

IMPLEMENTATION AND EVALUATION OF A NEW PBL ASSESSMENT MECHANISM

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ABSTRACT

Professional engineering practice requires both technical and transversal skills, which raises the need to create modern learning methods that develop both. In alliance with CDIO, Problem Based Learning (PBL) has emerged as an effective way of learning and teaching since it fosters the enhancement of transversal competences along with the required technical ones. Moreover, PBL employs real world problems as a learning tool and encourages students to learn independently while being supported by academic facilitators. In PBL approaches, the assessment process is one of the common issues pointed out by students and faculty since it should not only assess technical knowledge, but also transversal competences. Therefore, various academic institutions have developed different assessments tools and mechanisms. However, whereas such tools work in a given learning environment, the social, technical, pedagogical, and other aspects make of its implementation in other environments a challenge. This paper presents the design and implementation of a new assessment framework to evaluate the student work within PBL courses. It addresses new techniques to measure the individual student's contribution while he/she is working in a team to solve a real-life problem. Instead of the previously implemented assessment mechanism that involves only one mid-term and one final assessment, the new assessment mechanism suggests several individual and group sub-assessment tools distributed along the semester. The outcome of this new assessment framework is evaluated and compared to the previously implemented PBL assessment framework.

KEYWORDS

Project Based Learning, Engineering Education, Assessment, Standards 5, 6, 7, 8, 11.

INTRODUCTION AND LITERATURE REVIEW

Project Based Learning

The rapidly expanding knowledge base in different subjects necessitated the presence of a way for dealing with the enormous amount of knowledge. Project Based Learning (PBL) effectively shifted emphasis away from just collecting and absorbing amounts of knowledge to enabling the students to learn effectively and independently. PBL is a student-centered educational method which aims to build problem-solving skills through self-learning and promote sustainable learning and teamwork skills. In the PBL process, learning is initiated by and structured around complex problems rooted in situations that the learner is likely to encounter in the real world outside of school (Woods, 1985). It is a modern learning strategy

that first originated in the 1950s at the medical school at Case Western Reserve University. Then, in the 1960s, McMaster University in Canada introduced it. It was initially introduced as a method of educating physicians to apply their knowledge in the perspective of real patient health problems (Barrows & Tamblyn, 1980) and (Boud & Feletti, 1998).

In a PBL context, a real-life project usually suggested by or related to the industry is given to the students who take the main role of addressing its various problems and build a solution for it from the conceive stage till the last stage of operating it successfully as per the CDIO cycle. Compared to traditional lecture-based learning, PBL has many advantages such as student-independence and self-confidence, increased motivation in the learning process and finding solutions for real-world projects in an educational environment (Powell & Weenk, 2003; Graaff & Kolmos, 2007; Moreira et al., 2011; Fernandes, 2014). PBL is believed to motivate, teach clinical reasoning; store relevant information in an integrated way, and in the way it will be retrieved and applied; tie learned information to a vivid experience. Thus, it plays an important role in helping long term memory, facilitating recall and the transfer of that information to future related problems; reducing the overload of nonrelevant factual material; and promoting self- and peer-assessment and life-long self-learning skills. All these are accomplished in an active, interactive and satisfying way Willem, et al. (1985). So, self- and peer-assessment skills are among the skills encouraged by PBL, although the PBL curriculum does not guarantee the appropriate development of such skills (Langendyk. 2006).

Assessments Mechanism

The major challenge for PBL implementation is in the applied assessment strategy. Many institutions around the world still face challenges in developing the right assessment tools for the right group of students. The fundamental reason for this challenge is due to the lack of academics with the right skills and commitments. In PBL, tutors' role is different from the role of a teacher in a traditional and didactic teaching setting as per (Addae, et al., 2017). Indeed, human factors such as personal bias, errors/ effects such as leniency effect, stringency effect, central tendency error, logical error, and halo effect may affect tutors' rating of students in PBL (Zahid, et al., 2016). PBL delivery requires extra effort from the academics in ensuring students learn the desired knowledge within the specified time. In most cases, academics do not receive the training when they join a new institute which promote PBL mode of delivery. It is important to understand various proven assessment strategies and adopt those in PBL subjects. Tai et al., (2007) reported various categories on assessment strategies. According to them, content deals with the knowledge students acquire, while process focuses on the students' ability to apply knowledge and skills in problem-solving. Outcome assessments should involve the products students design and evaluate their combination of content and new applications of knowledge. Tai et al (2007) also shared that PBL tends to require more of a focus on assessing the process than on assessing the content, yet obviously content knowledge is still important. Ultimately, we need to seek evidence that students possess the means to embrace situations faced by practitioners of their profession and are competent to know how to go about dealing with such situations. White (2001) talks in terms of rather than assessing the achievement of content-oriented objectives, we need to assess achievement of process-oriented objectives - those that relate to how practitioners of a discipline or profession think about and solve problems within a certain field. The success of delivering effective PBL subjects starts with the development of the right assessment items for the relevant subjects. This paper presents some of practical experiences of the authors in developing and delivering the various PBL based subjects and assessments in the area of power systems.

At the Australian College of Kuwait (ACK), the students are exposed to PBL since their second year of study in all engineering disciplines it offers. It revealed a positive result in terms of improving student learning, motivation and graduate attributes (Alameen, et al., 2019). In PBL-based courses at ACK, students work together in teams of 4 to 5 members, to solve a real-life scenario, which require the application of contents of many courses offered in the same or previous semesters of their study plan and/or self-learn to acquire new knowledge required to address the project requirements. The implementation of PBL at ACK is also aligned with the CDIO process as students are required to conceive, design, implement and fully operate a solution for the project and are assessed accordingly.

Initially, the assessment of the teamwork was carried out twice per semester and was based on assessing each learning outcome of the PBL course separately and for each student according to a detailed criteria sheet that lists the required criteria for each level of accomplishment of each learning outcome. Those are collected from various assessment tools submitted by the students such as workbook, final report, peer and self-evaluation sheets. However, many concerns were raised by students and faculty members and both requested a more detailed and comprehensive assessment mechanism that simplifies the assessment process and fully recognize the individual contribution of each team member. Therefore, in alignment with the 11th standard of CDIO, several meetings were conducted between all involved PBL facilitators to share their experience on the most effective assessment mechanism. Students also contributed throughout their feedback to PBL facilitators.

In what follows, the design and implementation of a new assessment framework to better evaluate the students' work within PBL courses in ACK is presented. New techniques to measure the individual student's contribution while he/she is working in a team to solve a real-life problem are addressed. The new assessment framework is based on creating several individual and group assessment tools distributed along the semester to provide continuous feedback to students and smoothen the evaluation process.

PREVIOUS VS NEW ASSESSMENT MECHANISM

It is important that academic courses and programs are revised to suit the industry revolution. Accordingly, in the Australian College of Kuwait we have recently started curriculum review. Being involved in the curriculum review process for several subjects, it was found that developing the right assessment items is extremely vital in ensuring the students acquire the right skills and knowledge. Previous PBL assessment mechanism was based on two assessments as shown in Table 1. The midterm portfolio was taking place at the middle of the semester and consists of two elements, course portfolio and presentation (known as viva voce). Whereas the course portfolio groups the required evaluation tools and documents (workbook, self and peer assessment sheets, simulation files, etc.), the viva voce is dedicated to measure the level of understanding of the knowledge provided in the submitted portfolio in addition to the other soft-skills such as presentation, stress management, etc.

The first midterm assessment weights 30% and aims at providing an initial feedback on the overall students' performance and ways to improve their overall standing in the PBL course. Another similar yet more summative assessment which weights 70% is conducted at the end of the semester. This assessment evaluates the improvements achieved by the students after the first assessment and the overall achievement in each of the PBL course's learning outcomes.

Table 1. Initial Assessment Mechanism (Applied to all PBL courses)

Assessment No. and title	Method of Assessment	Learning Outcomes/ Performance Criteria Covered	Week	Weight
Assignment 1 Midterm portfolio	Course Portfolio	LO1 – LO9	1-7	30%
	Viva Voce		7	
Assignment 2 Final portfolio	Course Portfolio	LO1 – LO9	7-13	70%
	Viva Voce		14-16	

Table 2: Current Assessment Mechanism (Example: Embedded Operating System Course)

Assessment No. and title	Assessment tool	Individual (I) / Group Work (G)	Learning Outcomes Covered	Week	Weight	Total weight
Assessment 1: First Evaluation	Progress report	G	LO1-9	4-6	10%	10%
Assessment 2: Second Evaluation	Technical Evaluation	I	LO1-9	7	10%	20%
	Presentation	I / G		8	10%	
Assessment 3: Third Evaluation	Technical evaluation	I	LO1-9	7-14	15%	30%
	Final Presentation	I / G		7-14	15%	
Assessment 4: Final Evaluation	Workbook	I	LO1-9	14	20%	40%
	Final Report	G		14	10%	
	Final code Hardware prototype	I / G		15	10%	

The new assessment mechanism consists of four main assessments distributed over the semester where each one covers all course learning outcomes as shown in Table 2. Each assessment is then divided into sub-assessments tools based on the nature of the course. The first two assessments are conducted in the first eight weeks of the semester to provide an early intensive feedback to the students with an overall weight of 30%. The third and the fourth assessments cover the second half of the semester. As an example, the Embedded Operating System course as shown in Table 2, has eight sub-assessment tools that measure all technical and transversal skills that are required by professional engineering practice. Unlike the previous PBL assessment mechanism, each sub-assessment tool may assess one or more of the course learning outcomes.

To promote teamwork while keeping the significance of individual contributions, grades are distributed equally between individual and group work. As an example, part of the presentation

assessment grade is awarded the same for all group members (such as the presentation file, the organization, time respect, etc.) whereas the other part of the grade is awarded individually (oral presentation, questions and answers, stress management, etc.).

NEW ASSESSMENT MECHANISM EVALUATION

To evaluate and compare the two assessment approaches, data were collected via several meetings that were conducted with the involved PBL facilitators to share their experience and comments on the most effective assessment mechanism. Students also contributed by answering a well detailed self-administered questionnaire (survey). It is a descriptive study that has been performed on a random sample of students in Year 4 (n=62) those who are familiar with the old PBL assessment plan and experienced the new assessment framework for their first time. The anonymous survey was administered to the students at the end of the debriefing session of a PBL course to investigate their perception on the overall PBL approach, self- and peer-assessment and the new assessment mechanism. Collected data were coded and entered to a computer and processed using the IBM SPSS v. 22. Descriptive statistics were used, as frequency distribution and comparisons.

Table 3: Survey Participants: Gender and Age

		Gender		Total
		Male	Female	
Age	18-24	14	14	28
	25-34	12	12	24
	35-44	3	7	10
Total		29	33	62

Table 3 presents the age and the gender of the students who participated in the study. Almost half of the students are under 24 where the other half are between 25 and 44 years. Also, females count was slightly higher than males count.

Table 4: Professional Experience, Gender and Age

Professional Experience			Gender		Total	
			Male	Female		
None	Age	18-24	12	13	25	56.4%
		25-34	6	4	10	
1-5 years	Age	18-24	2	1	3	19.3%
		25-34	4	5	9	
6-10 years	Age	25-34	2	3	5	9.6%
		35-44	0	1	1	
More than 10	Age	35-44	3	6	9	14.5%
Total			29	33	62	100%

Table 4 shows that almost 45% of the participants have professional practical experience. This means that they can better evaluate the PBL approach in terms of teamwork, transversal and organizational skills.

PBL at ACK in General

The survey starts with general questions on the PBL concept to measure the students' perception on this method of education and its application at our college. A very positive feedback was obtained on whether PBL improved transversal, organizational and personnel skills as shown in Figure 1. Indeed, more than 80% of the students agreed that PBL improved their personal and interpersonal skills.

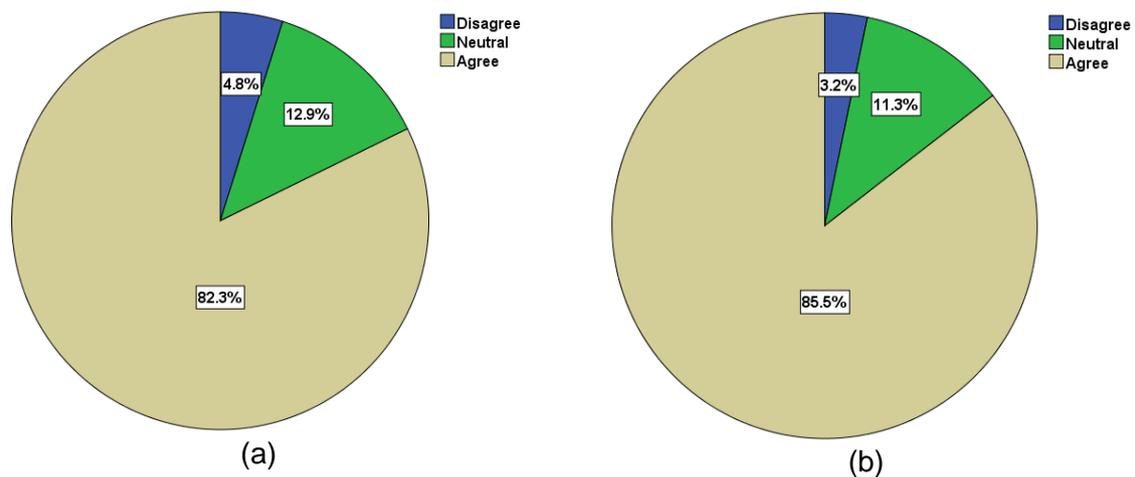


Figure 1. Students responses to general PBL questions: (a) PBL units helped me improving my transversal skills (e.g. management, leadership, critical thinking, etc.), (b) PBL units helped me improving my personal skills (e.g. communication, creativity, entrepreneurship, etc.).

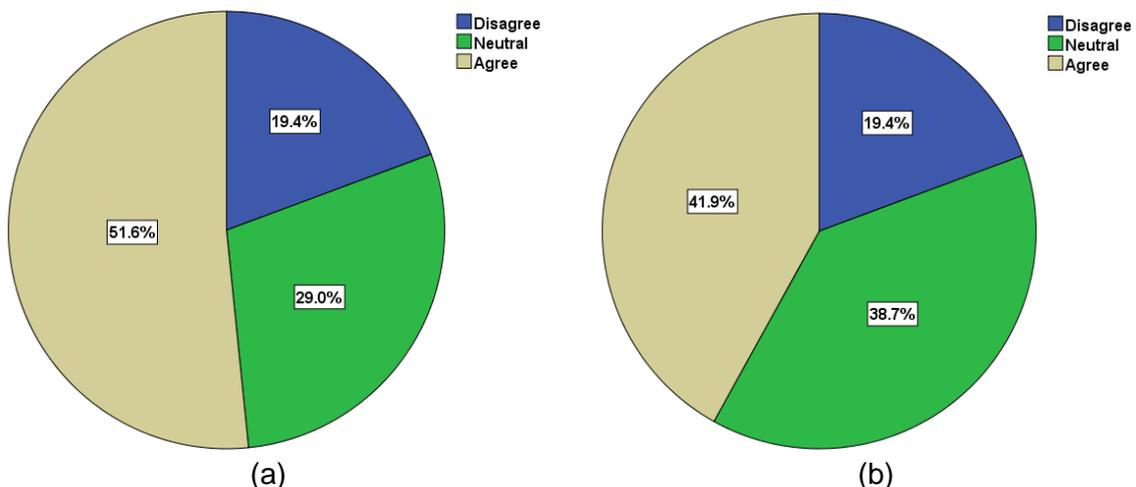


Figure 2. Students responses regarding peer and self-assessment tools: (a) I am in favour of peer assessments to clarify some points not seen by the instructor, (b) I am in favour of individual grade nomination to clarify some points not seen by the instructor.

As mentioned earlier, the peer assessment is a form each student fills to evaluate the performance of his/her peers in the same group. On the other hand, the self-assessment is

another form that each student fills to evaluate him/herself. In both cases, the student should refer to the evaluation criteria sheet and provide evidences. Both documents are submitted by each student confidently to the instructor. As shown in Figure 2.a, almost half of students are in favour of peer assessment to evaluate their group mates. The reason why this response was not high is that the students are avoiding embarrassment and conflicts with their group mates. Moreover, when they do peer-assessment they stress on "overall performance" instead of a detailed proof-based evaluation. On the other hand, Figure 2.b shows that 42% of the students agree on the concept of individual grade nomination, 39% are neutral and 19% disagree with it. The possible reason is mainly the difficulty in evaluating themselves using the criteria sheet or the considerable amount they require to evaluate themselves properly or in the other hand to the possible lack of confidence in their achievements.

New Assessment Mechanism

The second part of the survey is dedicated to evaluating the agreement of the students on the newly implemented PBL assessment mechanism that is based on multiple sub-assessments distributed over the whole semester. As such, the survey questions focused on two main aspects:

- The new assessment framework is improved over the previous one.
- Assessing individual student work within the team is clearly defined in the new PBL assessment plan.

Figure 3.a shows that 61% of the students agree that the new plan has improvement over the previous one as shown. This indicates that the students' understanding of the assessment criteria and grading scheme has improved over the previous criteria-sheet based evaluation. On the other hand, 67% of the students agree that assessing individual students within a team is better defined in the new assessment plan as shown in Figure 3.b. This suggests that students would better understand the variation of grades between the same group members and would result in less students' complaints and grades appeals.

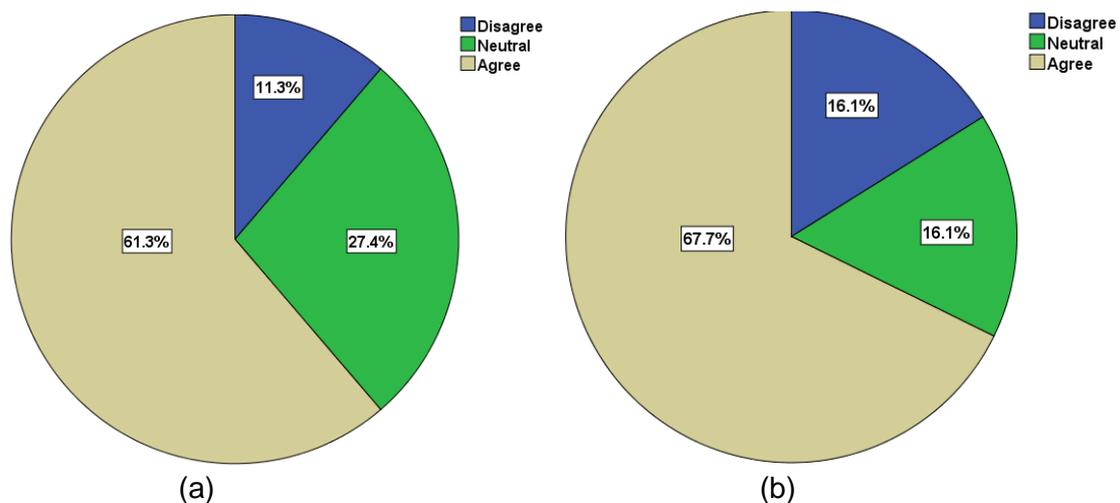


Figure 3. Students Responses: (a)The new assessment plan is improved over the previous one. (b) Assessing individual student within the team is clearly defined in the new PBL assessment plan

CONCLUSION

In this paper, a new assessment mechanism was designed to enhance the grading process and better evaluate the intended learning outcomes of PBL courses at the Australian College of Kuwait. Instead of the previously implemented assessment mechanism that involves only one mid-term and one final assessment, the new assessment mechanism suggests several individual and group sub-assessment tools distributed along the semester. This new mechanism provides better continuous feedback for the students and help them improving their learning process. The new assessment mechanism is evaluated via a survey that was taken by the involved students who were exposed to the previous assessment mechanism in previous semesters and to the new one in Spring 2019 semester. The results show that students generally agree with the new assessment mechanism which helps them better understanding the grades discrepancy between the same group mates.

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BIOGRAPHICAL INFORMATION

Mohamad Farhat received the B.Eng , Ph.D in Electronics and communication Engineering from London Metropolitan University and M.Sc. in Mobile and personnel Communication from King's College. He is currently an Assistant Professor of Electrical Engineering Department at the School of Engineering of the Australian College of Kuwait. His research interests include reconfigurable devices, techniques to suppress spurii in filters for electromagnetic compatible (EMC) systems and active learning.

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