IMPLEMENTATION OF COOPERATIVE PROBLEM – BASED LEARNING IN ACHIEVING LEARNING OUTCOMES

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Implementation of Cooperative Problem-Based Learning in Achieving Learning Outcomes

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Abstract – **Material Selection is one of the program core subjects introduced in Bachelor of Engineering in Manufacturing Engineering. Five learning outcomes have been outlined in the subject. In order to achieve the learning outcomes, the subject delivery involves implementing Cooperative Problem-Based Learning (CPBL) activities as a part of teaching and learning process. Generally, the summative assessment involves cognitive domain and soft skill. This is an improved approach in teaching and learning process as compared to the common practice. For each learning outcome, a specific learning domain and taxonomy level were defined and rubrics for assessment were developed accordingly. Constructive alignment among the learning outcomes, delivery methods, assessment and evaluation gives an overall reflection on the students' learning outcomes attainment. Students' achievement is evaluated based on Key Performance Index set by the Faculty. Students' reflection in the subject matters and teaching and learning process provides essential inputs in outlining a few strategies for Continuous Quality Improvement purpose. It was observed that Cooperative Problem-Based Learning activities are able to promote student-centered learning culture among the students. It also nurtures students to be graduates who fulfill the criteria outlined in the Program Outcomes.**

Keywords - Student-Centered Learning(SCL); Cooperative Problem-Based Learning(CPBL); learning outcomes(LO); assessment; rubric; Continuous Quality Improvement (CQI)

I. INTRODUCTION

Material Selection is one of the program core subjects introduced in Bachelor of Engineering in Manufacturing Engineering. Every student who enrolls into this bachelor program is required to complete this subject during the first semester of Third Year. "Material Selection" is an essential subject for Manufacturing Engineering students as it highlights basics in selecting materials for an engineering design in regard to material properties and processing techniques. All types of engineering material, ranging from metals, polymers, ceramics and composites are included in the subject content. There are five learning outcomes (LO) to be achieved by students upon completion of the subject, in which at the end of the subject, students should be able to:

(i) explain the relationships between design requirements, material properties, processing and product performance,
(ii) justify the suitability of a particular processing technique for selected material and design activity using data, charts and software,
(iii) select the most appropriate materials and processes to be used for product fabrication and commercialization,
(iv) communicate ideas relevant to material selection analysis in product design and manufacturing; and
(v) perform self-directed study in gaining new knowledge and skill.

Obviously, these learning outcomes addressed both learning domains in Bloom's taxonomy and soft skill elements. This is in line with the aspiration of Universiti Teknikal Malaysia Melaka (UTeM) as well as Ministry of Higher Education (MOHE) to impart both knowledge and soft skills among our graduates.

In Academic Year 2010/2011, a total of 260 students registered for the subject. These students come from five d departments, namely Engineering Materials, Robotic and Automation, Manufacturing Process, Manufacturing Design and Manufacturing Management. In conducting the subject, a team of five lecturers from the Department of Engineering Materials, headed by a subject coordinated, were appointed by the Faculty. The appointment is due to the nature of the subject in which strong background knowledge of various materials and their relationship between structure, properties, processing and performance is an advantage. In order to ensure the LO attainment among the students, Cooperative Problem-Based Learning (CPBL) were incorporated into the teaching and learning (T&L) process throughout the 14-week semester as an approach to accommodate student-centered learning (SCL) activities as well as to ensure that the assessment of knowledge and soft skills is possible.

II. METHOD

A. *Cooperative Problem-Based Learning (CPBL)*

Cooperative problem-based learning (CPBL) model is a combination of Problem-Based Learning (PBL) and Cooperative Learning (CL) to emphasize learning and solving

problems in small student teams (consisting of 3-5 students) in a medium sized class, of up to 60 students for one floating academic staff or facilitator [1]. The CPBL model is composed of three phases; viz. Phase 1 consists of the problem identification and analysis stage, Phase 2 is the learning, application and solution formulation stage and Phase 3 is the generalization, internalization and closure stage [1]. The teaching and learning activities (TLA) involved in each phase are outlined in TABLE I.

TABLE I. TEACHING AND LEARNING ACTIVITIES CONDUCTED IN EACH CPBL PHASE [1]

Phase		Teaching Learning Activities
Phase 1	Individual	Before class, read and prepare individual problem restatement and identification (PR &PI) for submission.
	Team discussion & consensus	In class discussion, starting from individual PR&PI to find consensus for team PR&PI within the given time. Draw up action plan and assign learning issues to each member to prepare for peer teaching. May request team PR&PU be submitted or presented.
	Overall class	In-class discussion of each team PR&PI, where students may be randomly called to provide team answer. Conduct discussion to promote learning community among all students.
Phase 2	Peer T&L	Individually prepare peer T&L notes, and conduct team peer T&L out of class. Submit individual peer T&L notes during class and have overall class peer T&L coordinated by a group. May give tutorials, quiz or mini lecture.
	Synthesis & application	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.
	Consensus on final solution	Reach a consensus on a solution that is deemed to be the best to all team members. Submit one report per team.
Phase 3	Presentation, reflection, team peer rating and feedback	Teams present final solution in class. 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 improvement.
	Closure	Summarizes and generalizes important concepts covered in problem. May compare different approached and solutions to suggest the best solution for the problem.

B. *Implementation of CPBL*

Two cycles of CPBL activities were conducted in line with the weekly topics to be covered in the subject syllabus. The design of the syllabus and CPBL activities is illustrated in teaching plan of "Material Selection" as listed in TABLE II. The first CPBL problem crafted was less comprehensive than the second one, considering that it was the first time CPBL being introduced into the T&L process and transition time was needed for students to adapt to the new T&L mode. Example of problem crafted for CPBL 2 is illustrated in Fig. 1. Throughout the T&L process, Cambridge Education Selector (CES) software, which consists of a database of material and process information, was introduced and made available for students' access in solving the CPBL problems.

TABLE II. DETAILS OF SYLLABUS AND TEACHING PLAN OF "MATERIAL SELECTION"

Week	Session	Contents	Remarks
1	Lecture 1 **CPBL 1** **Phase 1**	Introduction to Course Outline 1.0 Introduction to Material Selection	Briefing on Teaching plan **CPBL 1 Phase 1** • Question Distribution • Team forming
2	Lecture 2 **CPBL 1** **Phase 1**	2.0 Material Selection – The Design Process & The Basic	**CPBL 1 Phase 1** • Knowledge, Need to know, Learning Issues (KNL)
3	Lecture 3 **CPBL 1** **Phase 2**	2.0 Material Selection – The Design Process & The Basic	**CPBL 1 Phase 2** • Peer Teaching Note • Quiz 1 • Plus/ Delta Table
4	Lecture 4 **CPBL 1** **Phase 2**	3.0 Engineering Materials & Their Properties: Metals	**CPBL 1 Phase 2** • Group Teaching • Plus/Delta Table
5	Lecture 5 **CPBL 1** **Phase 3**	3.0 Engineering Materials & Their Properties: Ceramics	**CPBL 1 Phase 3** • Report • Presentation
6	Lecture 6 **CPBL 1** **Phase 3**	3.0 Engineering Materials & Their Properties: Polymers	**CPBL 1 Phase 3** • Presentation • Reflections
7	Lecture 7 **CPBL 1** **Phase 3**	4.0 Material Indices & Material Property Charts	**CPBL 1 Phase 3** • Closure **TEST 1**
8	Lecture 8 **CPBL 2** **Phase 1**	4.0 Material Indices & Material Property Charts	**CPBL 2 Phase 1** • Question Distribution
9	Lecture 9 **CPBL 2** **Phase 1**	4.0 Material Indices & Material Property Charts	**CPBL 2 Phase 1** • KNL
10	Lecture 10 **CPBL 2** **Phase 2**	5.0 Process and Process Selection - Shaping	**CPBL 2 Phase 2** • Peer Teaching Note
11	Lecture 11 **CPBL 2** **Phase 2**	5.0 Process and Process Selection - Joining	**CPBL 2 Phase 2** • Quiz 2
12	Lecture 12 **CPBL 2** **Phase 3**	5.0 Process and Process Selection - Finishing	**CPBL 2 Phase 3** • Report & Presentation
13	Lecture 13 **CPBL 2** **Phase 3**	6.0 Process and Process Selection – Systematic Process Selection	**CPBL 2 Phase 3** • Presentation **TEST 2**

14	Lecture 14 **CPBL 2** **Phase 3**	6.0 Process and Process Selection – Systematic Process Selection	**CPBL 2 Phase 3** • Reflections & Closure

C. *Assessment of CPBL*

Typically, the assessment conducted in the subject is to determine the attainment of pre-established learning outcomes among the students. For that purpose, a particular learning domain in Bloom's taxonomy or soft skill element to be assessed is specified for each learning outcome; defined by the subject coordinator and the team and referred to the overall curriculum design of the program of Bachelor of Engineering in Manufacturing Engineering. The mapping of learning domains in Bloom's taxonomy or soft skill elements to the learning outcome and its respective assessment methods are outlined in TABLE III. CPBL activities are utilized to assess the attainment of LO1, LO2, LO4 and LO5 which contribute to 30% of the total marks for the subject. For each assessment method, specific rubrics are developed based on a set of relevant criteria indicating the achievement of the learning outcome and the desired taxonomy level. The rubrics are also utilized to delineate consistent criteria of grading to all students involved since the subject was taught by a team of five lecturers. TABLE IV summarizes the mapping of CPBL activities, assessment methods, respective LO to be assessed and related rubrics.

TABLE III. MAPPING OF LEARNING OUTCOMES (LO) TO LEARNING DOMAINS IN BLOOM'S TAXONOMY AND SOFT SKILL ELEMENTS AND RESPECTIVE ASSESSMENT MODE

	Learning Outcome (LO)	Learning Domain / Soft Skill Element & Taxonomy Level	Assessment Mode
1	To explain the relationships between design requirements, material properties, processing and product performance.	Cognitive (C2)	CPBL
2	To justify the suitability of a particular processing technique for selected material and design activity using data, charts and software.	Affective (CTPS3)	CPBL
3	To select the most appropriate materials and processes to be used for product fabrication and commercialization.	Cognitive (C4)	Test, Final exam
4	To communicate ideas relevant to material selection analysis in product design and manufacturing.	Psychomot or (CS3)	CPBL
5	To perform self-directed study in gaining new knowledge and skill.	Affective (LL2)	CPBL

THE SCENARIO

You have just started working with a team of Research & Development Engineer in SunCover Structure Sdn Bhd in Kuala Lumpur. SunCover is one of the leading manufacturers of window treatments that Malaysia has to offer. Working from a comprehensive selection of window adornments such as blind, shades, shutters, drapery and motorization options, SunCover is a one-stop resource offering superior quality, innovative technology, attentive service and distinctive design. Committed to the principles of sustainable development, SunCover is aspired to find a stylish solution to suit its customer's privacy, light control and energy-saving needs.

Recently, SunCover received a call for bidding on the "Building the Walkway" project from Universiti Teknikal Malaysia Melaka (UTeM), Melaka. Being a leader in designing, manufacturing and installing thousands of shade structures and walkways with over 25 years of experience in Malaysia and throughout the world, SunCover is interested to bid for the project.

One day, in the office...

You and your colleagues were called for a meeting with Mr. Vincent Raj, the R&D Manager. At the meeting;

"I've just received an email from Mr. Kenny (the Manager of Business Development Department) this morning, saying that SunCover would like to bid for a walkway construction project at UTeM, Melaka. So, BDD want us to propose on which materials to be used and the related processes. At this point, I wanna listen to your suggestion based on the design requirements listed in UTeM's RFP (Request for Bid Proposal)," said Vincent Raj.

"Hmmm...enclosed walkway in campus? This is the first time I ever come across it," said Ann, a new engineer. Another engineer, Ahmad replied, "Yeah, but it's very thoughtful of UTeM to ensure students walk comfortably under the hot sun as well as in the rain!"

"You're right! But, it's also highlighted that they want it to be energy-saving. Assuming that the walkway will be installed with some kind of ventilation system like air-conditioner, we need to have heat radiant barrier on the shade to reflect heat as much possible," Sean, a senior engineer, added.

"I suppose a layer of metallic material is needed for heat reflection purpose. How about being corrosion resistant? As far as we know, metal is prone to corrosion!" Ann doubted.

"Hmmm...good question! We can have a polymeric coating on top of the metallic layer but be sure that the coating will not diminish the intended reflectivity," Sean replied again.

"Superior strength... we need a kind of reinforcement, perhaps?!" Ahmad asked. Ganesh yelled, "Oh, reinforcement! We can go for composite or laminate to increase strength."

"Well, I think we gotta stop here today, I have another appointment with the CEO." Then, turning to you, Vincent added, "Why don't you head this project. Here is the design proposed by our architects. Just focus on the roof design at this moment. We will talk about the others later. Gather your team, and suggest on the specific materials to be used based on our discussion just now, together with the processing methods. I want you to do a thorough job of investigating all possible options in both materials and processes, and come to a final choice based on reasonable justification, in line with the design requirements. Don't forget to include types of testing and standard necessary to comply with the customer's requirements in the report. I want to see a one-page progress report by this week, and a presentation with the full report in three weeks. This is the first project I'm putting you to in charge of, so do it well."

Figure 1. Example of problem crafted in CPBL.

TABLE IV. MAPPING OF CPBL ACTIVITIES, ASSESSMENT METHODS, LO AND RELATED RUBRICS

Phases & TLA in CPBL	Assessment Method	LO & Taxonomy Level	Evaluation
Phase 1			
Question distribution Team forming	Group peer teaching note / KNL	LO1 (C2)	Rubrics for assessment of peer teaching note (TABLE V)
Phase 2			
Quiz Peer teaching note	Quiz	LO1 (C2)	Formative assessment
	Individual peer teaching note	LO5 (LL2)	Rubrics for assessment of peer teaching note (TABLE VI)
Phase 3			
Report Presentation Reflection note Peer rating	Group technical report	LO2 (CTPS3)	Rubrics for assessment of report (TABLE VII)
	Group presentation	LO4 (CS3)	Rubrics for assessment of presentation (TABLE VIII)
	Individual reflection on content and learning process	LO5 (LL2)	Rubrics for assessment of reflection note (TABLE IX)
	Individual peer rating	LO5 (LL2)	Rubrics for assessment of peer rating (TABLE X)

TABLE V. RUBRICS FOR ASSESSMENT OF PEER TEACHING NOTE / KNL (PHASE 1)

(LO 1): Explain the relationships between design requirements, material properties, processing and product performance.	**Weak 1**	**Moderate 2**	**Excellent 3**
1. Identify different types of material used in a product	< 2 materials mentioned	2- 4 materials mentioned	>4 materials mentioned
2. State design requirement of a product (Function, Objective, Constraint and Free Variables, e.g. leak free containment)	< 2 elements mentioned	2- 4 elements mentioned	>4 elements mentioned
3. Identify the role of processing route with regard to materials utilization	Not mentioned in peer teaching notes	Mentioned in peer teaching notes	Mentioned in peer teaching notes appropriately
4. Identify the effect of material properties towards product performance	Not mentioned in peer teaching notes	Mentioned in peer teaching notes	Mentioned in peer teaching notes appropriately
5. Recognize the importance of understanding design requirement in material selectio	Not mentioned in peer teaching notes	Mentioned in peer teaching notes	Mentioned in peer teaching notes appropriately

TABLE VI. RUBRICS FOR ASSESSMENT OF PEER TEACHING NOTE (PHASE 2)

(LO 5): Perform self directed study in gaining new knowledge and skill.	**Weak 1**	**Moderate 2**	**Excellent 3**
1. Define learning objectives	Learning objectives are not defined	Unclear learning objective	Learning objectives are clearly defined & appropriate to learning issues
2. Show evidence of reading diverse and recent resources about materials properties, processing, and design requirement	No references mentioned	References reported are insufficie nt, less reliability & information; cited incorrectly	References reported are sufficient, reliable & informative; cited correctly
3. Make effort to improve/discover new/additional knowledge e.g. consult lecturer advice, workout in literature search	Shows no evidences of self-discovery (literature search are not detailed)	Work out on some literature search, have an informal meeting with a lecturer during the class session	Work out in details about literature search, have a formal meeting with the lecturer outside classroom
4. Able to find and organize appropriately the relevant information from different sources	Explores the topic at a surface level	Explores the topic with some evidence of depth	Explores a topic in depth and structurally organized
5. Show evidence of accomplishment of learning objectives	Work is not carried out appropriately	Work is carried out partially fulfilled the learning objectives	Work has been carried out and strongly fulfilled the learning objectives

TABLE VII. RUBRICS FOR ASSESSMENT OF REPORT (PHASE 3)

(LO 2): Justify the suitability of a particular processing method for selected material and design activity using data, charts and software.	**Weak 1**	**Moderate 2**	**Excellent 3**
1. Infer the utilization of different materials based on various design requirements	<2 types of material being proposed	2-4 types of material being proposed	>4 types of material being proposed
2. Discuss design requirements in selecting materials	<2 design requirements are included in solution	2-4 design requirements are included in solution	>4 design requirements are included in solution
3. Relate manufacturing process to the materials used	No consideration of material attributes on	Fair consideration of material attributes on	Thorough consideration of material attributes on

appropriately	discussing processing method	discussing processing method	discussing processing method
4. Integrate materials selection tools e.g. material properties charts, material selection matrix, process selection matrix in problem solving process	No application	Insufficient number of charts generated for analysis	Sufficient number of charts generated for analysis

TABLE VIII. RUBRICS FOR ASSESSMENT OF PRESENTATION (PHASE 3)

(LO 4): Communicate ideas relevant to materials selection analysis in product design and manufacturing.	Weak 1	Moderate 2	Excellent 3
1. Structure of presentation			
Content is well-structured to enhance audience understanding and clarity	Difficult to follow presentation due to erratic topical shifts and jumps	Most information is presented in logical order, which is easy to follow	All information is presented in a logical, and interesting and sequence, which is easy to follow
2. Content			
Cover ideas relevant to material selection attribute in product design and manufacturing (e.g. design requirement, materials selection steps, materials properties)	The presentation does not include information on the major areas	Most areas are presented with brief explanation	Most areas are presented with enough details on each subject matter
3. Presentation Clarity			
Able to explain clearly and show in-depth understanding of the project matters	Clarity is not evident	Clarity of speech is uneven; delivery is halting	Strong, clear speaking and points are delivered with good clarity
4. Presentation Style			
Able to communicate fluently and confidently during the presentation	Control of speaking tone, volume and eye contact is not evident	Speaking tone, voice level and eye contact is evident during presentation	Appropriate speaking tone, voice level, good eye contact and invite audience participation
5. Presentation Materials			
Able to utilize technology and proper presentation materials relevant to subject matters	Poor slide presentation	Moderate slide presentation	Visual aids quality is good
6. Questions & Answers			
Able to respond to the questions independently	Shows no grasp of information, thus unable to respond to the questions appropriately	At ease with content and able to elaborate and explain to some degree	Demonstration of full knowledge of the subject with explanations and elaboration
7. Time			
Able to provide clearly and effective presentation in limited time	>5 minutes	+5 minutes	+/- 2 minutes

TABLE IX. RUBRICS FOR ASSESSMENT OF REFLECTION NOTE (PHASE 3)

(LO 5): Perform self-directed study in gaining new knowledge and skill.	Weak 1	Moderate 2	Excellent 3
1. Self disclosure on experience during meet up with problem assigned, team discussion, peer-teaching and problem solving process	Little self-disclosure, minimal risk in connecting concepts from class to personal experiences. Self-disclosure tends to be superficial and factual, without self-reflection	Ask some probing questions about self, but do not engage in seeking to answer these. Examine somewhat cautiously their own personal experiences as they relate to the learning activities. Sometimes defensive or one-sided in their reflection	Demonstrates an open, non-defensive ability to self-appraise, discussing both growth and frustrations as they related to learning in class. Risk asking probing questions about self and seeks to answer these. Examine openly their own personal experiences in the past as they relate to the learning activities
2. Connection to class discussions & course objective	Restate some general ideas or issues from the class discussion as they relate to the course content	Synthesize clearly some directly appropriate ideas or issues from the class discussion as they relate to the course content	Synthesize, analyze and evaluate thoughtfully selected aspects of ideas or issues from the class discussion as they relate to the course content
3. Exploration of ideas for improvement on problem solving process	Little concern to explore alternatives available around oneself to solve problem, instead suggested other person to do so	Moderate effort in exploring alternatives available around oneself to solve problem	Identify more than one suggestion for improvement, detailed with specific steps & referred actions
4. Able to identify	Immediate corrective	Immediate corrective	Immediate corrective

immediate corrective actions to be taken	actions are not clearly defined in terms of time, venue and person-in-charge	actions are referring to own self, specifying time and venue	actions have been identified, specifying time, venue and related reference

TABLE X. RUBRICS FOR ASSESSMENT OF PEER RATING (PHASE 3)

(LO 5): Perform self-directed study in gaining new knowledge and skill.	**Name of Team Member**				
Self Attitude	1)	2)	3)	4)	5)
Able to discuss a topic and stand up for his/her point of view.					
Attend every class and arrive on time.					
Does his/her best effort in each class and assignment.					
Always eager to participate in discussion.					
Open to criticism and accepted feedback openly.					
Use feedback to improve his/her attitude.					
Participate actively in the class discussion.					
Share important and valuable information with the team.					
Show responsibility and commitment.					
Collaborative work attitudes					
Hand in work on time.					
Attend every group meeting and arrived on time.					
Work as hard as the rest of the team.					
Help team mates who are lagged behind.					
Work towards achievement of the team's learning objectives.					
Listen to team mates.					
Respect other people's opinions.					
Show responsibility and commitment in all team tasks.					
Offer feedback to his/her team mates in a constructive and friendly way.					
Rating scale: 1-5 1: very poor; did very little; not a team player 2: poor; did only what was minimally required; not a positive member of the team 3: about right; met reasonable expectations; a member of the team 4: good; performance was above average for the team 5: excellent; effort went above and beyond the call of duty; a team leader.					

In the CPBL activity, the overall evaluation for student is concluded based on each individual performance and contribution throughout the CPBL cycle. This is possible as peer rating is being practiced and auto-rating system is being applied in all marks secured through team's work. This approach is observed to promote self-initiative among students, avoid the presence of "free rider" and enhance teamwork. An example of the use of auto-rating system in generating individual marks based on team presentation mark is illustrated in TABLE XI.

III. EVALUATION

Evaluation of students' attainment of learning outcomes was made individually based on students' performance through each assessment method. TABLE XII shows an example of overall LO attainment in one of the groups of students, i.e. the third year students of Bachelor of Engineering in Manufacturing Engineering (3BMFX). Key Performance Index (KPI) is set in accordance to the KPI of the Faculty. Based on the result in TABLE XII, the 3BMFX students are well-performed in majority of the CPBL activities except for the quizzes. The students demonstrated unprecedented accomplishment in the assessment of soft skill, explicitly critical thinking and problem solving skill, communication skill and lifelong learning skill. On the other hand, the LO attainment among the 3BMFX students for LO1 and LO4, which is mainly rooted on cognitive assessment is slightly below the KPI value.

From the reflection note submitted by students in regard to the subject matter, it is revealed that this group of students found difficulty in understanding the technical term used particularly in materials engineering as they only acquired prior knowledge on the field in one subject, which is BMFB 2213 Engineering Materials during their Second Year of studies. Besides, most of the information obtained during the team discussion was limited to resources from websites which are usually not describing the fundamentals and essential theories in details. Apart from that, some students also commented that their poor English proficiency has inhibited their understanding of the subject matter during lectures as well as during CPBL problem solving process.

IV. CONTINUOUS QUALITY IMPROVEMENT

Reflection note is used to reflect the progress of the CPBL accomplishment on the subject matters and the T&L process; outlining strengths, weaknesses and improvement action to be taken by either lecturers or students. Thus, the reflection notes submitted by the students in CPBL Phase 3 has been discussed in class and provides essential insights for improvement from all parties involved, which are the students, lecturers and subject delivery itself. In other words, it helps in ensuring continuous quality improvement (CQI) of the subject. Based on the students' feedback, a few improvement strategies are being delineated as in TABLE XIII.

TABLE XIII. IMPROVEMENT STRATEGIES BASED ON STUDENTS' REFLECTION

Weakness	Improvement Strategy
Limited prior knowledge in subject matter	Review syllabus of BMFB 2133 Engineering Materials to put more emphasis on the basics of materials structure, properties and processing.
Limited reference sources	Provide scaffolding, i.e. specific references or articles on the learning issues.
Poor English proficiency	Encourage students to communicate in English among their team mates during lectures and CPBL discussion.

TABLE XI. AUTO RATING FOR EVALUATION IN PRESENTATION

Student	Vote A	Vote B	Vote C	Vote D	Vote E	A_i[a]	A_i/N	A[b]	f[c]	Marks for Presentation (Group), M	Marks for Presentation (Individual)[d]
A	82	90	86	88	90	436	87.2	84.96	1.03	5.14	5.28
B	73	88	84	88	90	423	84.6	84.96	1.00	5.14	5.12
C	74	89	84	84	90	421	84.2	84.96	0.99	5.14	5.09
D	76	90	83	89	90	428	85.6	84.96	1.00	5.14	5.15
E	76	88	83	89	80	416	83.2	84.96	0.97	5.14	5.01

a. A_i = Vote A + Vote B + Vote C + Vote D + Vote E

b. A = (Σ(Ai/N))/N (Common for all students); N = number of members in a team

c. f = (Ai/N)/A, max. = 1.05

d. Individual marks for presentation = f x M

TABLE XII. 3BMFX STUDENTS' ATTAINMENT OF LEARNING OUTCOME

Learning Outcome (LO)	Assessment Method	Marks Distribution		Total Marks (%)	KPI[a] (%)	Total Number of Students	Number of Students Achieved KPI	Percent of LO Attainment (%)	Achievement of KPI
		CPBL 1 (%)	CPBL 2 (%)						
1 (C2)	Peer Teaching Note (Group)	1	2	6	3.6	58	31	53.4	No
	Quiz (Individual)	1	2						
2 (CTPS3)	Report (Group)	2	4	6	3.6		58	100.0	Yes
3[b] (C4)	Test (Individual) (20%)	-	-	70	42		29	50.0	No
	Final Exam (Individual) (50%)	-	-						
4 (CS3)	Presentation (Group)	3	6	9	5.4		42	72.4	Yes
5 (LL2)	Peer Teaching Note (Individual)	1	2	9	5.4		56	96.6	Yes
	Reflection (Individual)	1	2						
	Peer Rating (Individual)	1	2						

a. Key Performance Index (KPI) set refers to Faculty's KPI

b. These assessment methods are not evaluated via CPBL activities.

V. CONCLUSION

Implementation of CPBL in "Material Selection" is beneficial as its teaching and learning activities enhanced knowledge and imparted soft skill within students. Students are required to construct knowledge through their own participation in CPBL activities as well as with the support of their team mates and course mates. At each phase of the CPBL cycle, the assessment is designed to align with the teaching and learning activities with specific rubric developed based on essential criteria reflecting the achievement of the intended outcome. This constructive alignment gives an overall reflection on the students' LO attainment based on the summative assessment conducted. The students' reflection and conducting the closure phased helps in providing insightful strategies for improvement of the subject matter, the students and the lecturers self quality. It enables CQI to be taken in ensuring the achievement of the learning outcomes and contribute to produce graduate with criteria outline in the program outcome.

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