Promoting Creativity through Problem Oriented Project Based Learning in Engineering Education at Malaysian Polytechnics: Issues and Challenges

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Abstract: Self-directed learning and other life-long learning skills are among requirements of today workers. To sustain in competitive globalised world of work they need to be creative, innovative, critical and analytical in their approach. In order to achieve all those competences, learning institution can no longer teach their students using traditional teacher-centred approach only. More student-centred approach such as Problem Based Learning (PBL) and Problem Oriented Project Based Learning (POPBL) should be employed. It is believed that those two approaches are able to promote the competencies required for lifelong learners. In the present teaching scenario, polytechnics are still practicing the traditional approach in classroom such as pen-and-paper or exam-based learning. Students can no longer survive by memorizing textbooks, they now need to explore and experience genuine tasks that connects to the real-world; in which they can develop, master, and demonstrate authentic skills. Engineering Education needs to move from an instructive to constructivist approach.Problem based learning (PBL) is one of the constructivist approaches where cooperation among learners plays important role in the learning method. Project is one of the core subjects in the Polytechnics system which carries 2.5 credit hours. Students will be assessed based on their performance throughout the projects as well as the final outcome of the projects. However most of these final projects designed by students are lacking of creative and innovative dimensions.PBL differs in certain aspects from conventional learning. In normal conventional classes, students normally learned based on what the lecturers delivered in class. This paper discusses issues and challenges the lecturers faced in promoting students-centred approach such as POPBL. Several suggestions are proposed to assist the implementation of POPBL approach in the polytechnics setting in Malaysia

Key-Words: Problem Based Learning, Problem Oriented Project Based Learning, Engineering Education Malaysia

1 Introduction

Malaysian higher learning institutions are now facing the demand and challenges in producing competitive graduates who can perform work in complex situation. Flexibility and ability to adapt and transfer the knowledge are critical in this knowledge-economy (k-economy) world. In addition, critical thinking skills, effective communication and problem solving are also known as the life-long learning skills required of Malaysian graduates to be sustained and successed in the world of work [1]. Traditional approach in teaching where lecturers just give lecture and have the students to memorise concepts and theories is no longer relevant. A more flexible and constructive approach which enable students to innovatively and creatively transfer knowledge into real world situation is more appropriate in today higher learning environment.

Effort towards realising the lafty goal is aided by the Ministry of Higher Education's Framework named "*Malaysian Qualification Framework*" (MQF). In this framework there are eight learning outcomes every institution of higher learning should considered when developing their curiculum. The eight competencies are (i)content knowledge,(ii)psychomotor/practical/technical skills, (iii)professionalism/values/attitudes/ethics, (iv) social skills & responsibility, (v) life long learning & information management, (vi)communication & team skills, (vii) critical thinking & scientific approach and (viii) managerial & entrepreneurial skills.

Creativity is considered as a critical skill in life long learning, as well as a skill needed in scientific problem solving and entrepreneurship. One way of promoting creativity is through the approach of Problem Oriented Project Based Learning (POPBL)

2 Problem Formulation

In the last several decades, many of the world's most developed countries have shifted from an industrial economy to a knowledge economy, that based on the creation of knowledge, information, and innovation. Educational researchers have paid very little shcolarly attention to this economic shift, although it has substantial implication [2]. In today's knowledge society, creativity always occurs in complex collaborative and organizational settings. Creativity is the core of knowledge society, then the key task for educators is to prepare learners to be capable of participating creatively in an innovation economy.

A developing country such as Malaysia needs to increase producing more creative and innovative human capital in order to sustain in the globalised competitive world. As mentioned by our former Prime Minister (Tun Mahathir), *"...to achieve 2020 vision, we need not only be literate in technology as a user but also as a contributor to technology*"[3]. To achieve this vision our education system should go in line with what inspired to promote our economic and society well being. Therefore, we have to first understand how to nurture creativity among our Malaysian students. No doubt that the Malaysian Ministry of Education has taken the initiative in inculcating critical and creative thinking in national education curriculum through embedded approach, but the effectiveness of this effort is still questionable. Several researches on the efforts indicated that the approaches are not successfully implemented due to the examination oriented system in schools [4][5]. Therefore, it is urgent to find out how we could promote technological creativity among young Malaysia in other alternative ways especially at tertiary level.

Planning is an important part in implementation of any programme because it will determine the success or failure of the programme. Educational planning has to be evidence based in order to fulfill the contextual needs. The Malaysian Polytechnics System is the post secondary institution which train skilled and semi-skilled workers for the country. According to the research done by the polytechnic's management, most of the graduates of polytechnics will further their study to higher learning institutions or end up working [6].

Engineering education is the biggest programme offered by the polytechnics system. Therefore it is critical to study how technological creativity can be implemented through innovative teaching and learning such as Problem Oriented Project Based Learning (POPBL) in engineering education at Malaysian Polytechnics. The research question is how lecturers in polytechnics view of the components of POPBL and what are the issues and challenges faced by the lecturers. This effort is also in line with the view of students that teaching and learning in polytechnics is mundane[6].

2.1 Problem Oriented Project Based Learning (POPBL)

POPBL not only focuses on getting solution to interested social issues but also to promote students' creativity [7]. Having this experience, students could enrich themselves with the knowledge they discovered. It is more student-centred approach which does not require students to memorise theory or formula, instead they are required to have more analytical and creative thinking by analysing information gathered to solve the problem.

This pragmatic approach is concentrating more on the process rather than the content [8]. The challenge in implementing Problem Based Learning (PBL) is "*... In problem-based learning, the focus is on organizing the curricular content around problem scenarios rather than subjects or disciplines. They are expected to engage with the complex scenario presented to them and decide what information they need to learn and what skills they need to gain in order to manage the situation effectively"* [9]. So the research is trying to answer the question of to what extent does the Malaysian Polytechnics ready for PBL or POPBL?

3 Methodology

There are twenty polytechnics in Malaysia with more than 80,000 students' enrollment. The study was

conducted at 12 polytechnics for Engineering programmes. Those were Diploma programme in Electrical, Civil and Mechanical Engineering. The study was divided into two parts which are quantitative and qualitative approaches. 183 lecturers have participated in the study for the quantitative part. The quantitative part was a survey on lecturers perspective on some elements of POPBL which were self-regulated learning, group learning, psychological motivation, lecturers as facilitator, ill structured and real world problem, Life Long learning and assessment: continuous and alternative assessment.

The qualitative part was open ended questions regarding problems and challenges faced by the lecturers in their teaching and learning. Out of 183 respondents, 182 (99.5%) had answered the open ended questions.

Data was analysed using descriptive statistics (percentage, mean and standard deviation) for the quantitative data while the qualitative data was analysed using thematic analysis.

4 Result and Discussion

4.1 Respondents' Profile

Table 1 shows the percentage of respondents by department and gender. The majority of the respondents were from the three main engineering department (electrical, civil and mechanical). There were also a small number of respondents teaching the Engineering Programme but who are from ICT and Sports and Recreation Department. ICT and Sports are two general education subjects which are mandatory for all engineering students. Among the respondents, 88 (48.1%) are male and 95(51.9%) are female.

Table 1: Department and Gender of Respondents

Department	**N**	%
Civil Engineering	60	32.8
Electrical Engineering	67	36.6
Mechanical Engineering	49	26.8
ICT	6	3.3
Sport and Recreation	1	0.5
Total	183	100.0
Gender	**N**	**%**
Male	88	48.1
Female	95	51.9
Total	183	100.0

4.2 Lecturers' Perception on PBL and POPBL Characteristics

Figure 1 shows overall means and standard deviations of lecturers' perception on POPBL dimensions. Mean of 3.70 and above is considered high in terms of lecturers' view on characteristics of PBL and POPBL. The dimension of PBL and POPBL which got lecturers' highest rating was 'lecturers' role as facilitator" (mean = 4.00), meanwhile dimensions "assesment" and "self-directed learning" were among the lower rating with mean of 3.53 and 3.56 respectively.

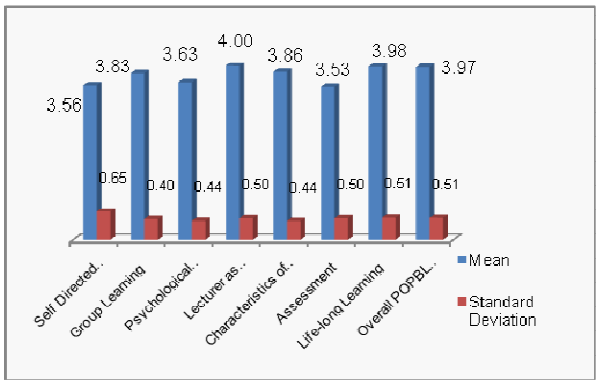

Figure 1: Graph of Mean and Standard Deviation of Lecturers Overall Perception on POPBL characteristics in their Programme

Table 2 shows items on assessment dimension. Assessment dimension in PBL and POPBL should have continuous and alternative assessment like process evaluation, peer evaluation and self-evaluation. It reveals that the existing programme still have traditional approach in assessing students. The alternative approaches were not fully implemented with lecturers were the sole assessor for the students. However students were assessed continuously through out the project implementation (mean=3.87).

Table 2: Mean and Level of Each Item in Assessment Dimension

Assessment	**Mean**	**Level**
1. In this programme, students' assignment are assessed by programme lecturers only	3.79	High
2. In this programme, students' assignment are assessed by other lecturers	3.11	Moderate
3. In this programme, student are actively involved in assessing their group members	3.45	Moderate
4. In this programme, assignments are assessed thru individual presentation	3.62	Moderate
5. In this programme, assignments are assessed thru group presentation	3.92	High
6. In this programme, students are assessed during group discussion	3.72	High

7. In this programme, students are assessed by peer group in the process of solving problem	3.19	Moderate
8. In this programme, students are assessed continuously in project implementation	3.87	High
9. In this programme, students are assessed only thru end product (project)	3.06	Moderate

Self-regulated Learning is an element one should have in order to be creative and innovative. The overall mean of 3.56 for self-regulated learning shows that the existing programme is not giving much space for students to explore and determine their learning. This can be seen in Table 3 where majority of the items having means of a moderate level.

Table 3: Mean and Level of Each Item in Self-Regulated Dimension

Self-Regulated Learning	Mean	Level
1. The programme allows for self-directed learning	3.67	Moderate
2. The programme allows students to determine their own learning	3.39	Moderate
3. The programme allows students to determine their learning needs	3.65	Moderate
4. The programme allows students to search online learning materials	3.69	Moderate
5. The programme is made easy through online search for learning materials	3.70	High
6. The programme is designed for online learning	3.44	Moderate
7. The programme allows students to do assignment with minimum lecturers' assistance	3.47	Moderate
8. The programme allows students to be more independent in solving problems	3.49	Moderate
9. The problem allows students to relate learning problem with personal experience	3.46	Moderate
10. The programme allows students to integrate all past learning with problem to solve in the assignment	3.63	Moderate

In the existing programme, students are required to complete a final project before graduating. Table 3 shows that most teachers rated the nature of problems given to students helped the students in many ways especially in the ability to solve problems. However the approach of exposing students to the outside and real world through community and industry involvement are still lacking.

Table 3: Means and Level of Lecturers' Perception on Nature of Problems

Items	Mean	Level
1. In this programme, problems to be solved are from real world problem	3.91	High
2. In this programme, problems to be solved are mostly ill structured	3.53	Moderate
3. In this programme, problems to be solved need specific knowledge	3.92	High
4. In this programme, problems to be solved are multidisciplinary	3.86	High
5. In this programme, thru problem solving new knowledge and experience gained	4.07	High
6. In this programme, problem solving helped to increase student's problem solving skills	4.10	High
7. In this programme, problem solving need students to get information thru ICT	4.01	High
8. In this programme, materials from web support students' learning	4.02	High
9. In this programme, self-solving activities help to develop student's verbal communication	3.92	High
10. In this programme, self-solving activities help to develop student's writing skill	3.93	High
11. In this programme, self-solving activities help to develop student's visual communication	3.99	High
12. In this programme, problems need to be solved in group	3.91	High
13. In this programme, problems need to be solved individually	3.46	Moderate
14. In this programme, problems need to be solved with community (industry) support	3.65	Moderate
15. In this programme, community (industry) is invited to give information in the process to complete assignment	3.64	Moderate

4.2 Lecturers Views on Problems and Challenges

The second part of the study was qualitative in nature with open-ended questions. The questions were around students' characteristics, lecturers' competence and; knowledge and facilities. Table 4 shows the qualitative answers by the lecturers on those aspects. Majority of the lecturers thought that they are having a very big group of students to handle. Besides that they are having problem with students' ability where they thought the students took so much time to understand the subject matter. Lack of creativity, not active and more dependent on lecturers are also considered to be the problem faced by the lecturers.

As far as the facility is concerned, the lecturers thought that they do not have enough space for a very big group of students. This lack of space contribute to the inconduciveness of the classroom

environment. Besides that ICT facilities like computer and internet were neither enough nor up to date.

In order to implement PBL or POPBL the lecturers see the challenges are to solve the above problems as well as to increase lecturers content knowledge and skills. To promote creativity of the students, creative teachers are needed as well; where they think as lacking. The elements discussed above can be achieved through professional development as well as exposure to industrial skills which are also deficient. To handle students with low ability and; lack of motivation and focus, the lecturers should be more patient and must try to improve on lecturer-students relationship.

Table 4: Qualitative answers by Lecturers on Problems and Challenges.

Student	Lecturer	Facilities
• Big group • Low ability (slow learner) • Not focus • Lack of creativity • Not active • Not independent • Easily get bored	• Mastering of content knowledge • Need to increase creativity • Industrial skills • Professional development • Patient and enthusiasm • Lecturer-student relationship	• Inconducive • Insufficient space • Lack of current technology

5 Conclusion

Through the result of the study, the existing Engineering Education programme at Malaysian Polytechnics do have some PBL and POPBL characteristics such as having cooperative learning approach, having lecturers with facilitators characteristics and psychological motive, and have other life-long learning elements. However the programme should employ more alternative assessment besides the traditional assessment. This might be due to the nature of the programme which is still more lecturer-centred rather than student-centred. This can be seen in the lack of self-directed learning elements in the programme. To promote creativity among students, lecturers should give more freedom to students to explore their own learning and construct their own meaning. The programme should give more attention to the process of getting to the end in producing an innovative product rather than just concentrate on the knowing the facts. Creative product is not just of individual traits, but also of societal and environmental factors. It means that a creative product is not accomplished by individual alone, but rather is the product of the interaction of a stable cultural domain and embedded in social system [10]. A more explicit curriculum such as PBL and POPBL should be introduced in promoting creativity because creativity underpins design and problem solving especially in technology and engineering education [11].

It can also be concluded that lecturers need to be retrained continuously so that they are more confident to have PBL or POPBL approach in their programme. More exposure to industrial training could also help the lecturers to be more creative in handling their programme and students.

Engineering education is a paramount important type of education in providing the nation with innovative, creative and critical thinking human capitals which will contribute to sustainability of the economy. To achieve this, a good and wholistic programme of engineering education at the post secondary level should be designed. One of the suggestions is the implementation of PBL and POPBL approach.

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