

Exploratory Problem Based Learning (EPBL) As A New Approach to Modify the Current Project-Based Learning (PBL) Inefficiencies and Problems

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Abstract

This paper proposes a critical review about the main drawbacks and inefficiencies of current PBL educational model, and how to overcome these drawbacks by introducing a new educational approach which is named EPBL. PBL model is a student-centered system that allows students to gain skills and knowledge by working on a specific problem/project for a specified amount of time. The students have to investigate and respond to an authentic problem, a complex question or a challenge. Unlike the traditional education model, which is a lecturer centered system, PBL focuses on making the way of education more towards student-centered system. Although PBL model has been implemented as an educational tool in some international academic institutions, there are debates regarding the efficiencies of current PBL in meeting the model's target. One of the causes that makes the current PBL model inefficient is that it places the majority of work responsibilities on students' shoulders without pre-qualifying them with enough knowledge and training to handle the challenges. Mostly, this will result to the accomplishment of the project in a robotic way because of missing censorious analysis of the main complication, even sometimes hatred feelings towards the project.

Like all other natural processes, any change in order to be considered successful must go through a transitional phase, which plays a vital role in providing students with the capability to relate the conceptual facts dynamically with practical practices. This phase is missing between the shifts

from classic traditional way of education to current PBL model. Hence, EPBL educational approach introduces the idea of constructing the students' knowledge to identify and analyze the problem/project systematically with full understanding of the topic at beginning not towards the end of the semester. EPBL model gives the students the chance of recognizing the core of a project to explore and fully understand all related problems and challenges in order to develop their capabilities in solving problems productively and successfully.

Keywords: Classic Education Model, Inefficiencies, Current Problem Based Learning, Transition Phase, Exploratory Problem Based Learning.

Type of contribution: The type of contribution for this work is under the conceptual paper, novel and innovative idea.

Introduction

The motivation behind this paper is to positively change the students experiences with PBL courses. Additionally, it looks for creating an innovative PBL model that qualifies the students with solid practical and fundamental knowledge that turns into a lifelong learning experience. The scope of this study focuses on pointing out all the drawbacks that PBL model is facing and to overcome them by introducing the new educational approach which is named EPBL model. Also, it initiates a new way of designing an academic curriculum that follows the framework of EPBL model. This newly constructed curriculum can train students and prepare them to be fully equipped with the required skills and knowledge to handle PBL courses. The missing transitional phase between classic and current PBL model which has been mentioned previously means shifting the students from receiving the theoretical knowledge in classrooms to implementing this knowledge practically. Therefore, EPBL is introduced as a new educational approach to create that missing transitional phase which is needed to diminish the current PBL model's inefficiencies. This will be achieved by enhancing the curriculum design to create a strong connection between lecturer-based and project-based educational models. In other words, it means that whatever information and skills acquired from a PBL course will benefit the students in getting better understanding of other PBL courses as well as lecturer-based courses. Hence, the proposed EPBL model will highly improve students' fundamental knowledge and engineering skills to lead them to be successful in both lecture-based and PBL courses. For example, students will be capable of exploring problems

related to their major which they are interested to solve. Also, they will be able to write proposals instead of being provided with project statements, which mainly happens in current PBL model. Finally, EPBL education model believes in qualifying the students with proper critical thinking skills, which enable them to analyze problems relate to their major fundamentally and systematically. Also, it makes them well prepared to face future challenges in their future work.

Problem Statement

1. A poorly designed curriculum which does not satisfy a real PBL educational model requirements because of the improper link between the courses.
2. The missing transitional phase in the curriculum which minimizes the students' ability to explore problems related to their project.
3. The improper way of selecting a project for a PBL course which is poorly linked with other lectured based courses in the curriculum.
4. The topics that are being selected by PBL instructors are mostly academic, which may confine and limit students' creativity.
5. The current system is facing disabilities and inefficiencies in preparing and providing students with enough knowledge to come up with project statements and proposals that meet their interests as well.
6. There are other problems associated with the execution of the current PBL project courses e.g. hardware, software, facilities and facilitators' experience, which they have to be also considered in the PBL planning curriculum.

Objectives

1. To design a perfectly linked curriculum that satisfies all the objectives of an efficient and enhanced PBL model.
2. To create a link between the curriculum and the students in a way to help them to explore problems and solutions by themselves throughout all semesters towards graduation project.
3. To nominate proper topics for PBL courses that students can link their lecturer-based learnt knowledge with their PBL projects in order to take the most advantage of all courses.
4. The selected PBL topics have to give and provide students with enough creativity to acquire

life-long learning skills.

5. To equip the students throughout the academic journey to be able to design their own PBL project statements and proposals, and to let them involve their interests as well.
6. To create a chain of cross-linked course contents taught by instructors for each semester which automatically fill the gaps of the current PBL in a systematic approach.

1. Methodology

The methodology used to present the efficiency of EPBL model and inefficiencies of the current PBL model is by analysing three different case studies. The case studies reported in this paper have been documented from an engineering PBL class. By comparing the two models, a great distinction was found between their actual outcomes in reference to the students that were studied in the case studies. The students who were analysed in case study #1 kept their research and studies under the current PBL model. Whereas the students analysed in case study #2 updated their research analysis by exploring the problem under the concept of EPBL model after they did the original task under the current PBL model. Last but not least, students who were analysed in case study #3 were following some concepts of EPBL model from the beginning without being aware of doing that.

1.1 Detail of the Issues Related to Case Study #1

Currently, the students are given prepared projects statements with defined problems in PBL courses, which will limit the student's skills in exploring the base of the problems from the origin. The pre-written problems introduced by instructors will narrow down the students critical thinking capabilities into the pre-set solution towards a well-defined problem. Even this may end up with students having less interest into the project, as some of them cannot build a strong relation with these predefined problems due to lack of enough knowledge and interest.

A second issue is that the students are focusing on getting things done quickly to prevent passing the deadline instead of understanding the foundation of all related problems and the aspects of their solution. It is like using bricks to build a structure, if the students explore the core of the project and understand every single detail of it, they will end up with a house that matches the pre drawn schematic draft, but if the students have not explored the aspects of the topic from the beginning, they will be lost and their final outcome from their activity is just a wall built of bricks.

In this case study, the students prior to start the PBL project have not been qualified enough with the proper skills in order to help them to breakdown the problem discussed in the project into smaller pieces. This eventually led them to have a purposeless work plans and future action items. In addition to that, because of inadequate relevancy of the classic subjects in their curriculum to their PBL projects, which might create a confusion in understanding the problem solution, the students were not able to come up with something creative and innovative due to improper knowledge and shortage of information. In other words, the group of students in this case study faced lots of obstacles in perceiving the core of the actual problem because of lack of awareness and knowledge toward the basis of the project that has been chosen for them. Their contribution in the projects has not been transformed into a deep understanding which could serve them in having broad view in major related contexts for their future.

1.2 Detail of the Issues That Were Analysed in Case Study #2

Another case study is for a group of senior engineering students who their senior project was followed by one of their traditional course in their curriculum. At the beginning, the students' supervisor proposed a senior project topic and the students agreed to work on it based on the assumption that it would be as easy, simple and similar as their passed pre-requisite lecturer-based course. Students started to solve the project with heavy calculations without true understanding of the entire problem. The solution provided by the students was restricted by the solid mechanism that has been taught in the related lecturer based course without understanding the dynamic application of it and how to implement it in a flexible and creative way. To solve the project, a deep understanding and exploring of the problem was required from the beginning with a plan of several practical/feasible scenarios that were shaped by the information provided in other pre-requisite lecturer-based course and PBL courses.

After they completed all the tasks and the project was submitted, based on their pure interest, they decided to continue the work. They started to do more research in order to have a better understanding of the problem and to get more knowledge about the project they have finished. About a year later, the students realized by themselves that most of the work that they have done in their senior project was partially wrong. There are many reasons behind the failing parts of the project. One of these reasons was, the fact that the pre-requisite courses taken was not enough in requalifying the students to handle and control a big project as senior or graduation project simply

out of their knowledge. Another reason was that, the students had a fixed mindset about handling all types of PBL courses by solving the problem directly without full comprehension exploration of the problems at the beginning and prior to start the project. In addition to that, the students chose their topic based on their previous knowledge in a lecturer-based course and current PBL courses they had, which made the transition from handling theoretical information to practical application challenging for them. Furthermore, one of the drawbacks of PBL courses which is submitting the workbooks and reflective journals, students have lost a huge source of references and information that could have been utilized in solving their senior project. Lastly, the lifelong learning aspects of current PBL is inadequate, because of the lack of critical thinking to utilize the skills used in problem solving with other kinds of future challenges that students might face in the future. Therefore, the students visions were narrowed down to the problem assigned to them without thinking of the possible different scenarios automatically to create more innovative feasible solutions.

1.3 All Issues Related to Case Study #3

The third case study is all about the experience of a group of senior students who practiced some fundamental concepts of EPBL model without knowing about it. Since the beginning of their project, the students were aware of the true conceptualization of PBL courses, which is based on the idea of self-learning, problem detecting and decision-making capabilities. The main key to meet the learning objectives in gaining life-long learning skills is to have a strong motivation towards solving or providing a new aspect of the proposed project. This could happen only if the students contributed in the fabrication of the project statement somehow by themselves.

The students started to have analytical and critical thinking about the project statement that was suggested to them, after spending a prolonged period of time in forming and reshaping the project statement. Then, they came up with a newly created proposal which matches their interest and have realistic contents that simulate real life problems that might be existed in their future work. The structure and objectives of the final proposal were reviewed by qualified supervisors to approve the validation and applicability of it as well. After determining the topic, students had in depth theoretical knowledge related to the chosen PBL topic. The task was not easy because of some shortage of knowledge from pre-requisite courses in their curriculum. Students found out that they have to work harder to cover pre-requisite materials by themselves. The biggest challenge

faced was the fact of the poor connection between lecture-based courses and their PBL project. By exploring the topics from the beginning and take part and being involved in writing the project statement from every possible angle, the students came up with multiple hypothesis and viable solutions for their PBL project. Their deep recognition of the project assisted them in developing a flexible application related to the PBL topic that could be modified based on conditions to meet the needs of the current situations. Students were trying to reach the optimum solutions throughout rational inputs and ideas that generated because of expanding their view in the field of their chosen PBL topic. In their learning process which is similar to EPBL model with all the obstacles they faced, the students were able to reflect about the real knowledge gained from their practical experiences and experiments by questioning and reviewing each step in the topic. These reflections will eventually convert into a lifelong learning experience for the students even for their future career.

2. Results and Discussion

After going through the different case studies mentioned above, the following results and discussion were found:

2.1 Student's Topic Selection Ability for a PBL Project

The first difference found between the three groups that were analysed in the three different case studies under the two different PBL models, was about their capability of selecting a proper topic for a PBL project which is referenced in objective #3. For case study #1, the students systematically followed the selected proposal given to them which led to lose their interest to contribute creatively into their project analysis. Looking at case study #2, although students were dealing with a previously given project statement, they were able to breakout the PBL framework and continued exploring more in depth to understand the problem deeply by shifting to EPBL model, which it resulted in having a successful complex application in addressing the entire problem. While in the case study #3, the students from the beginning decided to transform their provided proposal into something that matched their pure interest and they ended up with more and better understanding and analysis of the problem.

2.2 Project's Life-long Learning Skills

The second difference between the two PBL models is about the effect of these models on providing the students with life-long learning skills and experience, which is addressed in objective #4. The students in case study #1 did not have the chance to think critically about the other possible solutions for their project which resulted in lacking of life-long learning skills in their problem solving skills. For case study #2, the students realized that to understand the project, they have to explore it from its roots and basics, which helped in obtaining a life-long learning abilities in dealing with any topic related to their project from different points of view. On the other hand, students in case study #3 had a full awareness of the project's multi aspects which helped them in gaining the ability to use the optimization skills not only in their PBL project, but also to other possible future projects.

2.3 Student's Ability to Write Their PBL Project Proposals

A third distinction of the models is in the students' ability in coming up or contributing into their own project statements and proposals instead of being provided with prepared ones, which is referenced in objective #5. Due to the fact that students in case study #1 were lacking the critical thinking skills, they were not able to explore or to create any other problem statement related to their topic, except the one that was already provided to them. However, the students in case study #2 managed to come up with multiple project statements on their own. In addition to that, they had the ability to solve their project from different aspects and even bring it into a higher and advanced level. In the third case study, the students had the capability to come up with their own proposal for the project. The reason is, that they had spent enough time to explore all related problems to their project, and then they were able to transform the given problem statement into a relevant one as their own interest also was involved.

2.4 Difference in the Curriculum Design for the Two Models

Beside all above mentioned characteristics, EPBL model in terms of helping students' ability for exploring problems, provides a huge change in an academic curriculum design. As shown in figure 1, it illustrates an example of an arbitrary engineering curriculum that has been designed based on the current PBL system. It shows how poorly the classic and PBL courses are linked together as only a weak vertical link between the courses is existing. Also, there is not enough supporting PBL courses in the entire curriculum, which might make students to lack the fundamental and basic

knowledge they need for the following PBL courses in the future semesters. Furthermore, there is an obvious immediate or direct shift between the classic and PBL courses within each semester. This means that there is no transition phase that is necessary to have in order to build a strong basis for the students' knowledge and skills to be built up gradually and systematically towards the end of their academic journey.

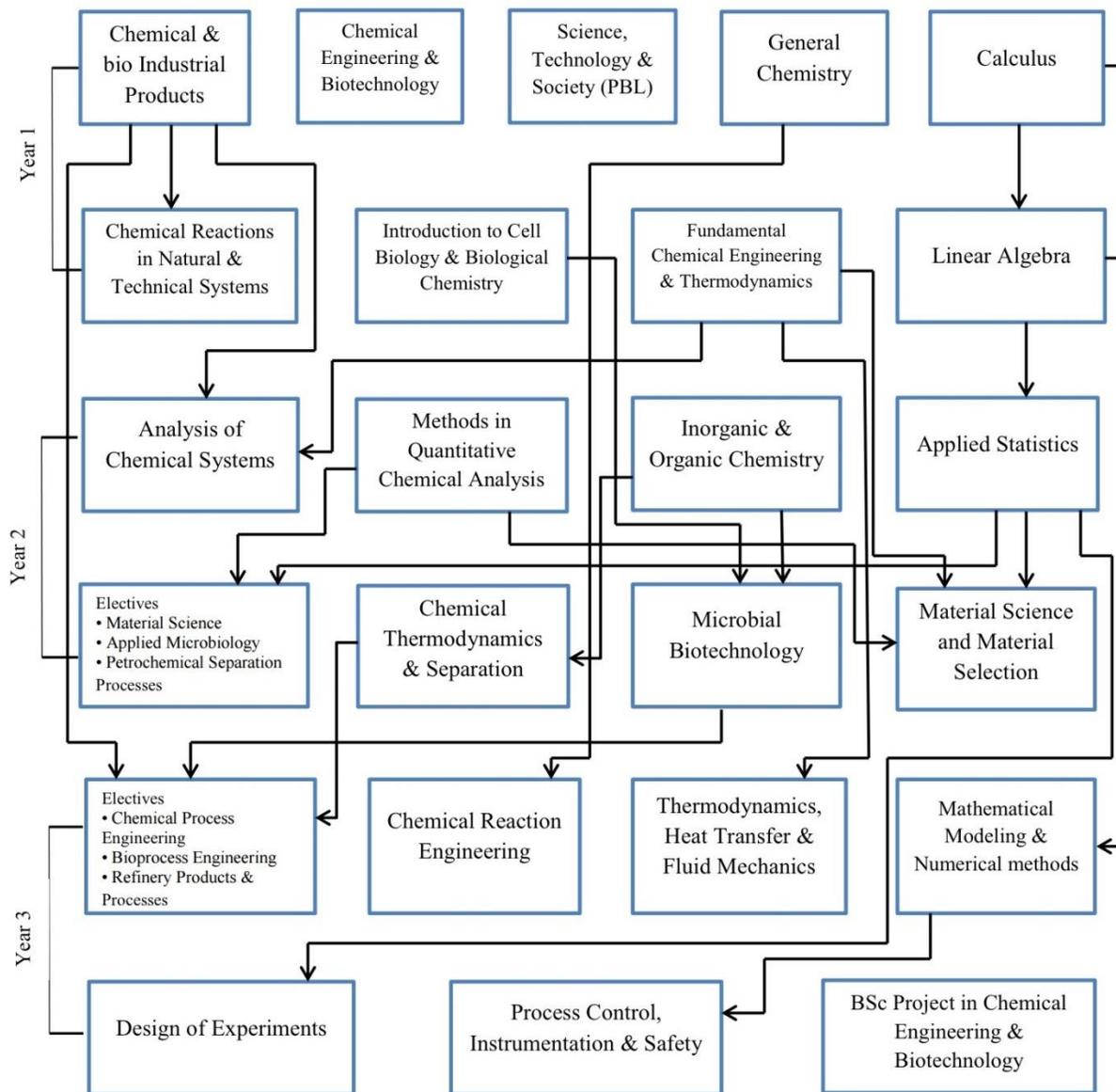


Figure 1: Curriculum designed based on current PBL model

Whereas, figure 2 illustrates an example of a curriculum after it has been designed and taken under the EPBL model. It shows that all courses are strongly linked together where lecturer-based courses and PBL courses are serving each other simultaneously. Also, it shows that designing a curriculum based on EPBL model has created the missing transitional phase in the current system, where courses are placed in a well-organized structure that leads to create a well prepared and trained engineering students to have a successful future career.

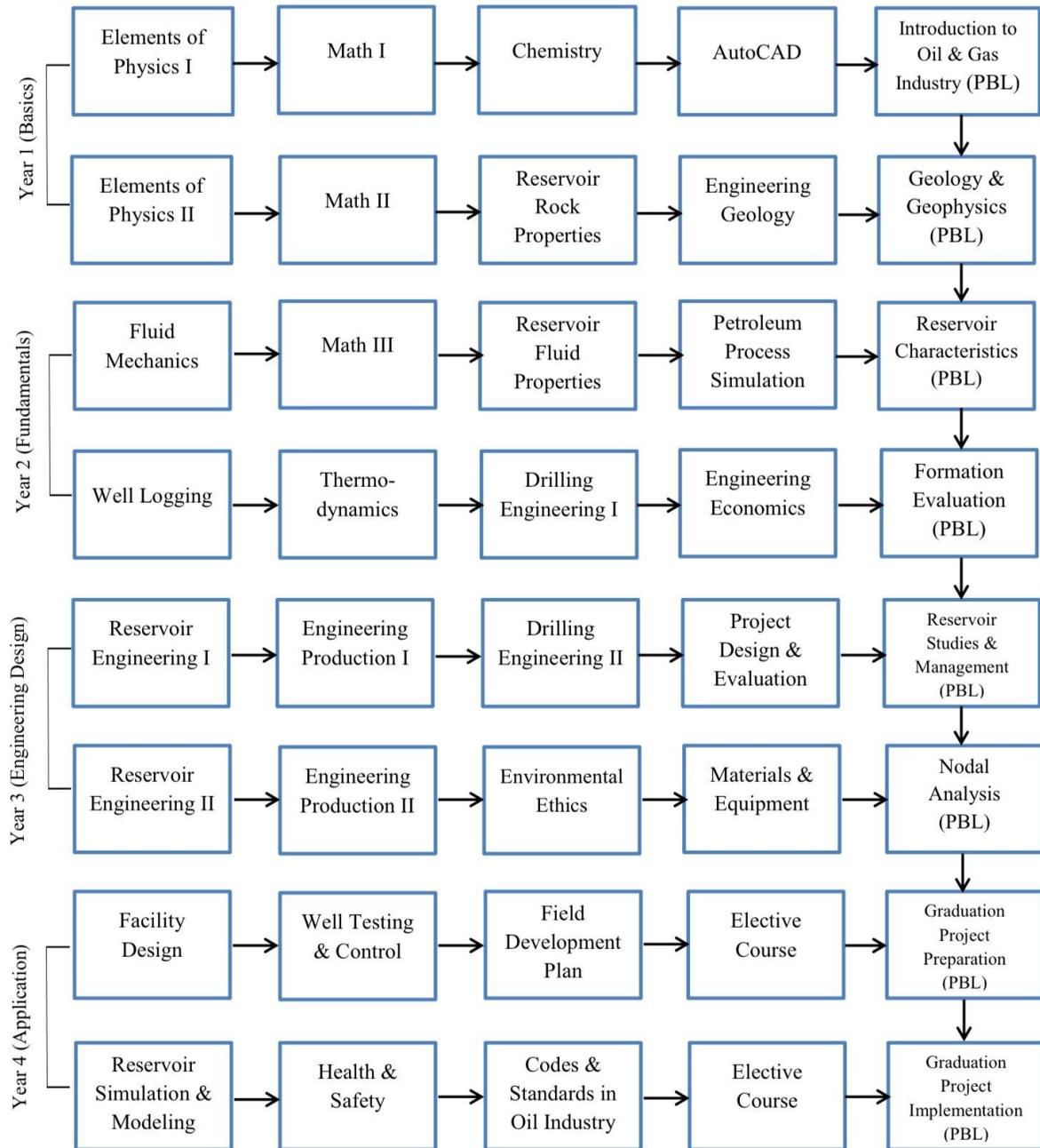


Figure 2: Curriculum designed based on EPBL model

Conclusions and Recommendations

Based on the above results and discussions for any new system there are lots of advantage and disadvantages, which PBL model is also one of them and cannot be exempted. The major issue with the PBL model, which has been looked into it in detail, was the lack of transition between the classic course and project based courses. This lack of proper linking between the two system made lots of inefficiencies which have been studied and mentioned in detail in the results and discussion. As the conclusion the EPBL model as the newest model can be utilized to overcome those inefficiencies, based on the following justifications:

1. EPBL design the educational curriculum in a way to make a strong cross linking between all the courses are taken in each and every semester from the beginning to the end in a horizontal way of approach rather than a vertical pre-requisite system which is commonly being practiced.
2. The students in the EPBL model will be able to work on the problems and to realize them in depth, instead of immediately start to solve them without proper understanding.
3. EPBL model has the ability to train the students to be able to involve their interests in writing project proposals or at least getting themselves' interest involved prior to start any project as PBL.
4. In the EPBL model the students will be trained to not only solve a problem by one method as they will be highly trained to use the learnt knowedelge from their previous PBL/lecture based courses as a lifelong learning skills and to be able to find first multi solutions and also to propose solutions to any other related problem.
5. EPBL model will be able to create well rounded graduates like the best professional specialists which for them to cure the patient, first they investigate more than they try to solve the problem.

Last not least for sure the new EPBL model has been introduced also needs to be implemented as well to see its weaknesses as well as it strengthens. There to be able to have a better education environments creating well rounded experts ready to face any challenges for their entire life not only simple graduate passed some courses.

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