

Creating a Constructively Aligned Learning Environment using Cooperative Problem-based Learning (CPBL) for a Typical Course

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Abstract

Cooperative problem-based learning (CPBL) integrates cooperative learning principles into the problem-based learning (PBL) cycle. It was inspired by Bransford's How People Learn framework, and designed in-line with Bigg's Constructive Alignment. CPBL has been proven to support students to attain difficult to achieve outcomes, especially problem solving, team-working, life-long learning and deep learning of challenging technical knowledge. To successfully support students in attaining the desired outcomes, the CPBL learning environment must be properly designed and planned. Given that CPBL is designed based on constructive alignment, it is only natural to utilize the concept in creating a learning environment for implementation in a typical course. This paper explains the philosophies and principles used as the bases in designing CPBL. Knowing the concepts is useful in deciding essential scaffolding and assistance that can be given, and avoid cutting corners that can be detrimental in attaining the desired outcomes. These concepts also provide the compass for facilitators in guiding students to successfully undergo CPBL.

Keywords: Problem-based learning, cooperative learning, constructive alignment, cooperative problem-based learning

1. Introduction

Problem based learning (PBL), an inductive learning approach, has been proven to inculcate qualities desired in graduates of the 21st Century. Various studies showed that PBL is able to enhance motivation and engage learners in deep learning (Mohd-Yusof, et. al., 2011; Strobel and Barneveld, 2009; Woods, 2000; Woods 1996; Albanese and Mitchel, 1993). Students who had undergone PBL are also known to develop problem solving and meta-cognitive skills, which are necessary, but normally difficult to develop skills among students (Downing, et. al., 2011; Strobel and Barneveld, 2009; Downing, et al., 2008; Tan, 2003; Woods, 2000; Boud and Feletti, 1997). Because of the attainment of these highly valued outcomes, there is widespread interest among engineering programmes to implement PBL in engineering courses. Nevertheless, there are an assortment of PBL models, mainly because of differing institutional needs and cultures, constraints, supporting structures and desired learning outcomes, which makes it necessary to properly identify the suitable model to be used in a typical course.

Cooperative Problem-Based Learning (CPBL), which integrates cooperative learning principles into the PBL cycle, has been shown to be effective when implemented in a typical engineering course with 40 to 60 students. Students are assigned to small groups of three to five students, in which they learn and solve the given problem together as they go through the CPBL process in a cooperative learning team. With proper implementation, CPBL has been shown to enhance deep learning and motivation, problem solving and team working skills among students (Mohd-Yusof, et al, 2011; Helmi, et al., 2011).

This paper explains the philosophies and principles behind CPBL. Understanding the philosophies and principles is important in adapting the CPBL process in different courses. In addition to the constructivist underpinnings of PBL and the social interdependence underpinnings of cooperative learning, CPBL is inspired by Bransford's How People Learn (HPL) framework (Bransford, et al., 2004) , while the step by step process is designed using Bigg's Constructive Alignment (CA) theory (Biggs, 2010; Biggs, 1996). Understanding these bases is not only useful in planning and designing an effective CPBL learning environment, but also in selecting appropriate scaffolding to support students. In addition, they act as a compass in facilitating students through the CPBL process. Most

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importantly, knowing the principles will prevent facilitators from cutting corners that can be detrimental to the attainment of outcomes.

2. Cooperative Problem-Based Learning Principles

Cooperative Problem-Based Learning (CPBL) infuses cooperative learning principles into the PBL cycle, as shown in the CPBL process in Figure 1. The three phases of the typical PBL cycle is maintained. However, since CPBL is designed to be implemented for small groups of students in a medium to large class setting with one floating facilitator, each phase in the PBL cycle is expanded to incorporate cooperative learning principles for ensuring functional learning teams in which students may support one another while learning and going through the CPBL process. A detailed description of each phase in the CPBL process can be seen in Mohd-Yusof et. al. (2011).

To better understand CPBL, the underlying philosophy and principles that support its design and process are elaborated. Constructive alignment is used as the basis to design of the CPBL cycle. The CPBL learning environment is underpinned by the following principles:

- Constructive Alignment
- PBL as a philosophy
- Cooperative Learning
- How People Learn (HPL) framework

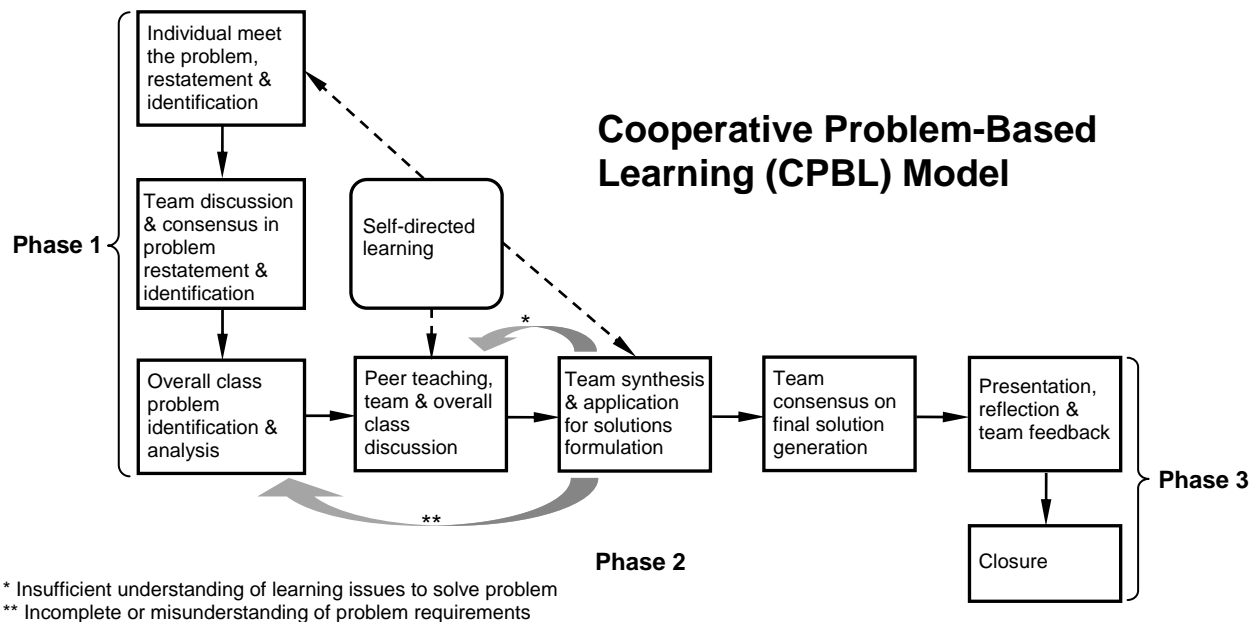


Figure 1. The Cooperative Problem-Based Learning (CPBL) Framework

2.1. Constructive Alignment

Constructive alignment (CA), which is also sometimes known as Outcome-Based Teaching and Learning (OBTL), was put forth by Biggs (2010, 1996). Given that CPBL is designed based on constructive alignment, it is only natural to utilize the concept in creating a learning environment for implementation in a typical course. Similar to outcome-based education, constructive alignment (CA) require the outcomes of a course to be properly aligned with assessment tasks (AT) and teaching and learning activities (TLA). However, CA recommends that the TLA should be based on the constructivist approach, where students go through a learning environment that gives them the opportunity to construct knowledge or skills specified in the desired course outcomes. Biggs asserted that teachers should design activities that activate the verbs in the learning outcome statements. Since students go through TLAs that is aligned to the outcomes, assessing them as they go through the activities naturally aligns the ATs to the outcomes.

In designing and planning the CPBL learning environment, this is the governing principle that must be followed. The teaching and learning activities (TLA) must correspond to the desired outcomes of the course. Assessment can be made as students go through the TLA (especially formative assessment), or through a separate assessment task that can similarly show the student's attainment of the learning outcome. For example, if the outcomes of a course states that students will be able to solve problems, then the activities that students go through in the course must actually guide students in developing the skills for problem solving, and assessed accordingly.

2.2. Problem-Based Learning Philosophy

While Problem-Based Learning (PBL) had sometimes been seen as a teaching and learning method, it is actually a philosophy that aims to develop a holistic, student-centered environment. The constructivist underpinnings of PBL (Savery and Duffy, 1995), simply means that teachers should create a learning environment that encourages students to construct knowledge and/or skills from the activities that they go through to learn.

In PBL, part of the learning environment is created through an unstructured problem that serves to contextualize the knowledge and engage learners in learning. Contextualization means that the smaller learning issues and tasks are anchored to a larger task or problem, that illustrates the relevance of the objective and provides meaning of the tasks to the learners. The open-ended problem must be realistic (if not real) and draws the learners in with meaningful roles and possible outcomes that is beneficial. The complexity and intricacy of the solution should draw learners in learning, deliberate on possible approaches to the problem and come up with possible solutions, and finding the best solution for the problem, given the specific scenario. Students, in effect, should have ownership of the problem.

Tan (2003) asserted that:

“PBL is not only about infusing problems into the class, but also about creating opportunities for students to construct knowledge through effective interactions and collaborative inquiry.”

In the process of constructing knowledge through solving the problems that they have been given, students learn to learn. As they go through the PBL process, students learn about themselves as learners, as well as problem solvers. This occur through all the phases in PBL. In Phase 1, as students identify the problem, they learn to focus, analyze and organize their thoughts on the problem, while making connections between their prior knowledge to those that they have to learn first before solving the problem (ie the learning issues) (Tan, 2003). In identifying the learning issues, students are also inculcated with the importance of identifying and filling in their knowledge gap, preventing them from jumping in to solve the problem. Knowledge and information gathered must be synthesized to properly come up with the best approach to the solution in Phase 2 of the PBL cycle. Finally, in Phase 3, after the solutions are discussed and compared, a reflection of the process that they have gone through must be made to

identify the lessons learned and what needs to be improved on, which also develop their meta-cognitive skills. The closure in this phase serves to tie-up loose ends, while generalizing the theories or concepts learned.

Through all the phases, facilitators in PBL act as cognitive coaches, as they sought to make students' thinking and learning process visible. Barrows encouraged facilitation to be at the meta-cognitive level (Savery and Duffy, 1995). Questions to develop learners' thinking and self-directed learning skills, such as those to clarify meaning, justify decisions and seek implication or reasons, are posed to invoke higher order thinking and deep learning. Questioning by the facilitator is a form of support or scaffolding for developing students' thinking process. While the problem and some form of questioning provides a challenge for learners, there are forms of facilitation and questioning that can support learners. Support is necessary to help learners develop the required skill or learn new knowledge faster, and prevents them from giving up. Therefore, good facilitation requires a fine balance between challenging and supporting students as they learn and develop the required knowledge and skills to solve the problem

2.3. Cooperative Learning

Cooperative Learning (CL) promotes a positive environment for students to learn together in a small group in a cooperative and supportive environment. Rooted in social interdependence theory and cognitive developmental theory, both theories support that CL would yield promotive interaction among learners, thus resulting in higher achievement compared to individualistic learning.

CL is proven, through various studies, to promote cooperation among students resulting in improved learning quality and skills, such as academic achievement, interpersonal skills and self esteem (Prince, 2004). Social interaction among learners can create collaboration, leading to a significant positive impact on learning (Jonassen, et. al., 1995; Johnson, et. al, 2006). In a CL environment, the following five principles (Johnson, et. al., 2006, Felder and Brent, 2007) must be present:

- Positive interdependence (C1)
- Individual accountability (C2)
- Face to face interaction (C3)
- Appropriate interpersonal skills (C4)
- Regular group function assessment (C5)

Assigning students to work in groups does not mean that they are undergoing CL. There is a clear difference between group-based learning and CL. All the five principles of CL must be present in a learning activity before it can be classified as CL. Smith (2007) described four types of learning group performance in the classroom:

1. **Pseudo learning group:** Group members do not want to work together and compete with each other. Group performance level lower than if members work individually.
2. **Traditional classroom learning group:** Members accept that they have to work together, but do very little joint work together because assignments given can be broken up and done individually. Support among members is non-existent. Free-riders cause responsible members to feel burdened, resulting in low performance and morale. Group performance level is about the same as the level if members work individually.
3. **Cooperative learning group:** Members relieved they can work together in a group, and understand that success depends on the effort of each member. Group performance level is higher than those of individual members.
4. **High-performing cooperative group:** In addition to meeting the criteria of Cooperative Learning group, members are committed to help each other and the group succeeds. Synergy is achieved resulting in a group performance level that is much higher than those of individual members.

Students typically resist working in groups, be it in laboratories or class projects, because of prior experiences working in a group that falls under the pseudo learning group or traditional classroom learning group categories (Felder and Brent, 2007). Students grouped together and left on their own resources without proper guidance on team working will normally end up with dysfunctional groups. Instead of having positive interdependence among group members, there is negative interdependence, which caused them to discourage and obstruct one another.

In contrast, students in a cooperative learning environment will be driven to at least achieve a cooperative learning group or a team, where each member is accountable, with positive interdependence among them. Group members have a shared goal. They support and facilitate each other's effort to collectively reach the goal, which in turn leads to positive interpersonal ties, happiness in being together, and increased group efforts (Johnson, et. al., 2006).

A cooperative learning environment cannot be achieved by students on their own. Instructors play an important role in creating this environment: starting from the team formation, which should be decided by the instructor, asking group members to come up with a shared goal, giving activities that cause each member to be accountable, and have positive interdependence, to assessing how the group is functioning. Students should be made aware of the goals and reasons behind the tasks given, and desired behaviors for success should be properly explained.

2.4. How People Learn Framework

The How People Learn (HPL) framework can be utilized for analyzing and designing learning environments through four overlapping lenses. The four lenses are knowledge centered, learner centered, assessment centered and community centered (Bransford, 1997).

Knowledge centered basically refers to what would we intend students to know and do after going through a lesson and finally a whole course. While this may simply sound like the definition of course outcomes in the outcomes based approach, knowledge centered refers to more than just having a list of disjointed outcomes. What is important is to organize knowledge that is interconnected around the fundamentals of a discipline. Taking this approach requires a thorough reflection on the part of educators to determine the "enduring ideas of the discipline", that takes into account the interconnections of key concepts that can facilitate future learning (Bransford, 1997). In CPBL, the problems crafted must take this aspect of HPL into account. A good problem crafter always think about the context of the content that he wants the student to learn, ie how is the knowledge actually being used.

Learner centered refers to framing the delivery of the knowledge in a learning environment that takes into account the background, preconceptions (which are often misconceptions), connections to prior learning or existing knowledge of students, as well as difficulties that they go through in learning the new knowledge, and how to help them understand and develop mastery (Bransford, 1997). Acknowledging the students' background and prior knowledge is critical in assisting them make connections with what is learned in classrooms - ie what is learned is now set in a context that is not disjointed from life or what actually happens in the real world. To assist in the progression of the students' ability, instructors must also help students to understand themselves as learners.

Community centered refers to students being part of a learning community consisting of their peers (Bransford, 1997). As part of a community, they support each other in a positive manner, develop a sense of belonging and bonding amongst classmates. Consequently, students feel safe to participate and ask questions in class, not afraid to venture into new things and make a mistake in learning. They are encouraged to work together in pairs or in small groups, and share their thoughts with the whole class as a community. Studies show that students learning in such a positive environment feel that their learning as well as social needs are met, leading to higher level of interest and self-efficacy (Johnson, 2006). Cooperative learning activities, which encourage and guide students to learn in a team as explained earlier, fits in the community centered lens very well.

Assessment centered refers to the kind of assessment that helps students to obtain feedback about their current performance level and provides a chance for them to improve themselves. Assessment should be for learning, and not just to assess learning - it should be formative, rather than just summative. In addition to getting feedback from

others, developing meta-cognitive skills will enable students to self-assess their own learning process, rather than just relying on others. Allowing students to discuss, receive feedback from peers and listen to other students' explanations in class is also a form of formative assessment that had been shown to help students to learn and develop their self-confidence in learning. Summative assessment should be indicative of students' ability to perform a task, rather than to just answer written examinations. It should reflect the degree to which a student can transfer what they learn in class to the real world setting. This idea is in agreement with constructive alignment that recommends that the teaching and learning activities (TLA) be the same as the assessment task(AT).

3. Problem Crafting for CPBL

This section briefly relates the characteristics of a problem used in CPBL to the principles that has been outlined in the previous section. A more detailed guideline on how craft problems for CPBL can be seen in Mohammad Zamry, et al. (2010).

Design of the CPBL learning environment first and foremost, starts with crafting the problem. The problem should be designed so that the specific desired learning outcomes can be achieved when students have gone through the process of solving the problem. In accordance with constructive alignment, the intended outcomes of the problem consists of the content, skills and attitude outcomes at the desired level.

Outcomes addressed are mostly in the form of functioning knowledge, as problems need to be set in the context of how the knowledge to be acquired is actually used in the real world setting. This provides a platform for the intended outcomes to be activated as the teaching and learning activity during the CPBL cycle while students try to solve the problem. In addition, connection with prior knowledge also needs to be established, requiring instructors who craft the problem to determine the level of prior knowledge that students have acquired. This meets the requirement of the knowledge centered aspect of the HPL framework. Adding the prior knowledge connection to the problem provide an opportunity to find out preconceptions in students, thus addressing the learner centered aspect of the HPL framework.

Apart from ensuring the inclusion of outcomes at the desired level, the problem should be packaged in a way that would make it attractive to students, which meets the learner centered aspect of the HPL framework. The scenario and the way the problem is written should draw students into the problem, engaging them to learn and solve the problem, inspite of the difficulties encountered. Students should be able to see the value of the task given in the problem through the context that it is being set in, motivating them to invest time and effort in learning.

CPBL requires the problem to be unstructured and open-ended, with interconnected layers of complexities to mimic real-world problems. Since the problem cannot be divided into parts that can solved individually, this creates a challenge for students to work together to solve the problem, rather than attempting to work on it alone. This brings out the community centered element of the HPL framework in encouraging students to work together as a learning community. The unstructured and open-ended nature of the problem in CPBL is also important for invoking critical thinking as well as developing learning maturity in students.

4. Realizing a Constructively Aligned CPBL Environment

Once a well-aligned problem has been crafted, the learning process through the CPBL cycle has to be properly facilitated to achieve the intended outcomes that should be attained when students learn and solve the problem. All facilitators involved should know the intended outcomes of the problem, because the outcome can be translated into a clear goal that can help them decide on how to best guide students. In addition, a cooperative learning environment must be encouraged amongst students. It is highly recommended that students new to CPBL be motivated by instructors on the reasons and justification for asking them to learn through CPBL. This section elaborates the implementation of each phase of the CPBL cycle, and how constructive alignment is ensured through each of the phases.

4.1. Phase 1: Problem Restatement and Identification

Phase 1 aims to train students to stop and think when faced with a problem, preventing them from jumping straight to find the solution without really understanding a problem and its requirements. The outcome of Phase 1 is to guide learners in understanding and analyzing the problem, defining it in terms of their existing knowledge, as well as the new knowledge needed. To do this, students were asked to individually restate and identify the problem in their own words, as illustrated in Figure 1 and explained in Table 1. Students are required to submit a problem restatement and identification (PR&PI) to invoke construction of their own understanding before coming to class for discussions with their team mates. Individual submission will drive students towards individual accountability because it pushes each of them to think about the problem and prepare before coming to class. Consequently, the team discussion to reach consensus on the restatement and identification of the problem can be immediately be carried out in class. In addition, this also allows instructors to assess students' ability to understand and define a problem, as required in constructive alignment. Constructive alignment recommends that as far as possible, the TLA that students go through also become the AT.

Table 1. Phase 1 TLA mapped to Educational Principles

Phase	TLA	Description of TLA	AT	Principles
1	Individual PR&PI	Post or give problem a day or two prior to class. Before class, students read and prepare individual PR&PI for submission.	Individual PR&PI	CL: C1, C2 CA and HPL
	Team discussion & consensus	After submission of individual PR&PI at the beginning of class, students discuss in teams, starting from individual PR&PI to find consensus for team PR&PI, and draw up action plan and assign learning issues to each member to prepare for peer teaching, within a given time in the class. May request presentation of team PR&PI.	Feedback on PR&PI discussed	CL:C1, C2, C3, C4 CA and HPL
	Overall Class PR&PI	In-class discussion of each team PR&PI, where students may be randomly called to provide team answer and discuss differences. Conduct discussion to promote learning community among all students.	Feedback on overall PR&PI discussed	CL: C1, C2, C3, C4, C5 CA and HPL

CA - Constructive Alignment

HPL - How People Learn

In CPBL, the problem is analyzed by establishing the following categories of information:

- existing knowledge or information that is known or given in the problem
- further data and information needed to solve the problem (learners have the knowledge but lack the data or information)
- learning issues or new knowledge that must be learned to solve the problem.

The purpose of listing out the existing knowledge that is known is for students to explicitly recall their prior knowledge to allow them to make connections to act as the basis for learning the new material. This will also prevent students from jumping to conclusion, eliminating biases and correcting misconceptions, which is in-line with the learner and knowledge centered lenses of the HPL framework.

Referring to Table 1, the team discussions are held in class to allow students to reach a consensus for the team PR&PI. Other than reaching a consensus, the purpose of discussions is also to give confidence for learners to volunteer their view during the overall class problem restatement and identification. In addition, these discussions are important in developing thinking skills required in starting and planning to solve the problem, as well as inculcating a sense of community and cooperation among the whole class. Thus, instructors should facilitate in a way that probe students into the higher order thinking region, rather than providing straight forward yes or no answers. In addition, facilitating the overall class discussion and assessing the individual problem restatement and

identification provides feedback and evidence for the instructor on the achievement level of students so that appropriate scaffolding can be given if the need arise.

4.2. Phase 2: Peer Teaching, Synthesis, and Solution Formulation

Phase 2 aims to train students to fill in the gap in their knowledge that they have identified in Phase 1 before trying to find a solution to the problem. This is the essence of self-directed learning, that is central to the PBL philosophy, where student search and acquire new knowledge driven by the need to use or apply the knowledge. The outcome of Phase 2 is to have learners develop self-directed learning skill to fill their knowledge gaps, synthesize and apply them to formulate the solution. During this phase learners have to learn together, evaluate different approaches to solve the problem and justify the choices made. Table 2 summarizes the TLA and the corresponding educational principles.

At the beginning of Phase 2, learners individually prepare peer teaching notes in the form of explanations of what is understood, ideas or concepts that needs to be verified and questions on hazy points on the learning issues that have been assigned by their teams. A copy of the individual peer teaching notes must be submitted to align the activity with assessment. Other than promoting accountability, students learn to construct new knowledge by extracting important concepts and information, explaining what they understand, and inquiring about what they do not fully understand to develop abilities to learn through questioning. The purpose of the specific instruction given in preparing the peer teaching notes is to provide scaffolding for students in starting to learn new content. This way, students are made aware that it is normal when learning new material that they will not initially be able to understand all the content. What is important is for them to be able to identify what actually they do not understand, or not really sure about, so that they can start discussing and asking questions when they do their team peer teaching. Without coming up with specific questions, it is very difficult for others to help a student to learn. Thus, forming questions on material not understood is also a part of learning. Formally having this activity is in accordance with the constructivist underpinnings of PBL, and consequently, constructive alignment, because it forces students to try to construct knowledge on their own first to forming their ability to conduct self-directed learning, instead of relying on others to teach them without knowing why they need the knowledge and what it is used for.

Table 2. Phase 2 TLA mapped to educational principles

Phase	TLA	Description of TLA	AT	Principles
2	Peer T&L	Students individually prepare peer T&L notes, and conduct team peer T&L outside of class before overall class peer teaching session. A copy of the individual peer T&L notes is submitted at the beginning of class and an overall class peer T&L discussion coordinated by a team assigned in the previous class. May give tutorials, quiz or mini lecture if required.	Individual peer T&L notes. Quiz and/or tutorial on important concepts	CL: C1, C2, C3, C4, CA, HPL
	Synthesis & application	Students synthesize knowledge and information together as a team and use them to come up with possible solutions. Conduct progress check for problems with a duration of more than 2 weeks.	Progress check/report, e-learning forum	CL: C1, C2, C3, C4
	Consensus on final solution	Students reach a consensus on a solution that is deemed to be the best to all team members, with proper justification. Submit one product per team.	Final product	CL: C1, C2, C3, C4, CA, HPL

Once students have made an attempt to learn on their own, they are given the opportunity to learn in their team, followed by an overall class discussion, in accordance with the community centered lens of the HPL framework. Team peer teaching is essential in developing skills to learn in students, especially on technically challenging

material, where they would easily give up if they were to study alone. Students explain what they understand to teach team members while learning together, and discuss the questions or unclear concepts before coming to class for the overall class peer teaching and learning session. Learning in a small team in which they are comfortable in provides an environment that encourages students to share what they learned, and feel safe to ask questions. This also gives students the opportunity to realize that they are not the only ones facing difficulties in learning something for the first time - that it essentially happens to almost everyone. This leads them to be more confident in sharing their understanding and asking questions in the overall class discussion. It is recommended that facilitators explain the reasons for the each step taken and instruction given. An open environment where students can express the difficulties that they face should also be encouraged so that the appropriate motivation and support can be provided, in-line with the learner centered lens of the HPL framework. The individual peer teaching notes submission and feedback that students obtain on material learned during the class discussion are also forms of assessment for students (ie both formative and summative).

The overall class peer teaching discussion is a 2-hour session monitored by the facilitator where each student understand that they need to be prepared to participate in the discussion as part of the learning community to gain most and maximize their learning. Each team is expected to come to class with a list of questions or ideas on concepts that they want to verify with other teams. They also try to answer each other's questions. By supporting one another in learning, students soon realize the benefits that they get, encouraging them to participate further, developing positive interdependence among them. Facilitators have to monitor the overall class discussion well to assess students' understanding of the learning issues, and probe them so that they may reach the required depth of understanding. The probing questions should lead students to think further and deeper in understanding and integrating concepts that they are learning. For example, if there were difficulties in understanding certain material, instead of explaining the concept outright, previously learned concepts related to the new content may be invoked to let students make the necessary connections and understanding. Supporting activities should help make students' learning visible, not only to the facilitator, but also to the students and facilitators so that proper feedback and support can be given. The TLA of this phase is constructively aligned to the general outcomes of this phase, which is developing thinking skills and deep learning. A quiz on important learning issues may be given as formative assessment to enable students to gauge their understanding, and indicate to the facilitator if additional scaffolding, like tutorials, should be given.

This is the essence of cognitive coaching in PBL, which is scaled up in a larger setting in CPBL. However, in CPBL, cognitive coaching and support is not the sole responsibility of the facilitator because it will be quite difficult to listen in on all students in a typical class setting. Instead, part of the responsibility is transferred to peers in the team, as well as the whole class as a community. Nevertheless, peer support is only effective with positive interdependence, as stipulated by the social interdependence theory. For this reason, the tools or activities in cooperative learning that incorporates all the five principles to drive students to work as a learning team is crucial to successfully attain the desired outcomes. In addition, it is important for facilitators to motivate and guide students as they learn and work together, in addition to asking them to assess the way their team is functioning.

During the final part of Phase 2, all collated information and knowledge is shared and critically reviewed, before the relevant ones can be synthesized and applied to solve the problem. This step can be iterative, where students may need to re-evaluate the analysis of the problem, pursue further learning, reporting and peer teaching. The final part is mostly performed outside the classroom, relying further on cooperation and proper interpersonal skills especially in coming up with a consensus for the best answer. For this reason, students need to be aware of the need for an effective learning team before they get to this part of Phase 2 so that they understand the need to work well together to find the best solution for the problem. Facilitators need to provide guidance to instill the essential qualities of a learning team and deep learning, as well as awareness on resolving conflict, in-line with Constructive Alignment, as part of the TLA to support the outcome of developing a cooperative learning team among students. Additional support can be given in the form of e-learning forum designated for the problem, where students are encouraged to ask questions, give opinions and views, and discuss the concepts in order to solve the problem. The electronic forum is monitored by the facilitator and if necessary, will join in the discussion to probe, motivate and bring students to the right path whenever they are off-track.

4.3. Phase 3: Generalization, Closure and Internalization

Phase 3 aims to invoke critical evaluation of solutions, develop students' meta-cognitive abilities in reflecting and improving themselves as a learner and summarize as well as tie-up loose ends. The outcome of Phase 3, is to have learners critically determine the best solution for the problem and use meta-cognitive skills to internalize and generalize the concepts and skills learned. Students submit their solutions, whether it is a report, presentation or other deliverables, as shown in Table 3. If there is insufficient time for all teams to present, presentation of solution from one or two teams would be sufficient to start the ball rolling to discuss solutions obtained. In this case, the assessment of the final solution will depend on the report or other deliverables handed in, rather than the presentation, which serves as a discussion session on the possible solutions found by the different teams. The type of deliverables should be aligned to the intended outcomes of the problem. As in the earlier phases, the facilitator should probe students during the discussions to determine acceptable solutions, and justify their choice of the best solution for the problem. Allowing a thorough discussion of the solution and concepts learned is important know students' actual level of learning, whether deep understanding was reached.

During the closure, the facilitator comments on the possible solutions, as well as identify the best solution. The feedback from the facilitator serves as part of the formative assessment on students performance. The feedback may also correct mistakes or misconceptions in important concepts, and in process or team-working skills. Generalization should include connections between concepts and applications in other areas. This is necessary to widen the views and facilitate the knowledge transfer for other types of applications, thus deepening students' understanding. It is also important to tie up loose ends to avoid feelings of dissatisfaction among students. As shown in Table 3, having a good closure would fit in with both the learner and assessment centered lens of HPL.

To strengthen the community centered aspect in terms of developing students' team working skills and improving their learning process, a team-based post-mortem on the process that they went through and the team performance must be conducted in class. Confidential peer rating and written feedback from each team member to his/her team mates, (eg: what is good and what needs to be improved) is also given during a class session. Giving peer feedback requires students to develop the ability to execute positive critical thinking that would allow them to help their team mates improve. Receiving peer feedback, on the other hand, trains students to appreciate advice that is intended to help them improve. Both giving and receiving advise is part of the development in good interpersonal skills and positive interdependence, which can strengthen the learning community.

Table 3. Phase 3 TLA mapped to educational principles

Phase	TLA	Description of TLA	AT	CL Principle
3	Presentation, reflection, team peer rating and feedback	Final solution presented in class, with different solutions and approaches discussed. Conduct individual reflection, rate team members and provide written feedback on good actions to keep up and things to improve on. In-class discussion on overall team performance and strategies for improvements.	Reflection, peer and self rating, written peer feedback	CL: C1, C2, C3, C4, C5 CA, HPL
	Closure	Summarizes and generalizes important concepts covered in problem. May compare different approaches and solutions to suggest the best solution for the problem, given the scenario. May also include "what if" or variations in conditions in which the concepts may apply.	Feedback on solutions and final reports	CL: C1, C2, C3, C4, HPL

As part of the learner centered approach, CPBL stresses the importance of developing meta-cognitive skills through reflection is essential so that students may perpetually assess and analyze their own performance, thus continuously learning and improving themselves. This step must be taken seriously; otherwise, students will lose the opportunity to discover themselves and gain through the learning experience that they went through while solving the

problem. Reflection may be assigned individually or team-based. Initially, prompting questions can be provided as scaffolding. In submitting individual reflections and the team feedback, students are guided to internalize what they have learned and evaluate their learning process to ascertain how they could do better in the future. Students' reflection are assessed, which fulfilled constructive alignment. Feedback from the facilitator can assist students in improving their reflective thinking abilities. If this is done three to four times in a semester, most students learn to internalize not just knowledge, but also the process that they went through to develop their skills and improve themselves by the end of the semester. The reflection is therefore a form of formative and summative assessments.

5. Conclusion

Each step in the three phases of the CPBL process has its significance and supporting theories. The phases and steps develop essential skills for students to learn and work together in a cooperative team. The sequence of steps ensures meaningful learning takes place efficiently in a harmonious environment, where each member is accountable and motivated to learn.

Phase 1 and Phase 2 starts out with individual effort, followed by team effort, and finally an overall class discussion session. The individual effort is essential so that each student prepare, go through the process and develop the necessary skill before getting their team's support. The overall class discussion serves as additional support and a window for facilitators to find out the level of students' learning to provide the necessary scaffolding and cognitive coaching. As a continuation to Phases 1 and 2, Phase 3 provides a conclusion and feedback for students after going through the CPBL process to solve the problem.

Unlike small group PBL, team members, and classmates to a certain extent, also provide support and cognitive coaching in CPBL. The rotation of roles in CL, and instituting the role of a skeptic is part of this effort. In addition, giving students the proper tools and knowledge to understand themselves as learners while they go through the CPBL process enhance their ability to work together as a team and help one another improve. The reliance on peer support makes it essential to equip students with knowledge and skills to learn together and self-monitor themselves to evaluate their learning process as a team. The CL elements in each of the steps in the three phases in CPBL drive the development of positive interdependence among students.

Designed based on constructive alignment, the TLA and AT in each of the phase is aligned to achieve the outcomes of each phase and the whole problem. The CPBL cycle is also underpinned by the HPL framework. Each phase follows the flow of the PBL cycle, integrated with CL principles to ensure a successful small group in a medium class implementation. Thus, each step in the CPBL cycle must be explained and implemented properly to attain the necessary outcomes to avoid a mechanical routine of going through the motion in each phase. Only through embracing the principles and the philosophy can the full potential of CPBL be realized.

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