# Implementation of Problem Based Learning Component for Open-Ended Engineering Laboratory: Early Comparison on Students' Performance

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**Abstract—**Problem based learning has been adopted worldwide in several disciplines of education particularly in medicine. The opportunity for implementation of problem based learning component was observed with the implementation of open-ended laboratory in engineering education. Achievements of students in two cohorts were compared to assess the effectiveness of the problem based learning component implementation component in Engineering Laboratory 4. The results shows promising improvement in students' achievements.

**Keywords—**PBL, fully open-ended, engineering laboratory

## 1 Introduction

The opportunity to implement problem based learning component in engineering laboratory was observed with the difficulty of students in relating the problem statement of the open-ended laboratory with the fundamental engineering knowledge prior to the commencement of the experiments. The consequence was that most students were unable to apply reasoning based on engineering principles to their analysis of the findings in the experiments. The outcome was reflected in their laboratory reports and of course in their score of the course.

As an effort to increase the effectiveness of the open-ended laboratory implementation, the component of Facts, Idea, Learning Needs and Actions in problem based learning was utilized to enhanced students' prior knowledge before attempting the experiments. It is the objective of this study to compare between the achievements of students between prior and after the implementation of the problem based learning component in the open-ended laboratory modules. The comparison shall be useful to gauge for the effectiveness as well as for further planning on the improvement in the engineering laboratory courses.

### 1.1 Problem Based Learning in Engineering Education

Problem based learning (PBL) has been adopted worldwide in medical schools since its first implementation at the medical school of McMaster University of Hamilton in Canada[1].

In a previous study, PBL was compared with example-based learning (EBL) with the finding that EBL was more effective in enhancing students' learning performance with the characteristic of EBL that represent the complete required knowledge [2]. However, PBL has its own advantage with the enhancement of students' knowledge retention due to the active involvement of the students' during the learning process [3].

### 1.2 Open-Ended Engineering Laboratory

Open-ended laboratory has a benefit of enabling students to design and conduct experiments as well as analyze and interpret data for a valid conclusion based on their prior knowledge [4]. It was proven that students understood the experiment concept