

Motivation and Learning Strategies: Promising Outcomes of Cooperative Problem-based Learning

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Abstract

Solving complex engineering problems is an essential skill that must be developed among graduates of the new millennia. Issues facing the world today are very challenging, and will become more challenging in the future. Thus, to become good problem solvers, graduate engineers of today must be motivated and equipped with learning strategies that will allow them to adapt to future requirements as self-directed learners. Evidence shows that engineering students who had gone through Cooperative Problem-Based Learning (CPBL) become highly motivated and are strategic learners. CPBL is the infusion of Cooperative Learning (CL) principles into the Problem-Based Learning (PBL) cycle that is used for effective implementation in a typical class. The question is how do the students acquire these attributes that influence the development of their problem solving skills? Based on qualitative analysis, four elements, expectancy, extrinsic motivation, intrinsic motivation and task value were grouped under motivation, and another four elements, organization, critical thinking, effort regulation and help seeking were grouped under learning strategies. Based on the findings, a model of motivation and learning strategies as a sub-model for enhancing engineering students' team based problem solving skills through (CPBL) is proposed.

Keywords : Motivation and Learning Strategies, Problem Solving, Cooperative Learning and Problem-Based Learning.

1. Introduction

Students' motivation and learning strategies play very important role in driving learning (Svinicki, 2005). It is one of the main bases for engagement - whether a person decides to spend his time and effort on a certain task (Urban and Schoenfelder, 2006). Cooperative Problem-Based Learning (CPBL), which is the infusion of Cooperative Learning principles into the Problem-Based Learning (PBL) cycle to allow effective implementation with small groups in a typical medium size class, had been shown to shape attitudes, motivate students to learn and develop effective learning strategies (Helmi, et al., 2012; Mohd-Yusof, et al., 2011). CL is a systematic team working approach in learning where all five CL principles, such as positive interdependence, face-to-face interaction, individual accountability, development of interpersonal skills and regular team function assessment, are applied (Johnson, Johnson and Smith, 2002, and Smith and Imbrie, 2004). PBL is a student-centred, inductive-based learning methodology, where using self-directed learning to solve ill-structure problems are the core principles (Prince and Felder, 2006; Hmelo-Silver, 2004; and Barrows and Tamblyn, 1980). Because of the challenges of CL and PBL in solving complex problems, if not properly facilitated, students can be de-motivated and give-up (Mohd-Yusof and Helmi, 2009). Nevertheless, with good facilitations and properly implementing CL and PBL, students' motivation and learning strategies will tremendously increase.

The learning environment within Cooperative Problem-Based Learning (CPBL) is in accordance with the expectancy-value theory. Expectancy-value theory states that students choose to engage in a task that they expect to succeed in, and that they deem to be beneficial if they completed the task successfully. As mentioned by Eccles and Wigfield (2009), and reported by Matusovich, Streveler and Miller (2009), expectancy-value theory conceives that motivation to perform a learning task depends on two dimensions: "expectancy of success" in the given task, and the "value" attributed to effectively performing the task. Expectancy of success is related to three factors: (a) how a learner attributes his past success or failure; (b) how a learner perceives

competence; and (c) how a learner maintains self-esteem. The “expectancy” dimension answer to the question of “Can I do this task?” The second category of expectancy, the value theories answers to the question of “Do I want to do the task?”. Based on the motivational theories, Liao (2005) suggested that in order to enhance motivation, instruction needs to help learners perceive competence as acquired skills and to enhance their sense of control over learning tasks. Making the learners believe that excellence is achievable by efforts and that they can make a difference, is attainable by enabling students to make improvements on their past self-performance rather than being graded by the performance of others. In CL, this pedagogical practice is called “equal opportunities for success” (Liao, 2005).

Supporting and monitoring students’ learning in small groups by a floating facilitator can be challenging in a typical class while implementing PBL. It is typical for students to become de-motivated by working in groups, be it in laboratories or class projects, because of negative prior experiences (Felder and Brent, 2007). Therefore, in PBL, the support needed does not only involve cognitive coaching, but also, guidance and monitoring to develop team working skills in students. In a proper CL environment, part of the monitoring, support and feedback can be attained from peers, especially team members, instead of solely relying on the facilitator. In fact, support can be further enhanced by developing the whole class into a learning community. To achieve this, Duch, Groh, and Allen (2001) and Prince (2004) suggested CL aspects to be integrated with PBL. Thus, it is only logical to have a model that integrates both CL and PBL to become Cooperative Problem Based Learning (CPBL) to take advantage of the natural synergy between them. With proper facilitation and scaffolding, students going through CPBL courses were more positive towards learning compared to those undergoing traditional lectures, and hence it is not surprising to see them develop challenging skills such as solving complex problems (Helmi, et al., 2012; Jamaluddin, et al, 2012).

2. Research Methodology

The research question is how do the students improve their learning motivation and their employment of learning strategies that will eventually enhance their problem solving skills? The question is answered using qualitative analysis. The research methodology used constant comparative method to study the process, or look for explanation of the process.

The question is investigated from series of students’ reflections and interviews from 2 groups of students. In this qualitative methodology, the research questions focused on the CPBL approach, on students describing their experiences mainly through interviews and reflection journals. The CPBL approach consists of the CPBL cycles and problems organization. Students reflected upon their works at the end of every problem they solved. Researcher interviewed several students at the end of the semester. The students’ reflections and the interviews are analyzed using NVivo 8 and themes emerged from the reflections and interviews are analyzed. Emerging themes are considered as saturated if they were frequently mentioned (Corbin and Strauss, 2008). As a rule-of-thumb, themes emerged more than seven times is considered as saturated. The themes are considered triangulated if they emerged from many different sources (Creswell, 2007). In this study, the researcher’s role is like an “instrument” through which the reality of the students’ problem solving skills enhancement is explored. The researcher’s presence is acknowledged, both by the students and the lecturer.

2.1 Technical Characteristics

The reliabilities of the emerged themes in the reflection journals and interviews are conducted using Cohen’s Kappa (Fleiss, Levin and Paik, 2003). According to Landis and Kosh (1977), if index of Cohen’s Kappa (K) is greater than 0.81, the reliability of the themes are considered as very high. Samples of coding and its’ respected themes are given to three (3) experts for the reliability analysis. The three experts are the CPBL expert, the problem solving expert, and the qualitative analysis expert. The results of the analyses show that the themes are totally reliable, with $K = 1.0$ from all the experts. Thus, all the emerged themes can be applied in the analysis.

3. Data Gathering and Analysis

A summary of themes emerged from the investigation and numbers of the themes repeated are shown in Table 1. From the analysis, motivation and learning strategies is divided into two elements: motivation strategies and learning strategies.

In the motivation element, themes such as expectation, intrinsic goal orientation, extrinsic goal orientation, and task value emerged. In the learning strategies, themes such as critical thinking, effort regulation, help seeking, and organization emerged. All the themes were mentioned several times, with help seeking theme

emerging the most, followed by effort regulation. The next theme that was mentioned most is their intrinsic goal orientation. Table 2 shows samples of data related to the themes. This table, together with Table 3 shows how students improve their learning motivation and their employment of learning strategies that will eventually enhancing their problem solving skills.

Table 1: Open coding and repetition of themes for motivation and learning strategies

Motivation and Learning Strategies	Reflections				Interviews		Σ
	Problem 1	Problem 2	Problem 3	Meta	Group 1	Group 2	
Motivation:							
Expectancy	5	3	3	3	1	4	19
Intrinsic	4	2	6	2	2	4	20
Extrinsic	2	3	5	1	2	4	17
Task Value	1	2	4	0	0	2	9
Learning Strategies:							
Organization	3	2	2	1	3	2	13
Critical Thinking	4	1	4	1	2	2	14
Effort Regulation	5	5	2	3	3	4	22
Help Seeking	7	4	6	2	2	4	25

Table 2: Samples of open coding for motivation and learning strategies

Elements	Sample Data	Open Coding
Motivation Strategies:	I won't be able to learn a new thing if I easily give up trying and learning from mistakes. We learn from mistakes. If I keep on trying and am persevere, then eventually I will be able to master the things I am learning.	Intrinsic
	As for Simulink, it was totally new to me. It was fun and interesting, seeing how graphs can be produced and learning how to analyze the graphs.	Task Value
Learning Strategies	With more feedbacks and comments, the original solution is improved and made better, and eventually the problem can be solved in a better way.	Critical Thinking
	Looking at the syllabus, I noticed that I can see the connection of all the 3 phases. Problem statement must be clear before confronting the problem.	Organization

4. Research Findings

How the students enhanced their motivation and learning strategies upon going through CPBL is shown here. In this study, the two most frequent themes in motivation are intrinsic goal orientation and expectancy, respectively. This is then followed by extrinsic goal orientation. Upon undergoing CPBL for one semester, the students' motivation in learning is driven by their intrinsic goal orientation. As stated by student A,

“I won't be able to learn a new thing if I easily give up trying and learning from mistakes. We learn from mistakes. If I keep on trying and am persevering, then eventually I will be able to master the things I am learning.”

This statement illustrated the intrinsic value component of the student's goal orientation, as he emphasizes his effort of not giving up due to his quest for knowledge. The next most frequent theme in motivation is expectancy. The expectancy component measures students' expectation for success in a course. This is mentioned by student A, as he said,

“I realized that if all of us contribute our parts during discussions, the outcome will be better as there are more ideas being generated.”

Student A highlighted that in order for him to succeed in the course, he need to contribute more in group discussion. As for the extrinsic goal orientation, a student stated that,

“As overall, I am very happy to have a great time during this class although sometimes I have a hard time. Lastly, for sure I need to get A in this subject.”

He concluded his statement of happiness and working hard with his expectation to get the best grade for the course. This extrinsic goal orientation will motivate him to work hard and finally achieved the reward of his

expectation. In this study, intrinsic goal orientation is mentioned more than extrinsic goal orientation. This signals that students are more into the problems with curiosity, as a challenge to master their understanding compared to their grades and rewards. Though, both are considered important for them. Another important theme that emerged in the reflections and interviews is task value, for example, student B stated,

“As for Simulink, it was totally new to me. It was fun and interesting, seeing how graphs can be produced and learning how to analyze the graphs.”

This statement shows the degrees to which the students perceive the course material in terms of interest, significance, and usefulness. All these statements show the students’ learning motivation, which are very important pre requisites to overcome and sustain the challenges in solving complex and open-ended problems such as the problems in CPBL.

The enhancements of students’ learning strategies can be understood from important themes that emerged in students’ reflections and interviews. Among all the themes, help seeking is most frequently mentioned. In fact, it is the most mentioned in this spotlight. Help seeking is about enlisting the support of others. As student C reflected,

“When we are discussing about certain topics, we help each other to understand the topic better.”

This shows how the students properly utilize resources and actively pursue assistance to enhance their learning strategies. The next most mentioned theme is effort regulation, as revealed by student D,

“First we need to study like mad people and then vomit it out to our team mate then only the real thing will come, a clearer picture of the content. It actually happens on all the four phases where we don’t know anything but at last produces something.”

This shows how the student was persistent in pursuing his learning goals even in the face of difficulties or boredom. Both of these themes, help seeking and effort regulation, indicate how the students enhance their resource management strategies as an important element in learning strategies. Other important themes that also emerged in this analysis are critical thinking and organization. An example of critical thinking which emerged through overall group discussion, student E said,

“With more feedbacks and comments, the original solution is improved and made better, and eventually the problem can be solved in a better way.”

The statement shows how the student’s problem solving skills is enhanced through the CPBL process. Organization refers to making connections between substances to be learned. With this regards, student F mentioned,

“Looking at the syllabus, I noticed that I can see the connection of all the 3 phases. Problem statement must be clear before confronting the problem.”

The emerging themes of critical thinking and organization indicate the use of cognitive and meta-cognitive component in problem solving. It shows how the students improved their thinking approach through connecting and representing knowledge to better understand, and making justified judgments as well as to transfer and apply knowledge in a different context.

Figure 1 shows the open, axial and selective coding of the analysis. The elements of motivation and learning strategies are considered as the axial coding that group all the themes into two categories. The selective coding is designated as motivation and learning strategies, which is the integration of the motivation strategies and the learning strategies, since both are closely inter-related to one another.

5. Discussion

The constant comparative method had been used in the analysis to find answer to the research question of how do the students improve their learning motivation and their employment of learning strategies that will eventually enhance their problem solving skills. From the analysis of the qualitative data, this paper presents the development of a sub-model of the enhancement, illustrated in Figure 2. The model symbolizes two intertwined characteristics of students who had undergone CPBL: enhanced motivation and learning strategies. There are four elements that influence how students develop their overall motivation: expectancy, intrinsic, extrinsic and

task value. There are also four elements how students enhance their learning strategies: organization, critical thinking, effort regulation and help seeking.

Elements that enhanced students' motivation is in accordance with the expectancy value theory, which is also supported by the quantitative findings on the same cohort of students who had undergone CPBL in the same cohort (Mohd-Yusof, et. al., 2011). Students were found to enhance their intrinsic and extrinsic motivation towards learning as they go through CPBL, which is consistent with studies on PBL that found to develop positive attitude in students (...). This is not surprising, because students believe the tasks that they were doing in CPBL is of value, and will help develop them into good engineers in the future. This finding is, again, consistent with the aim of using real, or at least, realistic problems in PBL, that serves to contextualize the knowledge that is being learned. Another strong element that emerged, expectancy, shows that students believe that they can succeed if they put in effort, even though the task may initially seem to be difficult. This caused them to go on and not give up.

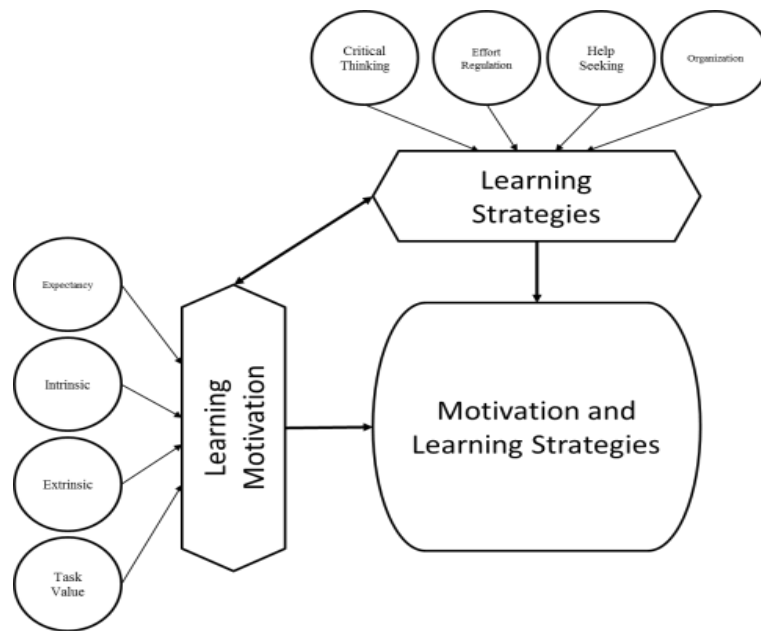


Figure 1: Open, axial and selective coding for sub-model enhancement of engineering problem solving skills (motivation and learning strategies)

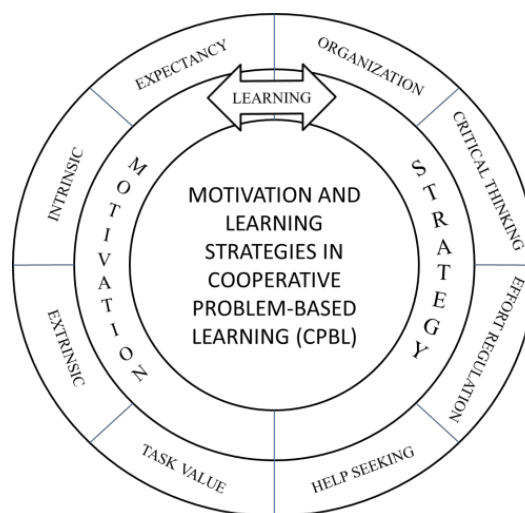


Figure 2: Motivation and learning strategies: sub-model of enhancement engineering problem solving skills through CPBL

The findings on the elements in value and expectancy are also consistent with the social interdependence theory which underpins CL. Social interaction among learners can create collaboration, leading to a significant positive impact on learning (Jonnasen, et. al., 1995; Johnson, et. al, 2006). This effect can be seen among students, when they realize that by having each of them putting in effort, the team will be able to produce better quality output than any of them can produce on their own.

The data that shows enhancement of the elements in learning strategies are closely intertwined with the motivation elements. Elements, such as help seeking and effort regulation, show a lot of times how working together in CPBL in a cooperative manner motivated and enabled them to reach a higher level in learning and solving the problem. Having their team mates and the whole class as a learning community made the students realize that they can rely on one another to learn, and that they are not alone in facing the difficult tasks and problem. As they go through CPBL, students develop the ability to better manage and utilize the resources that is available to them in learning

Cognitive and meta-cognitive elements can be seen in the way students became critical thinkers and organize their learning. As they go through the CPBL cycles, working through one problem after another until they reach the fourth problem at the end of the semester, they begin to realize that they cannot accept just one source of information, and they realize that although there are many possible solution, they need to come up with the best solution for the given condition and justify why they think it is the best. They manage to identify how to best organize information and make connections, as well as identify how they should improve their learning and problem solving process. This is consistent with the constructivist underpinning of PBL, which not only forces students to learn new knowledge required to solve the problem, but also to reflect upon their learning through the PBL process, thus making them self-directed learners.

6. Conclusion

This qualitative study shows that CPBL is able to enhance the desired cognitive and affective skills as in PBL and CL. Students were shown to enhance their strategies in learning, as well as become motivated in learning. By integrating CL and PBL, students were able to gain the best of both approaches, while overcoming the typical shortcoming of not having a dedicated facilitator. Therefore, the CPBL model can be used in a typical class without compromising the desired outcomes.

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