

Problem Based Learning in Power System Analysis Course: a Case Study

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Abstract— Problem based learning (PBL) is known as an innovative method that improves students in their learning aptitudes. However, PBL is still challenge to power system analysis course since it concerns with advance mathematics and complex methodology. However, two requirements have put a demand in developing the learning method: the first one is to improve students in five skills according to Thai Qualifications Framework (TQF) and the second one is to prepare students for ASEAN Economic Community (AEC) beyond 2015. Thus, PBL has been implemented for the first time in Department of Electrical Engineering, Dhurakij Pundit University and applied to the last year students. The objectives are to develop both students and lecturer. Students should improve their learning aptitudes, ability to integrate their knowledge, and personalities: communication, problem-solving skill, responsibility, and teamwork. The lecturer should develop herself to be a facilitator rather than transmitting knowledge and providing only course materials. The implementation was planned carefully. The objectives of PBL and the corresponding evaluation indexes were set clearly. Then, PBL was carried out corresponding to the sub-procedure planned. Finally, evaluation, student feedback and results were analysed and concluded. This paper presents the implementing process, learning outcomes, problems and experiences of implementation.

Keywords— Problem based learning, learning aptitudes, knowledge integration, personality improvement, facilitator

I. INTRODUCTION

Nowadays, there are three important factors influencing teaching method.. The first factor is learning media and technology, and modern data base. According to the advance in telecommunication today, knowledge and numerous information are available in many forms which students could find them faster and easier than in the past. In addition, teaching in class room may build only student fragile memory. Giving course materials and transmitting knowledge from a teacher to students may cause only short memory. After passing the checking questions in final examination, students may forget what they have learned. They may not be able to integrate knowledge from various subjects and may not be able to apply their knowledge to real world problems. Furthermore, students may learn separately from other colleagues. They may lack interpersonal skill. Students may lack other qualifications such as self-learning skill, communication skill, etc. On the other hand, learning from each other is the most instinctive and natural experience [1]. Therefore, teaching method must be changed.

The second factor is Thai Qualifications Framework (TQF) for higher education system [2] which requires student development in 5 domains: learning: ethical and moral development, knowledge, cognitive skills, interpersonal skills and responsibility, analytical and communication skills.

The third factor is ASEAN Economic Community (AEC). Thailand is a member of Association of Southeast Asian Nations (ASEAN) which has been formed in 1967 [3] with many aims. One important aim was to accelerate the economic growth in the region to strengthen the foundation for ASEAN community. In 1995, ASEAN has reaffirmed that “cooperative peace and shared prosperity shall be the fundamental goals of ASEAN”. Thus, AEC has been targeted in 2015 to accomplish four main aims: single market and production base, competitive economic region, equitable economic development and fully integrated into global economy. AEC framework agreement will allow free flow of products and services. These will cause many improvement needs in skilled labour such as languages, communication skills, interpersonal skills, their proficient knowledge, etc.

The strategies for AEC beyond 2015 [4] are employee development in proficient knowledge, languages and multi-tasking skill, and Thai education should concentrate in development analytical skill of students.

These three factors have driven Thai education to change teaching methods. Problem based learning (PBL) is known as an innovative method that improves students in their learning aptitudes [5]. In PBL, facilitators assign students an ill-structured problem of which solution procedures are not clearly apparent at the beginning. Students must work in a small group and investigate problems carefully to find an appropriate procedure. Students must use prior knowledge, find more information, integrate knowledge from various subjects and link them appropriately, and use suitable tools to solve problems. In addition, students must plan and organize their team, and practice their analytical and communication skills. They also learn interpersonal skills and responsibility. PBL leads to collaborative problem solving among students. Facilitator let students work together over class periods. This will create opportunity for students to share their knowledge, learn from each other, and discuss the algorithm of problem solving [6].

PBL was used for the power system analysis course in Swinburne University in 2008 [7]. The student feedback was very positive and promising.

Thus, PBL was chosen to be applied to the last year students in Electrical Engineering Department, Dhurakij Pundit University.

II. LEARNING PLAN EMPLOYED PROBLEM BASED LEARNING

PBL was applied to students who had learned three courses: Power System Analysis I and II, and Power System Laboratory. They must use prior knowledge and simulation techniques to accomplish the assignment.

A. Learning Plan

The learning plan was carefully designed. There were three objectives described below.

1st objective: Developing student skills: Problem-solving, communication, learning from colleague, finding information, and analysis.

2nd objective: Preparation student for working in real world such as planning, organizing, team work, process, relationship, independence, integration knowledge, and responsibility.

3rd objective: Developing lecturer by changing from a transmitter to a coach or a guide.

B. Plan Implementation

To achieve objectives in item A, the evaluation indexes were specified. Students were clustered into a small group, 3 – 4 students which they were not all close friends. The assignment was carefully designed.

The student mission was to design a three bus power system with two generators located in different buses. There was one load bus with 50 MW and 10 Mvar. The distance from a generator to load bus was at least 100 km. Students should select appropriate power plants, transmission lines and circuit breakers. They had collected various data such as investment cost, operation cost and other cost of power plants. They should learn how to dispatch power and how to control power flowing in transmission lines. They should able to calculate the fault currents at various points and select appropriate circuit breakers. In addition, they should learn about power system security and reliability. Students could use various computer programs to help them solving their problems.

C. Procedure

After receiving an assignment problem, students in a small group performed 5 steps as shown below.

Step 1 Plan organization

Step 2 Activate prior knowledge and find more information

Step 3 Application: Find appropriate procedures. Transfer their knowledge to the practical problem. Integrated prior knowledge with the new finding. Connect information.

Step 4: Analyst results.

Step 5 Conclude.

Students must follow their plan, PDCA (Plan, Do, Check, Act), problem solving, communication, working as a team.

The procedure in Step 2-4 should be performed as loops to improve their assignments.

Facilitator performed 5 steps described below

Step 1: Declare knowledge that student must learn from PBL.

Step 2: Encourage student to discover knowledge from various sources. Gain their attention. Assist students who can not understand well. Ask good questions, do not answer the question that students could find them by themselves. Do not interrupt students when they are discussing and expressing. Check whether they cover all objectives.

Step 3: Observe and evaluate the development.

Step 4: Analyst results.

Step 5: Conclude.

D. Evaluation

To achieve the objectives in item II.A, the evaluation indexes and target were designed as shown in Table 1 - 3. Before and after PBL implementation, students were asked to evaluate themselves in each entry in Table 4. The point was in range 0 – 5, where ‘0’ is the lowest level and ‘5’ is the highest level. Whereas facilitator evaluated herself in item 3.1 – 3.4 in Table 3 and weighed student skills in Table 4.

TABLE I
EVALUATION INDEXES FOR THE FIRST OBJECTIVE IN ITEM II.A

Item	Description	Evaluation Content	Target
1.1	Communication Skill	Communicate among students and facilitator effectively.	4
1.2	Finding information skill	Data and information obtained. Searching through various sources. Data screening skill.	4
1.3	Learning from colleague skill	Discussing and exchanging information with other groups.	5
1.4	Problem solving skill	Defining problem causes and the way of solving.	4
1.5	Analytical skill	Use mathematics and analyst the output correctly.	3

TABLE II
EVALUATION INDEXES FOR THE SECOND OBJECTIVE IN ITEM II.A

Item	Description	Evaluation Content	Target
2.1	Planning Skill	Objectives, evaluation index, implementation procedure in steps	5
2.2	Teamwork skill	Organization, cooperation, process, relationship	5
2.3	Responsibility	Doing assigned tasks	5
2.4	Integration Knowledge	Activate prior knowledge and link them with new finding knowledge.	5
2.5	Self-learning Independent	Find information, screen and use data, solve problems, analyst results.	3

TABLE III
EVALUATION INDEXES FOR THE THIRD OBJECTIVE IN ITEM II.A

Item	Description	Evaluation Content	Target
3.1	Planning	Objectives, evaluation index, implementation procedure in steps.	5
3.2	Organization	Arranging students in a group with variety capability.	5
3.3	Assignment	Providing assignment that has possibility to evaluate student in Table I and II.	5
3.4	Guiding	Motivating and assisting students to achieve their objectives.	3

TABLE IV
SURVEYING CONTENTS

Entry	Contents	(0-5) points
1	Relationship among students in group	
2	Communication skill	
3	Problem solving skill	
4	Planning skill	
5	Organization skill	
6	Teamwork	
7	Ability of learning from team	
8	Work sequence	
9	Integration knowledge	
10	Power system knowledge	
11	Self-learning capability	
12	Capability of finding information	
13	Analytical skill	
14	Responsibility	
15	Benefit from PBL	

III. RESULTS

There are seven groups of students. Student opinions and feedback were obtained from questionnaire surveying while the facilitator observed and weighed student learning outcome.

A. Student Improvement

Student opinions before and after PBL are compared in Fig.1. They thought that the skills after PBL were higher than those of before PBL every items. Before PBL, students thought that their best character was responsibility whereas the lowest skill was organization skill. After PBL, the highest skill was teamwork and the lowest skill was capability of finding information because they were used to obtain information from teaching materials. However, they were good at teamwork.

In Fig. 2, Student thought that the first three greatest changes are the knowledge integration, self-learning and analytical skill, respectively. Whereas, benefit from assignment, responsibility and communication skill are minimum changed because students expected high benefit in

the beginning and they could keep responsibility and communication among them in the same level.

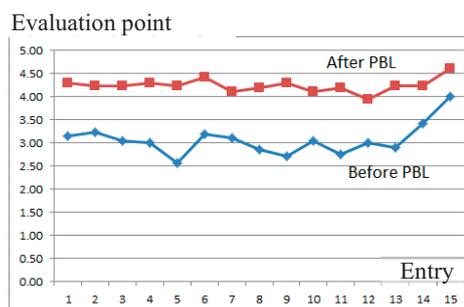


Fig. 1 Student opinion over their skills before and after assignment

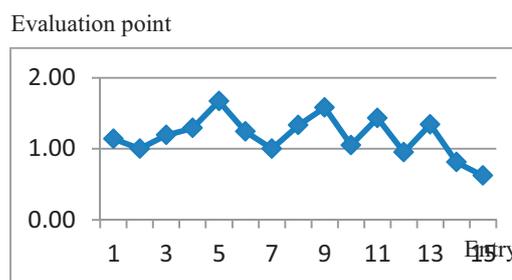


Fig. 2 Changes in student opinions over their skills after assignment

Student and facilitator opinions after PBL are compared and shown in Fig. 3 and Table 5. Most of evaluation points from facilitator are lower than those of students except entry 7 because students evaluated those skills relating to themselves whereas facilitator evaluated them relating to other students outside their class. The average points of student overall items in facilitator opinion is 3.31.

TABLE V
EVALUATION RESULTS

Item	Description	Target	Evaluation	
			Student Opinion	Facilitator Opinion
1.1	Communication Skill	4	4.24	3.23
1.2	Finding information skill	4	3.95	2.39
1.3	Learning from colleague skill	5	4.1	4.35
1.4	Problem solving skill	4	4.24	3.27
1.5	Analytical skill	3	4.24	2.62
	Average	4	4.15	3.17
2.1	Planning Skill	5	4.29	3.54
2.2	Teamwork skill	5	4.43	3.65
2.3	Responsibility	5	4.24	3.69
2.4	Integration Knowledge	5	4.29	3.77
2.5	Self-learning Independent	3	4.19	2.58
	Average	4.6	4.29	3.45

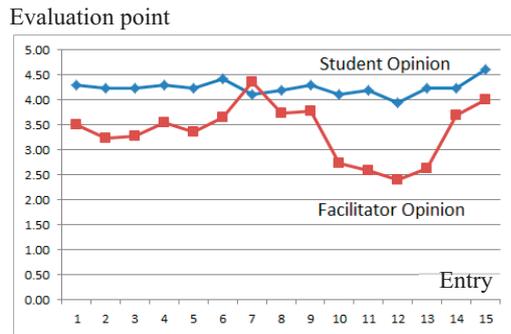


Fig. 3 Comparing opinion from students and facilitator

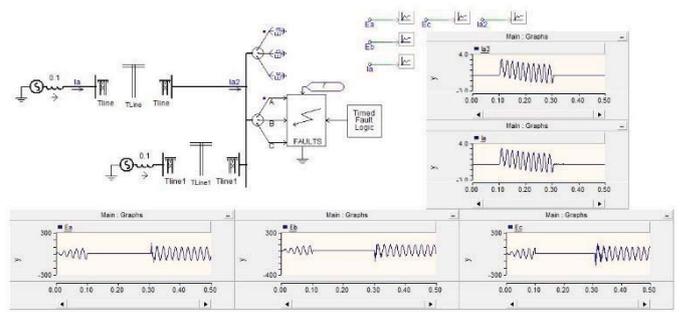


Fig. 4 Simulation program : PSCAD

B. Lecturer Improvement

Results are shown in Table 6. The evaluation are obtained from facilitator self-assessment. Facilitator needed to develop herself in guiding skill.

TABLE VI
EVALUATION RESULTS

Item	Description	Target	Evaluation
3.1	Planning	5	5
3.2	Organization	5	5
3.3	Assignment	5	4.5
3.4	Guiding	4	3

C. Student Feedback

Most of them had positive feedback though finding information was difficult for them. Assignment helped them in learning integration knowledge and teamwork. They could understand power system analysis course more clearly. Some students thought that working with their close friends would let them accomplish assignment faster. Whereas letting low responsibility students to work together will force them to work. Many students suggested to continue using PBL method in the next year.

D. Observation

Most of students have developed many skills, and some of them have better thinking method.

Most of them spent a lot of time to do PBL assignment, thought carefully, asked many questions, searched more information from various sources, learned new thing, tried to connect knowledge, tried to apply knowledge and tried to find answer by themselves. These led them to better understanding.

Students used at least two computer programs to analyst power system problem. Most of them can use power system simulation program, PSCAD shown in Fig. 4. They used PSCAD to find line parameters, power flow and short circuit currents in both symmetrical and unsymmetrical faults.

IV. LESSONS LEARNED IN PBL

Advantages are found and described below:

1. Students were more excited to learn than the conventional class.
2. Students learned how to integrate knowledge from various subjects.
3. Students developed various skills such as organization, integration, self-learning, and problem solving. They also developed other necessary skills for working in real world.

The problems are described below:

1. It was turmoil in the classroom because there were too many questions from each group. They were worried whether they could solve problem by themselves or not. They did not get used to PBL.
2. In some group, student relationship and their average responsibility were too low. Some of them did not help and did not learn anything.
3. Students were not proficient in English. This obstructed them from finding pieces of important information.
4. Students were not talented in computer programs.
5. Time was too short.
6. The third person was needed to evaluate facilitator.
7. Student could not perform in-depth analysis.

Suggestions for next PBL class are described below.

1. Group of students should be arranged carefully from their GPA, learning ability, responsibility, and leadership.
2. Students should have more skill in various computer programs used.
3. Assignment should be given early.
4. Learning in classroom should be arranged so that they can learn problem solving from other groups.
5. PBL should be applied to students with earlier years, they will get used to self-learning.

New Findings are described below.

1. Students with moderate group GPA (2.0 – 2.4) can cooperate with various students, share information with other groups, high ability of learning from other groups. Whereas students with high group GPA, work and share information and knowledge only in their groups.
2. The application of PBL in power system analysis course could stimulate students to integrate knowledge. But students could not analyse important formulas by themselves.

V. CONCLUSIONS

PBL in power system analysis course is applied to the last year students. Students were more eager to learn in PBL than in a conventional class. They developed themselves in various skills. Most of students gained benefit from this PBL. Student feedback was optimistic. There were suggestions to continue using PBL in the next year. However, the further study is needed for facilitator to gain more experiences to fully accomplish objectives.

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