POPBL EXPERIENCE: A FIRST A ATTEMPT IN FIRST YEAR ELECTRICAL ENGINEERING STUDENTS

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2ND REGIONAL CONFERENCE ON ENGINEERING EDUCATION (RCEE 2007)
3 – 5 DECEMBER 2007
JOHOR BAHRU

RCCE 2007
Johor Bahru, 3-5 December 2007

POPBL Experience: A First Attempt in First Year Electrical Engineering Students

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Abstract

With all the rapid change and progress in the world, little has changed in the way engineering graduates are taught. Project Oriented Problem Based Learning (POPBL) has become widely accepted as an educational strategy especially in engineering education. This paper discusses a review of a first attempt of POPBL for the first year electrical engineering students in Electrical Circuit Theory (BEE 1113) course for Faculty of Electrical and Electronic Engineering undergraduates at Universiti Tun Hussein Onn Malaysia (UTHM). The target of this POPBL is to complete three tasks related with experimental setup, computer simulation and designing circuit application related with RLC circuit. Students are working as a team to accomplish the task. The project is successfully completed in the given duration. Throughout the duration, undergraduates are working with a minimum supervision to distribute the subtasks, learn new computer simulation tool, determine the most suitable methodology flow and prepare the presentation materials and the documentation of the project. Close observation and rubric methods assessment has been used for evaluation. Analysis from grades distribution and questionnaires reveal that learning outcomes is improved.

Keywords: Project Oriented Problem Based Learning (POPBL); first year student; electrical circuit theory

1. Introduction

Various techniques have been used in education system to provide excellent learning process. However, the objective of the learning process is still to provide student with clear understanding on certain subjects and thus able to apply the knowledge in real life situation. Project Oriented Problem Based Learning (POPBL) is one of the methods used in education system particularly in the university [6]. POPBL is student oriented learning approach and it is believed to be the effective learning strategy for students. Without much supervision from their lecturers, students seek the information needed independently and think analytically to solve the given problem. Experiences through group discussion learning ensure the success learning outcomes. Furthermore, it also encourages students towards self-directive study. It provides more conducive environment such that the student work collaboratively with other colleagues to complete the task given rather than sit and listen to the lecturer. On a contrary, lecturer-based practice has shown that the delivery of knowledge is not good enough. Students tend to be bored and lost during the teaching session.

Educators who teach engineering courses require much effort to deliver the adequate knowledge to the students. On the other hand, students often prefer learning through practical aspect because it is easier for them to get the concepts and idea of the learning process. The POPBL technique emphasize on practical method throughout the learning process. Teaching engineering courses using POPBL has been conducted in many universities and across many area of study [1] [2] [3] [4] [5]. POPBL help students to develop creative and independent thinking in solving a problem. It is the important skills for the engineering graduate when they will become an engineer later. Working on a group with effective communication is a must to convey every possible idea, provide student with extra training for personal skills improvement. Moreover, they involve in hand-on activities instead of sitting and listening to the lecture. The hand-on skills is crucial for each engineering student. The implementation of POPBL brings out not only the knowledge, but also the value added which benefit the engineering graduate student. Using POPBL approach, student would able to get deep understanding on the certain subject where they learn through solving problem.

Realizing the advantages of the POPBL method, we have introduced this technique to the first year engineering student in UTHM with the intention to gain the experience as well as to provide students with deep understanding on the fundamental engineering subject. It is also to provide students with good learning attitude from the early phase of the study. As the POPBL approach is considered new

to the student at UTHM, this has become a great challenge for them in order to adopt the new learning curves. POPBL is not used widely in all courses in UTHM and this gives negative perceptions to the student whereby they have much burden compared to the lecture-based method.

This paper discussed the introduction of POPBL in teaching Electrical Circuit Theory (BEE 1113) at FKEE, UTHM. It provides useful experience to the student as well as lecturers as this approach was the first to be implemented. Results from assessment and student feedback through questionnaire are discussed. In addition, the comparison of grades distribution between POPBL and previous lecture-based method is also presented.

2. Course overview

The POPBL approach was introduced to the first year student in the Faculty of Electrical and Electronic Engineering, UTHM through Electrical Circuit Theory (BEE 1113) subject. It is one of the fundamental subjects for the Bachelor of Engineering (Electrical) with Honours in UTHM and it is also a prerequisite to several advance subjects. Generally, this subject discussed about the properties of electrical components and basic circuit analysis techniques. Furthermore, students also learn how these electrical properties are applied in the electronic circuits. It comprises a total of 42 contact-hours for lectures and 24 contact-hours for practicum session. There are 62 students enrolled for this section and all of them are from matriculations and STPM program. Previous education background tends to be spoon-feeding. For that reason their perception as well as feedback on the POPBL techniques is valuable for further enhancement. Basically, the implementation of POPBL has several objectives. The objectives are as follows:

(i) Provide hands-on understanding of electrical instruments such as millimeters (digital and analog), power supply and storage oscilloscope.
(ii) Be able to conduct experiment and prove it using computer simulation.
(iii) Be able to conduct technical presentation effectively.
(iv) Be able to write technical report and poster presentation effectively.
(v) Be able to work in groups efficiently.

3. Implementation

This practicum session (three hours per week) starts with training in basic laboratory skills with a number of experiments, and concludes the semester with group projects lasting five weeks as shown in Table 1.

Table 1. Schedule of POPBL

Item		Marks		Total Marks	%
Practicum	Practicum 1	10	80	200	
	Practicum 2	10			
	Practicum 3	10			
	Practicum 4	10			
	Practicum 5	10			
	Practicum 6	10			
	Practicum 7	10			
	Practicum 8	10			
POPBL	Progress Presentation 1	10	120		
	Progress Presentation 2	10			
	Final Presentation	30			
	Poster Presentation	20			
	Group management	5			
	Attitude	5			
	Final Report	40			

For these, students work in groups of four to five. It was decided by the lecturer based on the matriculation/STPM background. The standard group projects provide an experience of team working and an opportunity for students to explore a topic in considerably greater depth than in normal laboratory sessions. The group projects are also considerably more open ended than the experiments encountered previously and may involve material that the students have not yet met in their lecture courses. For the POPBL projects clearly defined topics (application of RLC circuits) were chosen that required an understanding of material that had not been covered in the lecture courses. The RLC circuit project was chosen and this project consisted of a number of tasks as shown in Table 2.

Table 2. Problem Crafting for POPBL

Task	Description
Task 1	Students are required to experimentally observe and verify the RLC circuit for series and parallel connection. Go to the respective laboratory and conduct your experiment there. Attendance will be recorded as a mechanism for performance assessment.
Task 2	Students are required to conduct experiment using any computer simulation tools available for example MATLAB®, Or CAD® PSpice, or Multisim® Electronic Workbench to prove the results in task 1
Task 3	Student are required to design any practical application of RLC circuit that you can found in control and communication circuits such ringing circuits, peaking circuits, smoothing circuits, resonant circuits, and filters. Creativity and innovative aspect must be considered in this task.

4. Assessment

The POPBL assessment strategy should be made on the student's learning process and the final result

of the task [7]. The projects were assessed continuously and the rubric matrix is used by the examiners to evaluate student performance. It is divided into three main evaluation parts; with oral presentation (Table 3), process skills (Table 4) and report writing (Table 5).

The focus of the assessment is on the presentation session whereas students need to show their understanding on the work they have completed and also provide good justification on the methodology they choose. Each student from a group must be participating in the progress presentation particularly in the question and answer session.

Table 3. Oral presentation evaluation rubric matrix

RUBRIC MATRIX ©Afandi Ahmad ORAL PRESENTATION					
Elements	**Marks**				
	1	**2**	**3**	**4**	**5**
TEAMWORK All members played a role and contributed to the presentation	Only one member played a role.	A few members played a role.	Some members played a role.	Most members played a role.	Everyone played a role.
CREATIVITY Able to present information interestingly using various relevant presentation tools, eg. graphs, charts, diagrams.	No used of presentation tools.	Used one or two presentation tools.	Used a few presentation tools.	Used some presentation tools.	Used various and relevant presentation tools.
CLARITY Able to articulate and convey information clearly.	Much hesitancy in presentation.	Some hesitancy in presentation.	Clear presentation.	Quiet smooth and clear presentation.	Smooth and clear presentation.
ORGANISATION Able to present ideas and information systematically	Presentation of information was unclear and unsystematic.	Presentation of information was quiet clear and quiet systematic.	Presentation of information was clear and systematic.	Presentation of information was quiet concise and clear.	Presentation of information was concise and clear.

Table 4. Process skills rubric matrix evaluation

RUBRIC MATRIX©Afandi Ahmad PROCESS SKILL					
Elements	**Marks**				
	1	2	3	4	5
TEAMWORK Able to cooperate and contribute to the team	Attended some meetings. Not interested. Did not participate in discussion.	Attended all meetings. Relatively quiet at discussion.	Attended all meetings. Participate in discussion.	Attended all meetings. Played an active role in identifying and getting tasks done.	Attended all meetings. Led and managed the group to achieve tasks.
CREATIVITY Able to generate original ideas relevant to managing the problem	No ideas. Not interested.	Attempted to participate by building on ideas proposed by team members.	Generated 1-2 ideas.	Generated 3-5 ideas.	Generated more than 5 ideas. Ideas were relevant to the problem.
REASONING Able to clarify and identify the facts	Could not identify the facts in the problem.	Tried to identify a few ideas but they were not the key ideas.	Identified a few facts. Still not able to solve the problem.	Identified most of the key facts. Able to solve the problem almost accurately.	Identified all the key facts. Able to solve the problem accurately.
RESEARCH Able to obtain information from the various sources independently	Needed much guidance in obtaining information.	Needed some guidance in obtaining information.	Obtained information independently but from a limited source.	Obtained information independently from a few sources.	Obtained information independently from diverse sources.

Table 5. Process skills rubric matrix evaluation

RUBRIC MATRIX©Afandi Ahmad REPORT WRITING			
Elements	**Marks**		
	1	3	5
ORGANIZATION Able to organize their report effectively	No table of contents; no page numbering; unsuitable title and sub-title.	Table of contents not in sequence; inconsistance page numbering; not relevant suitable title and sub-title.	Table of contents in logical sequence; page numbering; suitable title and sub-title.
PRESENTATION Able to present their ideas original ideas in an appropriate order and all the ideas supported by information.	No main idea presented; ideas are presented in an order that distracts from clear communication; ideas are not supported by information	Main ideas are presented to some extent; ideas are not presented in an order that adds clarity; some ideas are supported by information and logic.	Main ideas are clearly presented; ideas are presented in an appropriate order; ideas are supported by information and logic.
GRAPHICS Able to choose relevant graphics to support their ideas.	No use of pictures, models, diagrams, charts, tables and graphs.	Some appropriate use of pictures, models, diagrams, charts, tables, and graphs.	Effective use of pictures, figures, models, diagrams, charts, tables and graphs.
LANGUAGE Able to write their report effectively.	Errors in sentence structure, punctuation, terms, spelling and standard usage impair readibility.	Sentence structure, punctuation, spelling, and standard usage errors are noticeable, but do not seriously impair readibility.	Generally error free in regards to sentence structure, punctuation, terms, spelling and numerical standard.
CONTENTS Able to organize their report with sufficient information based on the requirements	Most of the report requirements are not complete.	Some proposal requirements are complete.	All report requirement are complete.

5. Results and Discussion

In order to evaluate the effectiveness of the POPBL implementation, we have compared to the distribution grades of lecture-based approach as shown in Table 6. The number of student achieved higher grade is increased almost 6% and all student pass the course. Fig. 1 shows a bar-graph of grades distribution where there has reduction in lower grades.

5.1. Student Feedback

As well as the standard anonymous questionnaires completed by all students at the end of a module, students' views on the projects were also obtained through open-ended questions.

Most of the student said that they learn more and have improved much not only on the subject, but also their attitude towards self-directed learning. In question one, 53% students strongly agree that POPBL project encourage them to integrate and skills from different disciplines as shown in Fig. 2. The skills includes effective communication, technical writing, time management, team works, electrical circuits theory, laboratory practical, computer simulation, and research skills. Fig. 3 shows that 45% students strongly agree that POPBL improve oral defense presentation and confidence level to stand what they have done to complete the task. Fig. 4 show that 40% student strongly agree that group discussion is important to complete the task while Fig. 5 reveal that 40% students strongly agree that they get deeper understanding on RLC circuits and even electrical and electronic engineering subject. The average rating for this question is 1.97 (1 is strongly agreed and 6 is strongly disagree) which describe that most student have better experience in the learning process.

From the questionnaire given, 57 students fill in the free comment sections to give feedback on the POPBL experience. Generally, more than half of the students agreed that POPBL improve their learning process as well as other skills such as communications. The remaining 11 students feel that the POPBL require much time and thus are not agree if POPBL is implemented in other courses. Some samples of student feedback shown in Fig. 6.

Table 6. Comparison of grades distribution between POPBL and lecture-based approach

GRADES	PERFORMANCE PERCENTAGE			
	POPBL		POPBL	
	WITHOUT	WITH	WITHOUT	WITH
A	1.11	4.84	35.56	41.94
A-	3.33	3.23		
B+	4.44	4.84		
B	6.67	11.29		
B-	8.89	8.06		
C+	11.11	9.68		
C	17.78	29.03	64.44	58.06
C-	15.56	12.90		
D+	11.11	11.29		
D	12.22	4.84		
E	7.78	0.00		
TOTAL	100	100	100.00	100.00

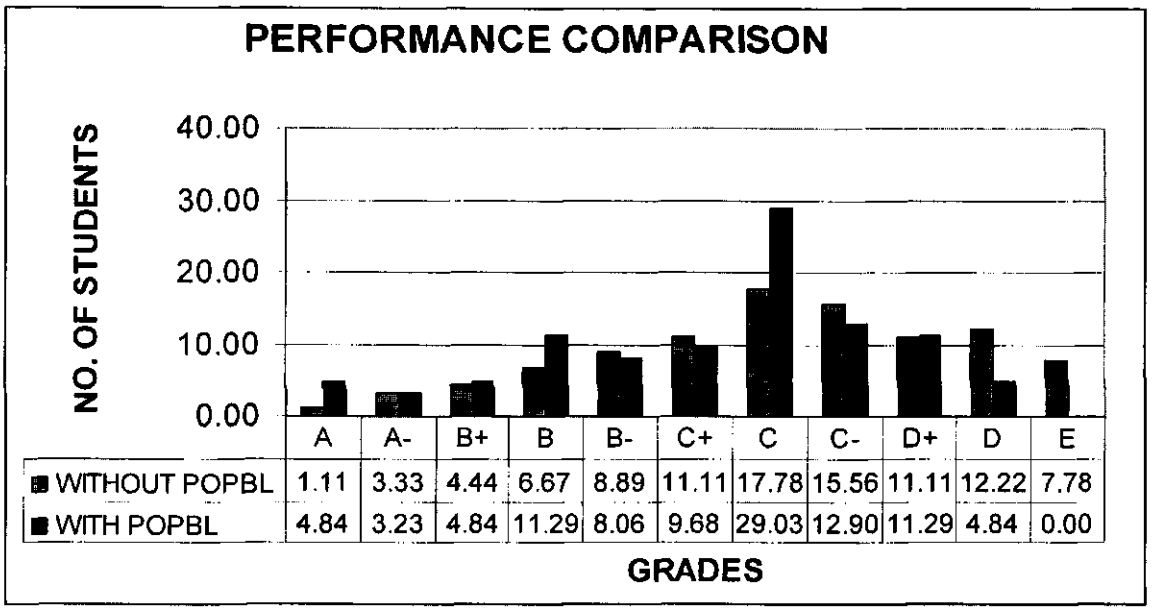

Fig. 1. Comparison of distribution grades for student performance in BEE 1113

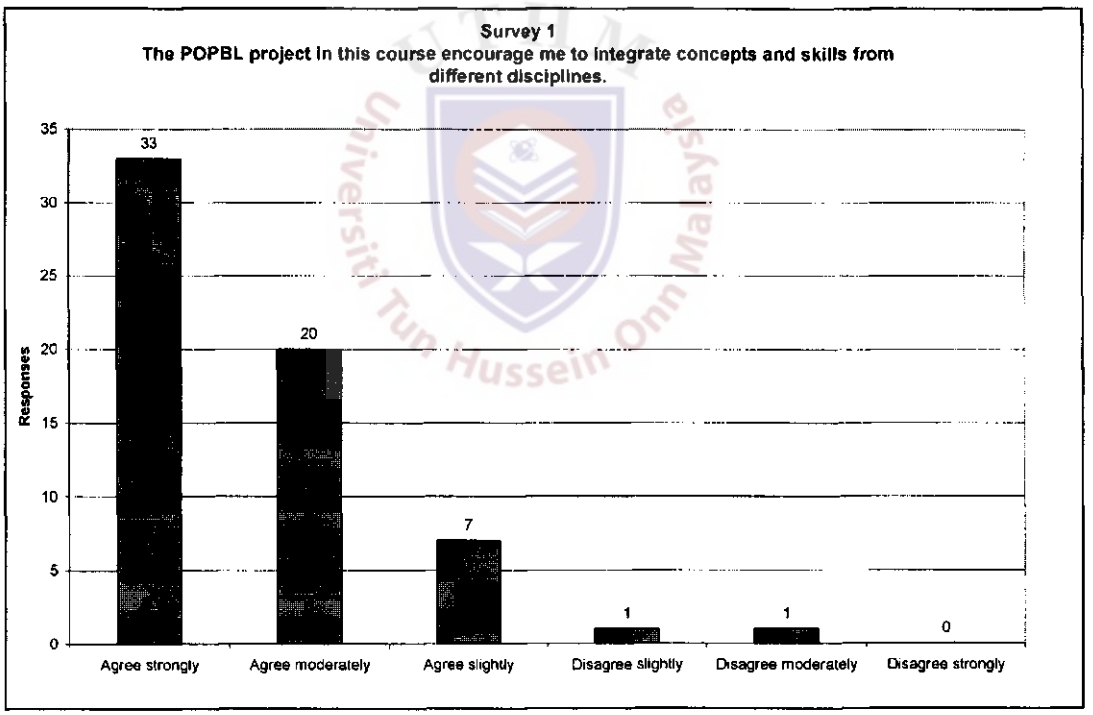

Fig. 2. Student feedback (integration concept and skills from different disciplines)

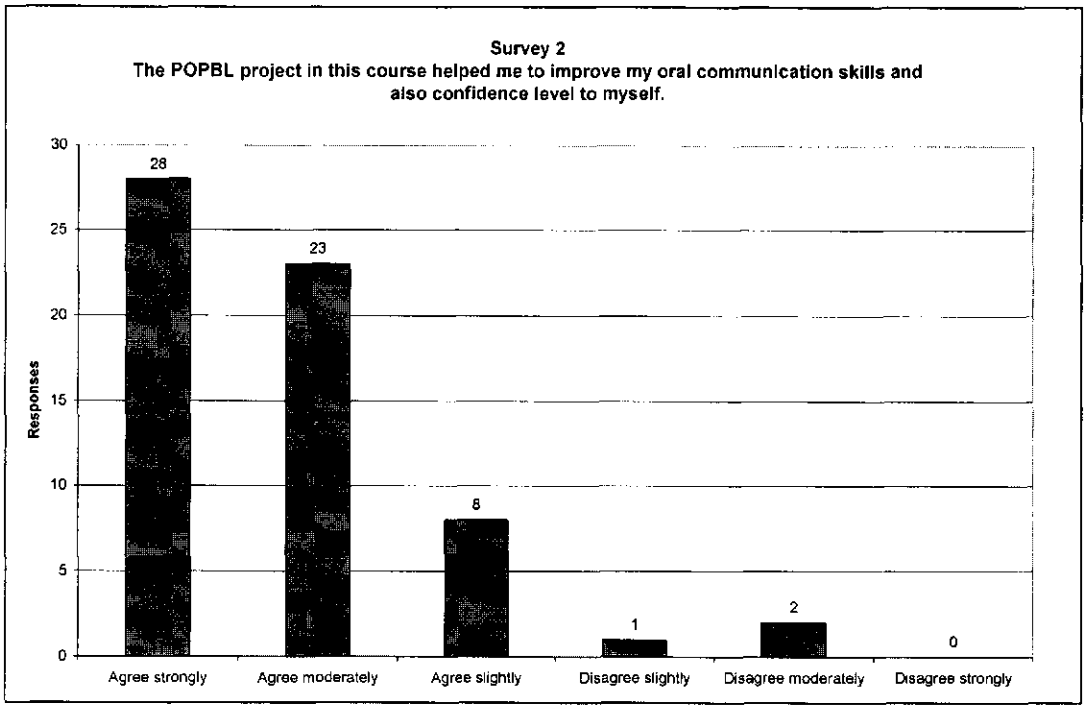

Fig. 3. Student feedback (communication skills and confidence level)

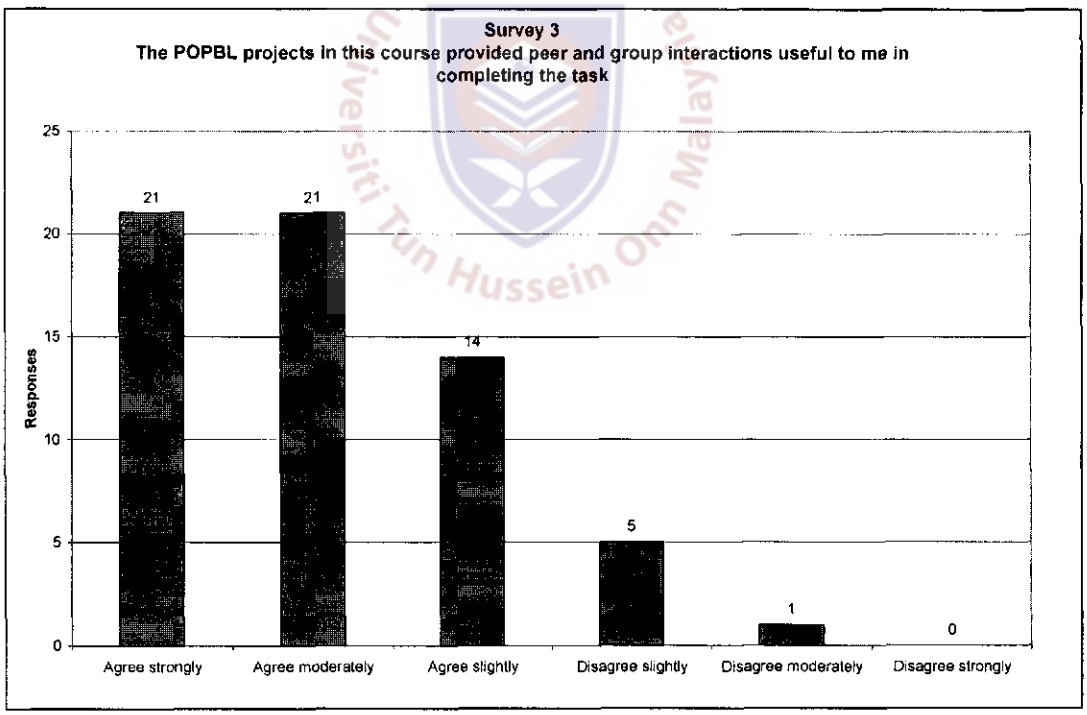

Fig. 4. Student feedback (the important of group function in the POPBL)

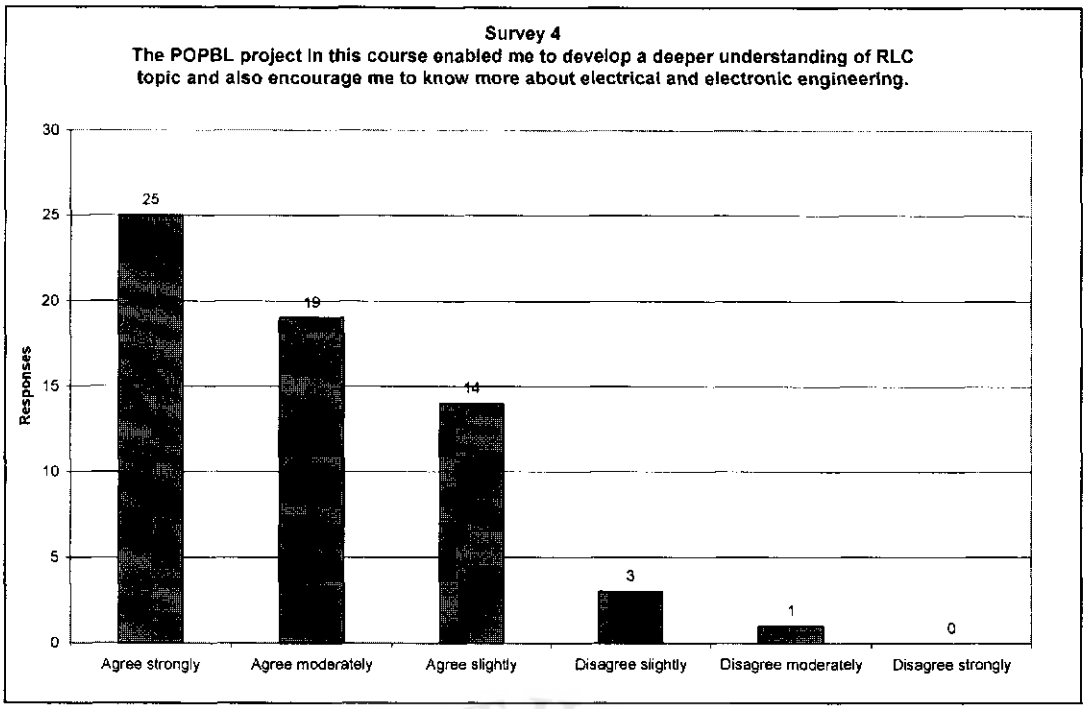

Fig. 5. Student feedback (understanding of the RLC topic)

1. POPBL is more challenging because they have overall evaluation and very details.
2. It totally different. But same a little bit. But actually the POPBL give me more advantages compare to disadvantages.
3. POPBL make students to be more independent. Students will try to solve the project by their own ways.
4. Help the students to gain knowledge of the concepts and formula, compare the other course without POPBL is just on exam orientation.
5. Its fun to have POPBL, and thankfully that not every subject has POPBL since we have to focus for our final.
6. POPBL will bring up many problems that cannot be seeing in other course without POPBL. Because POPBL is a program that make student to face the real-world problem.
7. I think POPBL project makes me understand better in the RLC topic.
8. With POPBL in particular course, it helps me to be a good presenter also increased my understanding.
9. There are a lot of discussions in POPBL, and it shows me that discussion can helps us in learning.
10. I think the POPBL project is more effective. POPBL also made me easy to understand certain topic – RLC in this case.
11. I will know more about the electrical and electronic engineering. Without POPBL, I have no experience in conduct any research.
12. After POPBL, we all more confident with our course.
13. Very different, it's because with this POPBL it improve my knowledge and work as a team.
14. With POPBL, I can understand more about the topic practically.

Fig. 6. Student comment on the overall POPBL approach

5.2. Learning Outcomes

Clearly, implementation of the POPBL in the first year engineering student has greatly improved students' learning process. The important thing is that student learnt themselves how to use relevant software to be used in the project. They take their own initiative to learn different software which is MATLAB®, OrCAD® PSpice, or Multisim® Electronic Workbench. In addition, they discussed the advantages and disadvantages of the software during final presentation. Student is trained to have good learning attitude for seeking knowledge. Besides, they also studied indirectly several advanced topics in which will be teaching next semester.

At the end of the POPBL, most of the students appear with an improvement on their learning motivation. Students are preferred on learning through practical approach. In the POPBL, they have to expert with instrumentation and measurement devices such as oscilloscopes and multimeter. Thus, implementing POPBL at the early program for undergraduate in engineering provide strong foundation to be self learners throughout undergraduate program.

In the groups, students need to participate actively to finish the task given. This provides cooperative learning skills among student which affect to others subject they takes. All the soft skills must be train from the beginning of the study for their career development and of course for the country development in the future.

6. Conclusion

Through the POPBL implementation students have experienced great learning process. As the objectives of learning is to help students to get deeper understanding on the subject, POPBL on the first year engineering student has a lot of potential to keep its momentum until graduation. Designing good and suitable POPBL problem crafting is crucial, so that student adequate soft skills as well as to ensure successful learning outcomes.

References

1. Gil Alterovitz and Marco F. Ramoni. 2007. Bioinformatics and Proteomics: An Engineering Problem-Solving Based Approach. IEEE Transactions on Education. Vol 50 No 1.
2. Michelle C. LaPlaca, Wendy C. Newstetter, and Ajit P. Yoganathan. 2001. Problem-Based Learning in Biomedical Engineering Curricula. 31st ASEE/IEEE Frontiers in Education Conference, October 10 - 13, 2001 Reno, NV.
3. Paul Chinowsky and Hyman Brown. 2006. Developing Knowledge Landscapes through Problem-Based Learning. American Society for Engineering Education.
4. Charles Coronella. 2006. Project-Based Learning in A First-Year Chemical Engineering Course; Evaporative Cooling. American Society for Engineering Education.
5. Raija Tuohi and Janne Roslöf. A Problem Based Learning Process Integrated in IT Engineering Education. 9th International Conference on Engineering Education. July 23 – 28, 2006. San Juan, PR
6. Chatterjea, Kalyani and Chang Chew Hung Problem-Based Learning within Traditional University Geography Courses: A Learning Experience. 2nd Asia-Pacific Conference on Problem Based Learning, Singapore, 4-7 November 2000.
7. Chen-Jun Tien, Shao-Tsu Chu, Tsung-Cheng Liu, A Problem-Based Learning Assessment Strategy. Proceeding of the 9th World Conference on Continuing Engineering Education, Tokyo, May 15-20, 2004