz et al., 2001). With this it is to be hoped that one of the ten shifts which is to produce holistic and balanced graduates can be fulfilled as stated in the Malaysian Education Blueprint (2015-2025).

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