

# Development of Profession Skills through CPBL among First Year Engineering Students

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## Abstract

Developing professional skills, such as problem solving, team working and communication skills are crucial for engineering graduates of the 21st Century. Cooperative Problem Based Learning (CPBL), which is the infusion of Cooperative Learning (CL) principles into the Problem-Based Learning (PBL) cycle, had been shown to enhance learning while developing the desired professional skills. This paper describes a qualitative study using reflective journals that showed the development of these skills among 32 first year students as they go through three cycles of CPBL to solve the problem given. Written reflections submitted by students at the end of each CPBL cycle were analyzed using qualitative data analysis technique of Miles & Huberman to determine the skills developed, as students progress through each of the three stages of the problem. The results show that although students initially faced difficulties in developing the skills, progress can be seen as they go through the CPBL cycle in each stage of the problem. At the end of the third stage, students realized that they have managed to attain important skills that are essential as engineers of the future.

*Keywords:* Problem-based Learning, Professional Skills, Reflective Journals;

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## 1. Background

Various engineering education reports (Duderstadt, 2008; Royal Academy of Engineering, 2007; National Academy of Engineering, 2005) from throughout the world stressed on the need for graduates who are not able to apply their technical knowledge, but also possess professional skills that can help them function well at the work place. These skills include problem solving, teamworking, communication, time management, leadership, etc. While there are possibilities of having additional courses to teach students these skills, the already overloaded engineering curricula leave little space for stand-alone courses to address each professional skill required. In addition, research shows that skill like problem solving must be taught in the context of the profession to be effective (Jonassen, 2006). Thus, it is essential for engineering courses to implement teaching and learning approaches that can help students to learn the content, while at the same time develop crucial professional skills.

For this reason, Cooperative Problem Based Learning (CPBL) was utilized to attain the professional skills outcomes in the Introduction to Engineering course taken by first year Chemical Engineering students in Universiti Teknologi Malaysia. CPBL has been shown to enhance motivation in learning and learning strategies, deep learning, as well as develop team based problem solving skills (Mohd-Yusof et al., 2011b, Syed Helmi et al., 2011, Phang et al., 2012). It is the infusion of Cooperative Learning (CL) principles into the Problem-Based Learning (PBL) cycle to provide crucial support for students through the development of team-based learning skills, that will enable them to successfully undergo a PBL learning environment in a typical course setting. Figure 1 shows the CPBL framework, which is used to guide students through the CPBL cycle step by step as they go through the learning process together. More details about the CPBL framework can be seen in (Mohd-Yusof et al., 2011a).

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After all the reflective were collected at the end of the semester, a qualitative data analysis technique recommended by Miles & Huberman (1994) was employed. The technique consists of three phases:

- data reduction
- data display
- conclusion drawing and verification

As there were 128 sets of reflective journals from 32 students, the first step of data analysis was to reduce the data in to a manageable volume to answer the research questions. By focusing on the research questions, information that was not important can be put aside. Keywords and phrases that could answer the research questions were highlighted.

In the second step, the data was re-organised using tables. The highlighted keywords and phrases were put into tables based on the generic skills such as team working skills, communication skills, problem solving skills and time management skills. The categorisation was organised for the same students over the different weeks of reflective journals to identify the change that the students experienced.

At the final phase, the categories were re-examined by comparing the slices of data at the second phase to the original full transcripts of reflective journals. This is to ensure that the quotations taken out were not interpreted out of the context. Finally, conclusions were made and they are as shown in the tables in the result section.

## 5. Results

This paper explores the enhancement of professional skills that students develop in the Introduction to Engineering course, which implemented CPBL. Table 1 shows the four generic professional skills most often mentioned in the students' reflective journals (RJ) that were written at the end of each CPBL cycle. The number given in the table shows the number of students who mentioned the skill in each stage of the different reflection journals.

Table 1. Professional skills found and the number in reflective journals of each stage

<b>Professional Skills</b>	<b>RJ 1</b>	<b>RJ 2</b>	<b>RJ 3</b>
<b>Team Working</b>	7	8	9
<b>Time Management</b>	3	10	6
<b>Communication Skill</b>	7	9	10
<b>Problem Solving Skill</b>	6	6	7

From the skills shown in Table 1, the reflection journal of each stage from one of the students that mentioned the skill was taken to provide a snapshot of his/her perception during the development stage. Table 2 shows some sample quotes for each of the professional skills. For each skill, the vignette written by a specific student for the reflection at the end of Stages 1, 2 and 3 are given to see the student's perception on his or her ability on the skills from the beginning to the end solving the problem.

At the end of Stage 2, the students' reflection depicted their effort to overcome the initial shortcomings that they had and were beginning to show the development of the skills. Although the students admitted that the tasks at hand were tough, they were expressing more positive remarks, which showed a higher skill level.

At the end of Stage 3, all four students reflected that they have managed to reach a higher level of achievement in the skills after going through the three CPBL cycles to solve the problem given. As seen in Table 2, all of the last vignettes show very positive reflections. All students expressed happiness and confidence, as well as pride in the work that they have done.

## 6. Discussion

There are four professional skills developed through CPBL by the first year students: team working, communication, problem solving and time management skills. This is similar to the findings of earlier studies conducted on third year students who had undergone CPBL for one semester (Phang et al., 2012, Syed Ahmad Helmi et al., 2011, Mohd-Yusof et al., 2011b). The skills developed are also consistent with other studies on students who had undergone PBL (for developing problem solving skills) and CL (for developing team working skills) (Syed Ahmad Helmi et al., 2011; Strobel and Barneveld, 2009; Prince, 2004; Johnson, Johnson and Smith, 2006). From the reflection journals that have been analyzed, it can be observed that students showed efforts on how they tried to rationalize their situations to cope with new learning style and to make proper planning in solving problem given. Students also showed strong commitment to be an effective team member, developed leadership characteristics and more about the behavioural aspects of effective team working.

The initial difficulties faced by students at the end of Stage 1 of the problem, after undergoing one CPBL cycle is also expected. This is because as explained by Woods (1996), students who are new to PBL will undergo an emotional cycle that is similar to those facing trauma. In the initial stage of the "trauma cycle", most students would be shocked and faced difficulties in trying to cope with a new learning method that required them to use skills that they did not have. Nevertheless, as try to cope

and accept that what they have to do is a necessity, students begin to develop the necessary skills as they improve themselves when they go through the CPBL cycle in Stage 2. This is reflected in the more positive outlook in the second reflection journal. At this stage, although they were still struggling, the students could see the fruits of their labour and began to appreciate the skills that they are developing through the learning process. Finally, similar to Woods' description for the end of the "trauma cycle", students reached a higher level of performance when they were able to integrate the new skills that they have developed or enhanced.

Table 2. Example of quotation for skills found at the end of each stage

<b>Professional skills</b>	<b>Reflective journal</b>	<b>Example of quotations from the reflective journals</b>
<b>Team working skills</b>	RJ 1 (S1)	It is really hard for me at first working in a team because I am not a type of person who really likes to work in a group especially in a large number.
	RJ 2 (S1)	It is normal thing in team that we have problems with team members along the project is execute but then as a team we should try to communicate among members and try to overcome all the problem that we face.
	RJ 3 (S1)	But thanks to my team members because this team really change a lot on my perspective when working with a team. They really help me a lot when I need them and motivate me when I needed.
<b>Communication skills</b>	RJ 1 (S2)	Language barrier seems to be main problem which I encountered because our team members came from a various races. There is a little bit awkward to communicate with each other.
	RJ 2 (S2)	This problem required me to think out of box and commit me to make the right decision. Communication barrier are now solved as we always meet for discussion and this make our communication improve from time to time.
	RJ 3 (S2)	It really suits me working in this environment for near future. It's really improve myself confidences well as my communication skills I hope that in years to come, there is a lot of programmed like this so that we can really learn something useful in our university life.
<b>Problem solving skills</b>	RJ 1 (S3)	It is a big pressure for me to handle as it is not a thing that I really familiar with. We have to face the first stage of this PBL that involved a lot of group discussion, completing the report and presentation.
	RJ 2 (S3)	I have to do a lot of research in order to get ideas on how to conserve energy in school. This is very stressful moment for me as the number of tasks to be completed was increased.
	RJ 3 (S3)	Honestly, I am very happy with the report as each of us gives full commitment to complete it. All these work are not easy as abc as each of us need to brainstorm like a half dead person to come out with a good report. However, it taught me to be patient and don't give up even though the challenges are big.
<b>Time management skills</b>	RJ 1 (S4)	We encountered a time problem as we were unable to match with each other timetables. We are realized that lacking of time will responsible to our team failure.
	RJ 2 (S4)	I learned time management by managing my time to do all works I need to do. I also learned not to procrastinate in my works. I did all the works on time in order to spend my time for revisions for the final exam.
	RJ 3 (S4)	PBL was very beneficial for me as a first year student. It had given me lots of exposure about university life. It also helped me to develop my soft skills especially time management which will be useful for me in the future. This kind of problem will equip me to become a better engineer in future.

This finding is also similar to an earlier study on the perception of third year engineering students who had undergone CPBL in a technically intensive course (Phang et al., 2012). In the earlier study, CPBL classroom observations were made throughout the semester, and the third year students were interviewed as the semester progressed to discover their perception as they experienced CPBL. The initial negative perception and frustration of the third year students were very much similar to the reflections made by the first year students. When the students were interviewed in the middle of the semester, evidence of coping and acceptance can be seen, just as the first year students in this study. Finally, at the end of the semester, the feelings of jubilation and success were indeed the same as the first year students after the completing the third and final stage of the CPBL.

The findings of this research shows that first year students who went through the CPBL cycles in their Introduction to Engineering course gained problem solving skills, which is also supported by the study on third year engineering students (Syed Ahmad Helmi et al., 2011). Although this study showed that students faced difficulties and did not develop problem solving skills immediately when they went through CPBL in Stage 1, they realized that they have managed to integrate this skill as they go through the subsequent stages and complete the problem. This shows that the CPBL learning environment is constructively aligned as is desired in its original design, and thus allow students attain this outcome.

## 7. Conclusion

This study shows that first year engineering students who went through CPBL in the Introduction to Engineering course were able to develop problem solving, team working, communication and time management skills. This is in accordance with previous studies which also showed that there was enhancement of professional skills after going through CPBL. This study also showed that there was a gradual development of the skills as the students go through three cycles of CPBL, which started off with difficulties in facing a new learning environment and negative perception before finally getting comfortable and attaining success.

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