AC 2012-2957: ENGINEERING STUDENTS' PERCEPTION ON LEARNING THROUGH COOPERATIVE PROBLEM-BASED LEARNING (CPBL) FOR THE FIRST TIME

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Cooperative problem-based learning (CPBL) has been proven to be a powerful technique in engaging and developing students in learning, as well as a multitude of professional skills. Nevertheless, academic staff in engineering who are new to conducting CPBL may face difficulties because students who are new to this inquiry based technique will normally be "traumatized" because of the drastic change in the learning environment and requirements. As part of a larger study on training and supporting academic staff in implementing CPBL, a phenomenological study was conducted on the categories of variations in students' perceptions towards learning as they go through a course that fully utilized CPBL in a whole semester. The main purpose is to identify students' perception towards CPBL in two aspects: the student perceptions and acceptance/rejection, and the benefits and improvements that students gained along the learning process. The paper illustrates the extent of acceptance and effectiveness of CPBL method for an engineering class taught by a lecturer who had undergone a series of training on cooperative learning and problem based learning, but is new to implementing CPBL. Through classroom observations, students' self-reflection notes and interviews with students for one whole semester, the results are reported in three stages: beginning of the semester, in the middle the semester; and at the end of the semester. Four types of initial-to-final students' perspectives were found. The analysis of the interviews reveal that, first and foremost, it is essential for academic staff to understand and embrace the philosophy behind CPBL, which will enable them to providing students with appropriate support especially in developing team working, time management, learning and thinking skills. In addition, proper explanation and justification behind each step in the CPBL cycle, as well as the overall planning through the different problems, are also necessary to avoid confusion and cutting corners in learning among students. Most of all, the analysis reveal the importance of emotional support in the form of motivation and encouragement, as students go through various emotions that form into perception, which in turn affect their performance.

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Engineering Students' Perception on Learning through Cooperative Problem-Based Learning (CPBL) for the First Time

ABSTRACT - Cooperative problem-based learning (CPBL) has been proven to be a powerful technique in engaging and developing students in learning, as well as a multitude of professional skills. Nevertheless, academic staff in engineering who are new to conducting CPBL may face difficulties because students who are also new to this inquiry based technique will normally be "traumatized" because of the drastic change in the learning environment and requirements. As part of a larger study on training and supporting academic staff in implementing CPBL, a phenomenological study was conducted on the categories of variations in students' perceptions towards learning as they go through a course that fully utilized CPBL in a whole semester. The main purpose is to identify students' perception towards CPBL in two aspects: (1) perception and acceptance/rejection; and (2) the benefits and improvements gained along the learning process. The paper illustrates the extent of acceptance and effectiveness of CPBL for an engineering course taught by a lecturer who had undergone a series of training on cooperative learning and problem based learning, but is new to implementing CPBL. Through classroom observations, students' self-reflection notes and interviews with students for one whole semester, the results are reported in three stages: (1) beginning of the semester; (2) in the middle the semester; and (3) at the end of the semester. Four types of initial-to-final students' perspectives were found. The analysis of the interviews reveal that, first and foremost, it is essential for academic staff to understand and embrace the philosophy behind CPBL, which will enable them to provide students with appropriate support especially in developing team working, time management, learning and thinking skills. In addition, proper explanation and justification behind each step in the CPBL cycle, as well as the overall planning through the different problems, are also necessary to avoid confusion and cutting corners in learning among students. Most of all, the analysis reveal the importance of emotional support in the form of motivation and encouragement, as students go through various emotions that form into perception, which in turn affect their performance.

Keywords: Cooperative Problem-Based Learning, Teaching and Learning, Student Perceptions

I. INTRODUCTION

Cooperative Problem-Based Learning (CPBL) is an inductive learning method that incorporates the five principles of Cooperative Learning (CL) into the Problem-Based Learning (PBL) cycle. CPBL is suitable for medium-sized classes of up 60 students sitting in small groups consisting of three to five students for one floating academic staff or facilitator[1,2]. A detailed description of the CPBL model can be seen in Figure 1[1,4].

Designed based on constructive alignment, the CPBL framework, shown in Figure 1, is a scaffolding for students to visualize the whole cycle, and go through the process in a systematic manner. Previous studies had shown CPBL to enhance students' problem solving abilities and team working skills[3]. It is also shown to motivate students to learn, as well as develop skills to learn and think critically. This is very much in line with the outcomes of PBL. As such, the CPBL model allows PBL to be executed in a typical classroom while attaining the desired outcomes normally possible only with small group implementation. A detailed description of CPBL can be seen in Khairiyah et al. (2011a)[1].
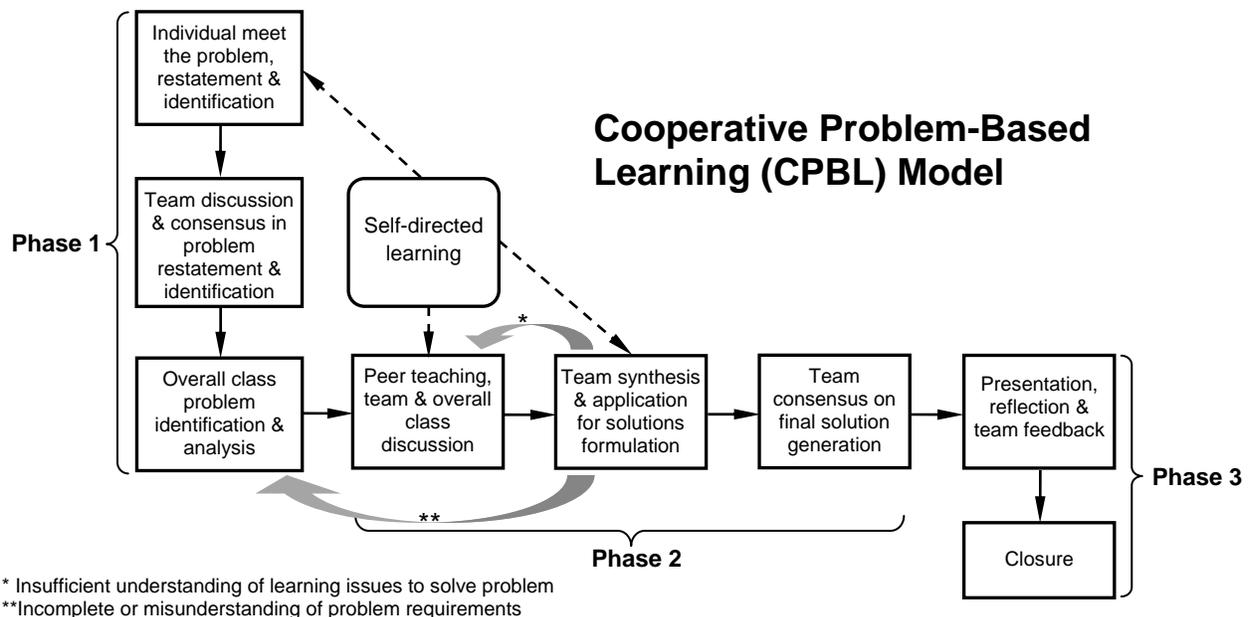

Figure 1: Cooperative Problem-Based Learning (CPBL) Model

Nevertheless, implementing and facilitating CPBL can be rather complicated, especially if the course where it is implemented is the only one using the technique among all others that use a more traditional lecture-based method. Students who face CPBL for the first time will typically feel shocked over such a drastic change in the teaching and learning method. In fact, Woods (1994)[5] stated that many will go through emotions associated with someone who had faced typical trauma. Students initially feel shocked, which then turn to denial, followed by strong emotion, and after that, resistance. Finally, they resigned themselves to acceptance, start to struggle, which in turn help them to attain better understanding, before finally attaining integration at a higher performance level than when they initially started. Therefore, part of the role of the facilitator is to provide support so that students will be able to overcome their initial frustrations in the shortest time possible. It is important for the facilitator to address these issues before they started to abandon the learning strategy[12].

However, this is not an easy task for the facilitator, especially when faced with many students in various stages of "trauma" in a class. While most students are able to go through and overcome this difficulty, there may be a few who continue to resist or feel negative towards CPBL until the end of the semester. Therefore, it is essential to identify their source of dissatisfaction to design proper support or scaffolding that can minimize students' frustration while guiding them in developing the necessary skills to learn and solve the given problem.

This paper describes a study which investigates the perception of third year students in a class while learning in a difficult, mathematically intensive engineering course. Although the lecturer for the class had gone through a series of pedagogical training on active, cooperative and problem-based learning, this is the first time the lecturer implemented CPBL. This study is actually part of a larger research on training and supporting academic staff in implementing CPBL.

III. STUDY DESIGN

This study was conducted in a three-credit course called "Process Control and Dynamics", which is required for third year chemical engineering students. The course was notorious for its difficult content because students need to be able to decipher and extract the

meaning behind mathematical representations of dynamic chemical process behaviors to select suitable controller settings or design appropriate control systems. To appreciate the course, students need to have a strong background in mathematics as well as the knowledge of chemical processes, which they had learned in courses taken in previous semesters. When lectures were used as the primary mode of instruction, thirty to forty percent of the class would fail, with an average passing grade of a C- to D+. Nevertheless, up to 90% of the course content is now covered using CPBL through four problems given throughout the semester. A detailed description of the implementation of CPBL in the course can be seen in Khairiyah et al.[1] and Khairiyah et al.[4]

This study involves 35 students in one of the three sections offered for the Process Control course. The main purpose is to identify student perceptions towards CPBL, conducted by a new lecturer in its implementation, in two aspects: (1) the students' perceptions and acceptance/rejection; and (2) the benefits and improvements that students gained along the learning process. This is part of a larger research to determine appropriate support and training for academic staff in implementing CPBL.

To study students' perceptions, a phenomenological research design was carried out through non-participant observations, unstructured interviews and students' written self-reflections which were collected at the end of every problem (there were four problems in this class). Students in the class were divided into nine groups (about four students in a group). During and after each problem, the students, selected based on convenient sampling, were interviewed on the following aspects:

a) Students' perceptions in the conduct of CPBL by the lecturer
b) Their experience and involvement during the CPBL learning process
c) Their acceptance of the CPBL as a teaching method for the course

During and after each problem, the students were asked with a set of questions centered on students' initial thought as they approach the CPBL system in earlier stage. The questions were to investigate the student's expectations on CPBL after attending classes in the first few weeks of the semester, what are the differences compared to their usual teaching and learning experience, and what concerns they had. At the mid-semester stage, the focus of the interview shifted towards their emotional aspect as students were showing frustration in struggling to adapt

to the CPBL cycles. The questions geared towards reflections of their learning issues and self development. At the final stage, they were asked about the CPBL as a whole, strengths and weaknesses, as well as their reflection of self improvement.

After one semester of exploration with almost all the students through interviews and observation by two researchers, it was found that the pattern of student perceptions can be categorized into four, which will be explained at the end of this paper. Further exploration on these categories was made to understand the change of their perceptions in order to identify the reasons for such a pattern. This is to inform the lecturers who are new in using CPBL to carry out the appropriate steps in CPBL that will ensure positive perceptions among students and avoid steps that might result in negative perceptions among the students. The overall perceptions of the students were presented in this paper drawing from the interview, observation and self-reflection data. The interviews were carried out after the classes every week either at the school building or at the students' residential colleges. Later, four students, one from each of the categories of the four patterns of student perceptions categorized, were selected to illustrate the results and further discussions.

IV. RESULTS AND DISCUSSIONS

A. Student Perceptions on at the Beginning of the Semester

In the first few weeks of the semester, the students were trying to review the overall CPBL framework, understand the CPBL cycle and deal with the work-load required by the CPBL process. During the initial cycle of CPBL, where for the first time, the students had to identify and understand the learning issues before they could solve a realistic and unstructured problem, many students felt obligated to make a lot of reading (something that they are not used to doing), to develop peer-teaching notes that they have to turn in and use during peer-teaching sessions with their team mates and with all their classmates during the overall class peer teaching session. Reading up on the assigned learning issues and making the notes made some of them felt burdened. Table 1 summarizes their early responses which actually show higher degree of dissatisfaction among the students. This conform to the initial part of the "trauma cycle"[5], which stipulate that students would feel shocked, denial, strong emotion, and resistance.

Table 1: Students' Responses towards CPBL at the Beginning of the Semester

Factor	Description
Confusion of the cycle of CPBL as the principles and method were not well explained	There was a lack of explanation from the lecturer of how to work with CPBL. Since active learning requires the lecturer to take on the role as a facilitator, students' questions were not given direct answers in order for them to construct their knowledge through their own search. The lecturer's answers draw no correct or false conclusions, however, there were no hints and clear justifications given to solve problems. The students were confused by the way the lecturer treated their questions.
Longer time engagement on CPBL activities	There were due dates set for other assignments of other courses. The students felt distracted because of the workloads in the CPBL cycle required more time spent for this course. They were facing a dilemma of dividing their time and attention for other courses taken in the same semester.
The work load anticipated by CPBL made them felt anxious and near to giving up	There was not enough time to obtain information in producing peer teaching notes. In the beginning of the semester, due to misunderstanding about CPBL, the division of tasks among the group members was ineffective. This caused them to feel that the learning cycle was too fast and difficult to follow. There was a sense of the shortage of time to submit reports and write peer-teaching notes.
CPBL requires more on self-efforts and fewer on lectures as conventional classes	The responsibility of learning in CPBL lies with the students. In CPBL, students were not given conventional lectures but were required to spend some time for group and class discussions in correcting concepts and calculations and to prepare reports and peer-teaching notes through group efforts.
Inconvenience, unfamiliar and insecure of the new learning environment	Since all the students were experiencing this new learning environment, they felt inconvenient and insecure of the learning process. One of them was the reference of different books to solve problems which caused different interpretation and understanding among group members. They faced difficulties to meet mutual understanding and were not at ease with differences of opinions.
Low participation or involvement and individualistic attitude among group members	In the beginning of the semester, students felt that there was low participation on group works from the group members. Some students showed greater effort in presenting in the class but when it comes to the group, they were just passengers who did not contribute to the group discussion.

These dissatisfactory responses on the CPBL implementation have been identified due to several following factors:

a) Confusion of the cycle of CPBL as the principles and method were not well explained

b) Longer time engagement on CPBL activities

c) The work load anticipated by CPBL made them felt anxious and near to giving up

d) CPBL requires more on self-efforts and fewer on lecture notes as conventional classes

e) Inconvenience, unfamiliar and unsecure of the new learning environment

f) Low participation or involvement and individualistic attitude among group members

After the completion of the first problem, the students' perceptions began to show some changes. While some of them were still resisting, others were showing positive attitude towards CPBL. For example, the following self-reflection shows positive attitude after the end of the first problem, which is labeled as Case Study 1 (CS1):

> ### RefCS1 - Respondent 03:
> *"After undergo CS1, I learned that CPBL had given me new a experience on learning. We were exposed to a situation that might occur in **real life**. I learned how to make a proper **problem identification** involving a table identifying - what we know, what we need to know and the learning issues. This is totally **different from lecture-based teaching"**.*

Note that all the reflections shown in this paper were corrected for grammatical errors, while preserving the original meaning.

This group of students realized the benefits of what CPBL can offer them especially when they enter the work place in the future. Some other students showed mixed perceptions of CPBL because this is just the first problem they had experienced. One of them said:

> ### RefCS1 - Respondent 02:
> *"Initially, I am very curious on the subject as it seem so challenging and difficult to learn. I am also curious on the topics and the **awkward learning system that is different than usual**. But, after series of discussions with group members, I began to understand the*

*flow of the learning system. But, it tends to make us **confused** and requires our **own efforts to read the suggested textbooks"**.*

This group of students could feel the benefits of CPBL, but were not willing to put their efforts into it. They were also still at a state of confusion because of the different technique of learning and the various opinions and approaches in trying to find an answer for the problem. This shows that the students still did not fully understand how CPBL works, and why they have to learn according to the steps outlined in the framework, as shown in Figure 1.

There is another group of students who could not accept CPBL as a learning method because of the demands CPBL requires. One of them said:

RefCS1 - Respondent 01:
*"I can feel difficulties for this semester. I have registered a subject that is **very tough** which is PC subject that are using CPBL method, with complicated cycle, needs full attention and commitment in order to find the solution"*

The first problem, which is the simplest of the four problems given in this course, is an introduction for the students to CPBL. It aims to provide the students of the appropriate method in defining problems and solutions. It also helps to prepare them for the upcoming problems that had more technically challenging content with more complex and real problems.

It is not difficult to anticipate such problems among students in CPBL because CPBL is a blend of cooperative learning and problem-based learning, which is highly grounded in the constructivist theoretical framework where the role of the lecturer is to facilitate the knowledge construction of the students and students must be prepared to take on the responsibility and ownership of their learning. CPBL is very remote to the students who are used to the conventional spoon-feeding teaching style and more individualistic learning approach. For this, the lecturers must be equipped with the right facilitating skills, understanding the philosophies and principles underlying CPBL and the ability to understand students' emotions and

psychological state in order to motivate them, especially in the beginning of the implementation of CPBL. This is to give them the sense of security of their learning progression in CPBL and to show them the benefits and learning that they are gaining through the cycles of CPBL.

However, in this class, the students' perception on the lack of explanation from the lecturer on how CPBL works, especially at the beginning of the semester, has caused confusion, frustration and dissatisfaction among the majority of the students. Some of them even thought that the lecturer was incompetent for not providing lecture notes and answering their questions directly.

B. *Student Perceptions on CPBL as a Means for Self-Improvement*

As the students experience the subsequent problems at the middle of the semester, they gradually shifted their perceptions to a more positive attitude towards the end of semester. They realized that the CPBL learning process has slowly optimized their learning skills. However, it is undeniable that the process has created higher workloads and extra learning hours. Some group members showed dissatisfaction towards irresponsible group members and became upset during the group discussions.

The change of student perceptions towards a positive attitude was because of:

a) the deeper understanding and higher skills in problem solving

b) the realization of the benefits CPBL can offer

c) the increase of self-confidence to achieve better result

Therefore, majority of the students confirmed that CPBL has contributed for:

a) self-independent and group work engagement

b) improvement of their reading and learning skills

c) optimizing their efforts in learning

d) offering better understanding of their mistakes through open class discussions

e) learning new approached in problem solving for future career

f) improvement of interpersonal skills and communication among friends

Table 2 shows the interview quotes of the students regarding self-improvement that they have achieved through CPBL. These responses were obtained at the end of the semester.

Table 2: Student Perceptions of Self-Improvement

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a. Self-independent and group work engagement

Q6-A1.3. "…I love this class! I love the self-making notes, group activities and open-minded class discussions. All these hardworking efforts make me appreciate myself more…"

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b. Improvement of reading and learning skills

Q6-A2.1. "…the presented notes are results from reviews on peer-teaching notes from friends. I have reviewed others' models several times and study the differences and similarities in textbooks. It causes me do lots of reading, rewriting and rereading, something that I have never done before…"

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c. Optimizing own efforts in learning

Q6-A3.1. "It very different! This learning style is not dependent on lecture and lecture notes, requires students to talk and discuss among each other. It mostly about self-learning…"

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d. Better understanding of own mistakes

Q6-A4.1. "It is truly different! If we have misconceptions, these concepts will be thoroughly discussed together again and again in the classroom. It differs from previous learning method, where it's only on the paper, nobody care to ask and most students just pretend to understand…"

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e. Approach towards future industry problems and applications

Q6-A5.2. "Since study using CPBL approach, my understandings on specific problems are better. Compared to previous classes, students only describe the theoretical situations and concepts in industry. But, through CPBL the problems are more practical, based on what may happen and how to solve the problems."

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f. Improve self-interpersonal skills and interactions

Q6-A6.1. "Before this, I am passive, shy to interact with friends and to come forward. But now, I feel relaxed, better communications and close to my friends. Now I can even freely tell my jokes!"

Most of the students claimed that they could now enjoy the learning process, became used to the challenging group discussions and felt the excitement to compete with each other to find the best solution. The students agreed that CPBL learning process had:

a) contributed to longer retention of the knowledge learned

b) made the time needed for examination preparation shorter

c) made them become more hardworking

d) increased the level of understanding, capabilities and self-performance

e) increased the level of confidence

f) increased their passion and interest in discussion and learning

g) improved their time management skills

The majority of the students agreed that the biggest improvement that students benefited from this CPBL learning process is critical thinking, team-working and communication, and interpersonal skills.

C. Students' Acceptance of CPBL

In terms of students' acceptances of CPBL, they can be categorized into three groups: positively accepting, moderately accepting and rejecting as shown in Table 3. Those who resisted CPBL claimed that the problems and cycles were wasting their time. Those who accepted CPBL found CPBL to be an interesting learning approach which offers advantages in all of the problems given.

Table 3: Students' Acceptance of CPBL

Acceptance	Reasons
Positively accepting	• Increase self- capability in time management • Increase reading skills • Increases personal efforts & patience
Moderately accepting	• Less time engagement in discussion • If the number of CPBL cycles can be reduced • If the number of problems can be reduced

Rejecting	• Wasting quality time
	• Uncertain results and increase worries
	• Difficulties in learning due to lack of notes, explanations and guidance

D. Overall Changes on Students' Perceptions after One Semester

The students' perceptions of their overall learning process depend on how the students interpreted difficulties in learning in either to transform into:

a) **benefits or self-improvement** – *which later develops a positive perception; or*

b) **difficulties and threat** – *that constructs into negative perception*

Analyzing the qualitative data obtained from students in the class, four types of changes on student perceptions can be seen as students undergo the CPBL learning process:

a) those that held positive perception about CPBL from the beginning until the end

b) those that held negative perception from the beginning until the end

c) those that changed from positive perception in the beginning to negative perception at the end

d) those that changed from negative perception in the beginning to positive perception at the end

Based on the analysis of interviews with one student from each category, factors that affect the change of student perceptions from the beginning until the end of the semester were extracted and summarized in Table 4. The main factors that can sustain the positive perception are:

a) the students felt that CPBL has improved their time management

b) CPBL has exposed them to the future application of knowledge they have learnt for workplace problem solving

c) the students are clear of the concept definitions

d) CPBL helps to increase students' soft skills

e) the students gained deeper knowledge and understanding

Table 4: Factors for the Change of Student Perceptions from the Beginning until the End of the Semester

Early perception	Perception Change / Maintain	
	Develop to POSITIVE perception	Develop / Maintain NEGATIVE perception
POSITIVE	o Improve time management o Exposure for future application and problems o Clear concept definition o Increase soft-skills o Deeper knowledge & information	o Demanding & wasting time o Difficult because tones of work loads o Very difficult to absorb o Too fast learning cycle o Feel of unfair to other courses
NEGATIVE	o Increase learning skill in learning together o Forced to more read o Clear concept definition o Improve time management	

Referring to Table 4, the factors that sustain negative perception among students are:

a) CPBL demands higher workload and time (students felt it was a waste of time)
b) some students who did not do enough preparation and group discussion felt the difficulty to absorb the learning
c) poor time management made the students felt that the learning cycle went too fast
d) the students felt they neglected other courses taken in the same semester because of the attention towards CPBL was higher than others

Factors that can change students' perceptions from negative towards positive are:

a) the students could see the benefit of studying together and felt that they cannot study alone in the setting of CPBL, and hence they felt an increase in their learning skills
b) CPBL made the students feel obligated to do more self-reading, which led students to master the concepts and knowledge
c) CPBL encourages students to reflect and plan their time properly and discipline themselves to fulfill the due dates of each problem

Comparing the factors that hold positive versus negative perceptions of CPBL, the same element tend to appear in both. For example, in terms of time, those who have positive perceptions at the end (both the initially positive and negative categories) tend to say that learning through CPBL trained them to manage time and handle their workload properly. On the other hand, those who have negative perceptions at the end tend to say that they were unable to manage their time because the learning cycle was too fast, causing them to neglect other courses. In terms of learning, those who have positive perceptions at the end managed to read more and learn deeper, as well as develop learning and professional skills. They appreciate learning with their team and classmates, and value learning in the context of their future work setting. However, those with negative perception at the end felt that learning with their team and classmates were a waste of time, because they were not able to learn (difficult to absorb). They obviously do not appreciate the opportunity to learn and develop themselves through CPBL, which is why they find it demanding and the workload too much. The issue of workload is in direct contrast to students with positive perception, who appreciate the inculcation of the reading and discussing culture in learning.

From the interview results, students with positive perception gained tremendously in terms of knowledge and professional skills. On the other hand, students with negative perception found it difficult to participate in the CPBL process, causing them to lose out in the learning and understanding the content, as well as professional skills development, which would also compromise their final grade in the course. Therefore, it is important for facilitators to identify students with negative perception to provide additional support and scaffolding, especially in terms of learning and thinking skills. In addition, looking at their reasons for dissatisfaction, correct understanding of the overall process, as well as the function of each step of the CPBL process need to be given to students, and reinforced throughout the semester. The students also need to be motivated and properly facilitated throughout the CPBL cycle. Regular assessment on the team functioning, as required in cooperative learning, is also necessary to promote accountability, as well as continuous improvement of team working.

The insights gained from the analysis of the findings shows the gaps that need to be addressed in training and supporting academic staff to implement CPBL successfully. Before

lecturers can guide students in CPBL, they need to fully understand not only the CPBL process, but also the underlying philosophy that forms the basis of the design of framework. This will enable them to provide proper support, design scaffolding and facilitate students through the myriad of emotion that they go through to finally allow them to develop positive perception so that they may gain from the numerous benefits of CPBL.

V. CONCLUSION

The phenomenological study on CPBL learning process for Chemical Engineering students has defined types of changes on student perceptions and their level of acceptances towards the learning of CPBL by a lecturer who is new to this method. Although studies have shown that problem-based learning enhance positive attitude among students[6,7], the key of these changes is on how the lecturer shapes the learning environment, understanding the students' emotion and learning issues, motivate and facilitate them towards the right direction by not just being a constructivist facilitator but also by providing the necessary support to develop the required skills[8,9] needed to work in a team, solve problems and manage time. Therefore, the lecturer actually plays a very important role in shaping students' perceptions of the learning approach that in turn will deeply impact their learning[10]. As Woods[11] stated that it may not be the fault of the teaching method but the way it is introduced to the students which causes students to develop the negative perception.

ACKNOWLEDGEMENT

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