



Integrating a Problem- and Project-Based Learning Approach into a Process of Thinking and Problem-Solving Course

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Abstract

According to the governmental policy, Thailand must change the educational system and strategies to encourage Thai students to have three main skills to live and work in the 21st Century. The aim of this paper was to illustrate the process and results achieved from the integration of a problem-based and project-based learning into a process of thinking and problem-solving course. Overall, 40 engineer students took part in online questionnaires which measured their satisfaction towards this course and 17 engineer students participated in the paper questionnaires which assessed their learning process during this course. It was found that all students had done 10 projects successfully which based on their project work, reports, the community participation and reflection, peer assessment, lecturer evaluation and students' satisfaction and reflection and most of them were satisfied in this course (the teaching, an instructional media, a lecturer evaluation and a classroom management). In addition, more than half of those students perceived that PPBL could enhance their thinking process and problem solving skill. These findings provide crucial information for Thai lecturers who are willing to apply the Problem- and Project Based Learning Approach (PPBL) in their courses. They also present vital information for Thai lecturers to develop the new curriculums to improve their students' learning skills via the actual community problems.

Keywords: problem- and project-based learning, problem-solving skill, thinking process, general education course, university students



1. Introduction

After Thailand was integrated with the ASEAN Economic Community (AEC) to enhance the business advantage of the region and sharing an educational resources which promote a social and economic development and a single market in 2015, Thailand must develop the human resource to achieve ASEAN or International standard and prepare Thai students to have the three main skills for living in the 21st Century (Upper Secondary Education Bureau Office of the Basic Education Commission, 2016). They comprised of 1) learning and innovation skills 2) information, media and technology skills and 3) life and vocational skills. In addition, according to the International Engineering Alliance, there were 12 vital characteristics that graduates must establish and one of these characteristics is problem-solving skill which can be shown via applying project-based learning, case studies and relevant workshops (Swart, 2016).

The change of socio-economic context was actually caused by the Digital Revolution and the Fourth Industrial Revolution (Thailand 4.0). It highlights the demand for skilled people in the 21st century that aims to develop learners with the skills of the 21st century which are 3Rs and 8Cs. These skills consist of 3Rs including Reading, Writing and Arithmetic while 8Cs include Critical thinking and problem solving skills, Creativity and Innovation skills, Cross-Cultural Understanding, Collaboration, Teamwork and Leadership, Communications, Information and Media Literacy, Computing and ICT Literacy, Career and Learning Skills, and the last one, Compassion (Office of the Education Council, 2017).

Integrated learning management is a way to encourage Rajamangala University of Technology Lanna (RMUTL) students to be able to form their identity that can link multidisciplinary knowledge. In order to achieve this learning experience in the practical way, we apply the knowledge and the ability in everyday life properly as mentioned in Progressivism theory of Dewey, (1963) with learning management. This theory believed in definite knowledge and supposed that the ultimate reality knowledge is always evolving. Knowledge is also assumed to be in charge of helping people to solve their problems, being most beneficial to the community, being used effectively as a philosophy of education that could attribute its importance to the learners. Learning occurs when learners have direct experience, learners are free to choose their own decisions as Bloom's Taxonomy mentioned about Cognitive Domain which involved brain processes in terms of intellectual (Anderson & Krathwohl, 2001). The problem solving emphasizes on learning experiences to the existing knowledge in the learner's brain. Students use the process skills to train the thinking process by engaging participatory teaching to encourage learners to create their own knowledge as Constructivism Approach which is based on meaningful learning Theory of (Ausubel, Novak, & Hanesian, 1978). In term of the theory, it emphasizes on the importance of learning in a meaningful way, learning new knowledge in the brain and transfer of Learning, following by putting learning into a new situation. Transferring learning is an important process because the purpose of the study is preparing students to be able to apply what they have learned into the future as well as in their careers and everyday life. This will lead students to see the relationship between the subjects and real life as Lardizabal, Bustos, Bucu, & Tangco, (1970) gave the meaning of integrated teaching and learning as a way of teaching by using learning activities, helping students solve the problem by themselves, also developing personality in all aspects so that students can adjust themselves and respond to the situations appropriately which is based on the experience and background of the individual. Hence, the learners can improve their behaviour, cognitive, skills and affective then bring these skills to solve the problems themselves and apply to the real situation to the fullest potential.



From the educational management approach and learning process set forth in the Act of the Office of the National Education, (1999) in Section 6, states that education must be developed to enhance Thai people to be complete human (mind, intellect, knowledge, virtue, ethic and culture in life). Thai people are expected to live together happily by allowing them to learning by doing and applying it in their daily lives. As a result, the process of learning was promoted and developed for Rajamangala University of Technology Lanna students based on the idea of producing graduates for community and society by emphasising students to learn from the actual experience. Learning of the problem solving process is a way that students learn the relationship between various knowledge for applying them in their real lives. In addition, interdisciplinary instruction is an integrated approach that is within the scope of the same content or Integrated Infusion Instruction. It will allow our students to complete their studies in the areas of knowledge, skills, learning process and morality appropriately. This course is taught through the lesson plans and evaluated by one or two instructors. Even though Rajamangala University of Technology Lanna students are taught by one or two instructors, they can see the relationship between the subjects or other subjects. In this study, the researcher integrated instruction in the process of thinking and problem solving (GEBIN101) because of its interrelations. Specifically, interdisciplinary Instruction is applied to link or combined two or more disciplines under the same theme. It is based on the usage of knowledge and understanding in science or knowledge in more than one subject to solve problems or to seek knowledge in a certain subject. In addition to language subjects, the content of this course is also related to social studies, science, mathematics, and other issues. Linking knowledge and skills between subjects will help students to learn deeply. It is not only superficial and very close to real life, but also develop students with the balance of knowledge, thinking, ability, goodness and social responsibility.

Hence, an objective of this paper was to illustrate the process and results achieved from the integration of a problem-based and project-based learning into a process of thinking and problem-solving course.

2. Method

It was found that the Problem- and Project Based Learning Approach (PPBL) successfully enhanced the students' learning process by cooperating with other organisations (Wiek, Xiong, Brundiers, & van der Leeuw, 2014). In this study, PPBL was applied in a process of thinking and problem-solving course to explore the engineer student's capability and their satisfaction towards this course.

A process of thinking and problem-solving course at Rajamangala University of Technology Lanna is one of the compulsory courses for all new students in 2017, especially engineering students. It was developed to enhance the undergraduate students to have the 21st century learning skills along with the vocational competency. It is conducted within 18 teaching weeks of every semester. It consists of both theoretical and practical part. There are two lecturers from the Faculty of Business Administration and Liberal Arts and the Faculty of Agricultural Technology, are responsible for giving a lecture and then giving some advice on the students' project work. (Please see Table 1.)



Table 1: Problem- and Project Based Learning Approach (PPBL) activities in the process of thinking and problem solving course

No.	Procedure
1.	Lecturer 1 and/or 2 : Introduction
2.	Lecturer1: Thai folk wisdom, innovation, the seven community tools for the learning process in the 21 st century and a case study
3.	Lecturer2: theories of thinking, thinking process in Sciences and problem-solving
4.	Choose the community, explore the community problems and choose an achievable problem Using <ul style="list-style-type: none"> - seven community tools - Interviewing - camera or mobile phones (if applicable)
5.	Present the proposals and submit them to the supervisors
6.	Amend the proposals
7.	Design the project work
8.	Meeting supervisors to report the progression of the project work and get some comments and feedback during design and do the project work
9.	Do the project work and a report
10.	Go back to the community to get some comments and feedback from the villagers
11.	Amend the project work according to the comments and feedback
12.	Present the final project work and submit the final report to the supervisors

The population in this study were the engineer students who enrolled a process of thinking and problem solving course in the second semester of 2017 (2 classes). Overall, 40 engineer students took part in online questionnaires which measured their satisfaction towards this course. In addition, 17 engineer students participated in the paper questionnaires which assessed their learning process during this course. Their participations were voluntary.

3. Results

According to the General Education curriculum, the lecturers divided the assignment for engineering students into 6 parts. They include:

Project work

In order to prepare an adequate knowledge and techniques for solving the problems when the students did their projects, the lecturers gave them 7 lectures. Specifically, the introduction of this course was conducted by two lecturers to explain the general information, course syllabus, assignment and measurement in the beginning of this course. Then, a lecturer from the Faculty of Business Administration and Liberal Arts gave the lectures which were relevant to Thai folk wisdom, innovation, the seven community tools for the learning process in the 21st century and a case study. Next, a lecturer from the Faculty of Agricultural Technology gave the lectures which were related to theories of thinking, thinking process in Sciences and problem-solving.



After listening to the lectures, the students had form their groups comprising of 7 – 8 group members. They were provided the guidelines and techniques by the lecturers. Each group had to choose the community that they would like to explore. Then, the group members had to investigate the community to identify the community problems and possibly solutions individually. Next, they had to discuss with other group member and chose an achievable problem for designing the best solution by conducting their projects which were based on their vocational knowledge and skills.

In this semester, there were 44 civil engineering students and 9 electrical engineering students who had enrolled in the process of thinking and problem-solving course along with other students (Section 9 and 10). Their projects are presented in the table below.

Table 2: Project titles

Number	Project title
1	Fixing clogs in water lines
2	Wastewater treatment at Mae Kha Canal, Chang Moi
3	Solving agricultural water problems : a case study of Rim Khan Village, Tambon Don Pao, Amphoe Mea Wang, Chiang Mai
4	Building the handicraft learning center in Pa Bong Luang Village
5	Building the roof by using lalang
6	Garbage management : a case study of Chang khian Village, Tambon Chang Phuak, Amphoe Muang, Chiang Mai
7	Tourism promotion : a case study of Muangkung Village, Amphoe Hangdong, Chiang Mai
8	Waste segregation in community for making the fertilizer
9	Product processing of longan
10	Creating a website to promote the wisdom of silverware

The project work's objectives were to provide the students a great opportunity to learn how to solve both group work and community problems in the real situations effectively and to practice the students' skills, for instance, observational skill, active learning skill and problem-solving skill that are vital for their future career.

Reports

To confirm that the students had learned how to apply the thinking process to solve the problems systematically and employed folk wisdom, Thai wisdom, innovation and modern technology to their projects, all students had to report all processes that they had done. The contents of report are shown in Table 3.



Table 3: The contents of report

Chapter	Title
1	Introduction
2	The general information of community i.e. – The history of community - Population and occupation - An organisational structure of community - Social and cultural traditions - The Geo-Social mapping
3	The tools for learning community life and solving community problems i.e. – A semi-structured interview - A questionnaire - A survey - An experiment
4	The results i.e. – The lists of community problems - An achievable problem - The solutions
5	Conclusion and recommendation i.e. – Conclusion - Limitation - Recommendation

Community participation and reflection

This process was vital for enhancing a problem-solving skill because the villagers who had lived in the community would reflect their opinions toward the projects, for instance, the possibility, the cost, an environmental effect, a location and the materials. Specifically, after designing the project work for solving the community problems, each group had to come back to the community to get some feedback and comments from the people who live the community. After that, the students had to modify their project work and amend some information in the group report. In addition, they had to make appointment to meet their supervisors at least twice before the final presentation. If they had any questions, they could ask their supervisors directly.

Peer assessment

In this course, the peer assessment was applied to review their project during the first presentation (proposal presentation). This strategy was very beneficial for the students' learning skill because the students from each group could learn different kinds of community problems and the solutions that other groups decided to choose to deal with these problems. Additionally, they could gain some useful feedback and comments to improve the quality of their project work and report. There were 6 steps of peer assessment. They included:

1. The groups were randomly matched with other groups (one on one) by a lecturer.
2. The students were informed about the criteria of the peer assessment on the first presentation (the proposal presentation) which was relevant to the readiness for presentation, the knowledge in the contents of presentation, a concordance of the objectives of project work



and a presentation, language usage, the patterns of presentation and time management. A questionnaire was given to every group.

3. After the presentation, all the group members discussed the paired groups' presentation which based on the given criteria of the peer assessment. They were allowed to ask some questions, if they do not understand some issues.
4. Every group submitted a questionnaire to the lecturer.
5. The assessment was analysed and summarised. Then, the lecturer announced the results of assessment to every group. This step was essential for all students because they could use these results to improve their final project work, report and presentation.

Lecturer evaluation

To confirm that the peer assessment was reliable, the lecturer had to evaluate every groups' knowledge and presentation skills both the proposal (10%) and final presentations (10%). The criteria of lecturer evaluation were relevant to the readiness for presentation, the knowledge in the contents of presentation, a concordance of the objectives of project work and a presentation, language usage, the patterns of presentation and time management.

In addition, the lecturer evaluated their academic performance based on the final report (10%), their meeting attendance (10%), their participation in classroom (10%), a mid-term examination (20%) and individual assignments from two lecturers (30%).

Students' satisfaction and reflection

The students were requested to participate in an online questionnaire by the Office of Academic Affairs and Registration, RMUTL. The online questionnaire measured the levels of students' satisfaction toward this course (teaching, instructional media, lecturer evaluation and classroom management). Overall, 40 students took part in this online questionnaire. It was found that an average level of students' satisfaction in this course was 4.35 out of 5. The criteria of students' satisfaction included:

- Teaching (4.34 out of 5)
- instructional media (4.31 out of 5)
- lecturer evaluation (4.29 out of 5)
- classroom management (4.40 out of 5)

Moreover, the students were requested to reflect their feelings and thoughts toward this course by a lecturer, especially learning the problem-solving skill via doing their project work. Interestingly, 17 students participated in this stage. The results will be illustrated below.

1. Personal information

The data was analysed from 17 Thai male engineer students with ages ranging from 20 to 23 years old ($M = 20.94$ and $SD = 0.75$). All of them were Thai and Buddhists. They were freshmen. The majority of participants were Civil Engineer students while an Electrical Engineer student took this course and voluntarily participated in this study. For more information, please see the table below.



Table 4: Descriptive Statistics

Variables	N	Percentage
Major/Degree		
Faculty of Engineering (Civil Engineering)	16	94.12
Faculty of Engineering (Electrical Engineering)	1	5.88
Grade Point Average (GPA)		
2.00 – 2.49	3	17.65
2.50 – 2.99	8	47.05
3.00 – 3.49	3	17.65
3.50 – 4.00	3	17.65
Variables	N	Percentage
A number of brothers and sisters (including yourself)		
1	4	23.53
2	12	70.59
3	-	-
4	1	5.88

2. Teaching in the process of thinking and problem solving course

2.1 Their attitude towards an instructional media in this course

Most students indicated that instructional media in this course were precise and easy to understand. Some students also thought that this subject was good.

2.2 Their expectation of this course

The results found that most students thought that studying in this course would enhance them to have the better problem solving skill while some students believed that the contents of this course would be useful and could be applied into their daily lives. For instance, March expected that studying in this course could help him to deal with the group work and he would be able to analyse the future problems.

2.3 Their opinion on practicing the problem solving skill via PPBL

Interestingly, over half of those students revealed that PPBL could enhance their thinking process and problem solving skill. In addition, a majority of students agreed that applying PPBL into this course could help them to learn how to solve the problems from the actual situations. Ohm noted that “PPBL can help me to understand the community problems clearly. I can ask the villagers to find a way to solve their problems.”

Finally, the students were asked what they learnt when they visited the local sites to investigate the community problems. The majority reported that they knew the community problems deeply and learnt how to solve them. Additionally, some students viewed that they learn about the community cultures and the ways of life. Guide said that he could understand the problem correctly and know the actual problems from the villagers.

2.4 What they had learnt throughout this course

Most students revealed that they had learnt how to solve the problems throughout this course, following by learning how to work effectively (For example, a systematic working, planning, writing a report).

2.5 The advantages and disadvantages of PPBL

The students who took this course thought that PPBL had varied advantages, for example, helping them to plan and work in the group harmoniously, improving a problem solving



skill and helping them to put their ideas into their work and describe their work clearly. They also mentioned that PPBL had some disadvantages, for instance, taking time to visit the sites and search for the information, a possibility to miss something that was vital for doing the projects and the complicated working process.

2.6 How to apply the learning process and problem solving skills into their daily lives

A majority of students indicated that they would use these skills to do the future assignment, following by solving the community problems and working with other people.

4. Discussion and Conclusion

The objective of this study was to present the process and results of integrating a Problem- and Project-Based Learning Approach into a Process of Thinking and Problem-Solving course. There were the key points that were emerged from this study. They included;

1. They had done 10 projects successfully which were based on their project work, reports, the community participation and reflection, peer assessment, lecturer evaluation and students' satisfaction and reflection.

2. A majority of students were satisfied in this course (the teaching, an instructional media, a lecturer evaluation and a classroom management).

3. More than half of those students perceived that PPBL could enhance their thinking process and problem solving skill.

4. The students who took this course thought that PPBL had varied advantages and some of them mentioned about the disadvantages of PPBL.

Specifically, most students perceived that PPBL was beneficial for them because they viewed that PPBL could enhance their thinking process and problem solving skill. In addition, the majority reported that they knew the community problems deeply and learnt how to solve them. These results were in line with those of previous studies which had indicated the roles that PPBL had on curriculum development, students learning and academic network (Corvers, Wiek, Kraker, & Lang, 2016; McGibbon & Van Belle, 2015; Wiek, Xiong, Brundiers, & van der Leeuw, 2014).

Moreover, most students realised that PPBL had various advantages while some of them recognised about the disadvantages of PPBL. These results partially supported the idea of Pinheiro & Arantes (2018) who suggested that PPBL was very beneficial for indicating the relationship between their occupations and virtuous behavior and Gonzalez-Rubio, Khoumsi, Dubois, & Trovao (2016) who found that PPBL could enhance students' problem solving skill and project comprehension.

This study illustrated the process and results achieved from the integration of a problem-based and project-based learning into a process of thinking and problem-solving course. However, there were some limitations that should be mentioned. Firstly, the participants in this study were engineer students who studied at Rajamangala University of Technology Lanna. It could not generalise to Thai students who studied in other cities or regions in Thailand. Secondly, there was a higher number of Thai male Civil Engineer students (16 participants) who took part in this study compared to Thai male Electrical Engineering student (1 participant) Hence, the difference in their majors of study probably affected their problem-solving skill and thinking process.

Despite some limitations, the findings in this study provided the preliminary data for university lecturers to understand and apply PPBL in other subjects. They also facilitated the vital data for the policy makers to improve the General Education curriculum by collaborating with other institutions. Future work needs to be done to establish whether PPBL is applicable to teach other students who take the courses in the General Education curriculum. Future research could also be



conducted to explore the effectiveness of PPBL in enhancing the students' learning process in other higher education curriculums.

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