

Design and Implementation of a peer assessment tool for Problem Based Learning in Engineering

Paul Bronson

Victoria University, Melbourne, Australia
Paul.Bronson@vu.edu.au

Anne Ng

Victoria University, Melbourne, Australia
Anne.Ng@vu.edu.au

Kwong K Wong

Swinburne University of Technology, Melbourne, Australia
KWong@groupwise.swin.edu.au

***Abstract:** The progressive approach of Problem Based Learning has become adopted by a number of universities Australia wide. At Victoria University, in Melbourne, the schools of Architectural, Civil and Mechanical Engineering (ACME) and Electrical Engineering began offering first year PBL subjects in 2006. As part of the shift from a traditional mode of teaching, research was undertaken to review current practices and develop appropriate assessment. This paper focuses on development of an assessment proforma for peer assessment that was implemented in three subjects in first year engineering. Students evaluated their peers on 5 major criteria and these were used by staff to help in assessment of teamwork skills. Although peer based assessment may be seen by some as biased, it is relevant in the context of a PBL environment and offers useful insights that would otherwise be overlooked. The assessment tool was evaluated for validity, reliability and practicality by engineering and language and communication staff.*

Introduction

The problem based learning (PBL) mode of learning/teaching varies considerably from traditional methods used in educational institutions. Students become more responsible for their own learning within this learning environment, and are required to work in groups to solve “problems”. Staff act less like teachers, but act as facilitators to guide student learning (Margetson, 1994; Gallagher and Stephien, 1996). PBL thus helps students to build upon communication skills, teamwork skills in addition to problem solving and technical skills.

Victoria University (VU) decided to adopt the PBL model as it realised that it was a novel approach to teaching and learning, and aligned well with the core graduate attributes of Engineers Australia (1999). As implementation of PBL into engineering programs only took place in 2006, a great effort has gone into training staff, and reviewing local and international PBL practices. Curriculum and assessment has undergone major changes as a result, in order to adhere more closely to the PBL paradigm.

Research and development of PBL courses has been taking place at Victoria University as a number of projects were launched in 2006 to help accommodate the shift from traditional teaching. The development and implementation of a peer assessment tool, and others, were part of a larger project to review PBL assessment practices and produce an assessment framework for staff in engineering. This project involved a number of members from the school of Architectural, Civil and Mechanical Engineering (ACME), one member from the school of Communication, Culture and Language (CCL) and an assessment specialist from Swinburne University. It was decided that since teamwork plays a major part in the learning

practices of PBL students that it was important to devise a means for valid, practical and reliable assessment of this component. Note that at VU both engineering and CCL staff act as facilitators in PBL subjects as there is an emphasis on fostering generic skills as well as technical knowledge and problem solving ability.

Methodology

Paul Bronson conducted a review of curriculum and assessment practices in PBL courses at Victoria University in 2006 and early 2007. After discussion with staff and students, and analysis of local and outside PBL practices it became apparent that some of the assessment methods being used in new PBL course at VU needed further development. What seemed most evident is that staff wanted clearer criteria to guide them in assessment. One area in need of particular attention was peer assessment, as both the schools of ACME and Electrical Engineering had subjects where teamwork was considered a key learning outcome, and yet did not have a definitive way to assess it. Students did not have clear guidelines on how to assess their peers, which resulted in a vast difference in the quantity and quality of student response. Furthermore, difficulty was experienced by staff regarding how student comments would be effectively incorporated into assessment, so a means to address this issue was important.

After consultation with staff and review of student essays commenting on the “ideal team-member” a number of criteria were derived to produce an assessment form for students to assess their peers. Suggestions from staff on the layout and the how marks would be recorded were also taken into consideration. The basic layout and guidelines for the peer assessment was the same for the subjects “Engineering Profession”, “Experimentation and Computing” and “PBL and Engineering Practice 1A”, see table 1. The form includes five main criteria for members of a team; contribution, cooperation, organisation/coordination, punctuality and whether team members are a “positive” influence. This proforma was designed to be given to each student individually and filled out anonymously.

Considerations In Assessment Design

It was important to incorporate a range of different measures when designing the peer evaluation tool. One of the key measures was that it would be valid, or in other words evaluate what it claimed to be assessing. Reliability or the repeatability of results (Weir 1993; McNamara 2000; Wong 2006) was also an issue as inconsistencies could have affected formative feedback or final results given to students. Practicality was a further consideration as the peer assessment form had to be filled out during PBL tutorial time. Particular attention was given to the presentation of the key criteria and guidelines for students in the proforma. It was designed to be easy to use for students, not be overly long, and yet give enough information for staff to assess team members adequately. If a particular assessment devise takes too long to assess in relation to the information gained, then it is unlikely to be practical as suggested by Weir (1993). The last main consideration was fairness, which concerns the inclusivity of the subject material. The evaluation form should not discriminate against people of different gender, socio-economic or cultural backgrounds (Weir 1993; Wong 2006). As a result the use of colloquial language and culturally specific terminology was avoided. Efforts were made to ensure that the parameters used to describe poor or excellent performance for each of the criteria were clear to students. This was to avoid the need for detailed instruction when issuing the assessment form.

Table 1: Peer Assessment in PBL

Assessor name _____ Team _____

Tick one box for each criterion. Comments should be included. Date _____

Student	Contribution to the team	1	2	3	4	5	
1 _____ 2 _____ 3 _____ 4 _____ 5 _____	Rarely contributes any useful suggestions or material.	-	-	-	-	-	Regularly contributes useful suggestions and information to the team.
Comments (space for comments)							
Student	Cooperation	1	2	3	4	5	
1 _____ 2 _____ 3 _____ 4 _____ 5 _____	Refuses to do work, and hard to get along with. Rarely answers or returns messages/ phone calls/email.	-	-	-	-	-	Sociable and works very hard to achieve team success. Readily contactable/ always returns messages/ phone calls/email.
Comments (space for comments)							
Student	Organisation and coordination	1	2	3	4	5	
1 _____ 2 _____ 3 _____ 4 _____ 5 _____	Poorly prepared for group meetings, work for team always late. Lacks basic time management skills.	-	-	-	-	-	Works well in ensuring that work is prepared in time for the team, and is a major asset in coordinating team contributions.
Comments (space for comments)							
Student	Punctuality	1	2	3	4	5	
1 _____ 2 _____ 3 _____ 4 _____ 5 _____	Late or absent from most workshops and team meetings without a good explanation.	-	-	-	-	-	Always punctual to workshops and team meetings.
Comments (space for comments)							
Student	Positive Influence	1	2	3	4	5	
1 _____ 2 _____ 3 _____ 4 _____ 5 _____	Negative and demotivating to the team.	-	-	-	-	-	Presence lifts team, and will motivate members in a positive/productive fashion.
Comments (space for comments)							
General Comments (space for comments)							

Implementation and Review

Peer assessment forms were issued twice for Engineering Profession (ACME), and Engineering Practice 1A (Electrical Engineering) and three times for Experimentation and Computing (ACME) in semester 1, 2007. They were utilised upon completion of a project and/or prior to a change in student teams. ACME consisted of approximately 180 students, while Electrical Engineering had roughly 60.

For each of the three PBL subjects, staff involved were later asked to review the peer assessment tool on the following criteria: validity, reliability, practicality, fairness, readability, usability, comprehensiveness, and adaptability. Facilitators were requested to rate each criteria between 1 and 5, and provide comments in an anonymous survey in July, 2007. However, further information was gathered via discussion of the assessment tool with staff as not all had responded to the survey, and several had come forth to offer their opinion, and others were later approached to get a more balanced overview. The authors realise that quantitative methods are often in evaluation of assessment tools, however as this the program at VU is only in its second year it was deemed more valuable to actually get the opinions of staff, as they would ultimately be the ones implementing the peer assessment form and interpreting the student responses and be well aware of the engineering PBL program and the students at VU.

Teamwork and Peer Assessment

Working in teams is an essential part of PBL, as “problems” or tasks are solved as part of the learning process. Teamwork has the advantage that it gives students the opportunity to manage more complex tasks that are unlikely to be solved individually. It also allows the use of problem solving strategies such as negotiation that would otherwise not be used. On the other hand, conflicts may arise and there are often complications in organising regular meetings because of different individual schedules (Grellier and Goerke, 2006). These issues however can be considered part of the learning process.

In this environment it is important to mark individuals fairly, despite the fact that students work in groups. Adoption of peer assessment is one way in which staff can gain useful feedback on individuals in a team which can help moderate overall assessment. McConnell (2000) suggests that by providing students with the opportunity to have a more active role in assessment promotes positive learning and improved engagement. It is valuable to utilise the insights of students as they view things differently than staff members, although often they need to be guided to make constructive comments about teammates, rather than just being critical (Roberts, 2006). In the case of peer assessment of team members at Victoria University the feedback was kept anonymous, although individuals were approached if they received mostly negative comments and/or grading so that they realised that their performance could be improved.

Evaluation and Discussion

Survey results and/or comments from 14 Staff involved in three different first year PBL subjects were received from July to August 2007. Although the sample size was small, the overall response to the proforma and/or individual interview was positive. Facilitators generally agreed the form was highly readable, valid and fair for the students.

Yet, there were comments from some staff that the form may not be that reliable, as students may not accurately evaluate their peers. This is a common criticism of all peer assessment, and thus it cannot be seen as specific to this particular assessment tool. In reality all comments made will be biased on what individuals perceive as true, or fair, so it is impossible to remove all subjectivity from this type of assessment. What can be done however is to cross-reference student gradings with the feedback that they write to see if it is consistent.

Another moderating factor would be the observations of staff, who may know whether a particular student has demonstrated good attendance or participation in class.

Readability of the tool was rated highly by most staff consulted. But there were suggestions that some students had difficulty reading it. However, this was isolated mostly to one class which contained alternative entry students who had lower literacy skills on average. In two other classes consisting of approximately 60 students in total, only four students asked questions as to how the form should be filled out. So the readability issue could be a combination of the average literacy levels of the students submitting the peer assessment and/or the amount of instruction given by individual PBL facilitators. When staff were later questioned as to how the document could be made more readable, it was suggested that it be left unchanged or that not much more could be done to improve it.

As the form attempts to assess all group members on one form, in order to save space and to allow comparisons between group members on the same page, comments in regard to layout were of interest. One staff member considered that aligning the criteria vertically across the page may save students having to repeatedly write the same student names five times. This may be a reasonable option, although it would require some careful reformatting.

The practicality of issuing and collecting the form in class was agreed to be high, and most agreed that it was practical for staff to assess. Feedback to the contrary was that it took a long time to analyse the comments made by students. It was suggested by one staff member that it may be useful to put the form online and have the actual grading automated, although this would still require that written comments be read manually. This is also likely to have affected the response rate, although since peer assessment is compulsory in the subjects in which the survey was issued this should not be a problem.

It should be noted that previously, in 2006, only room for general comments were included for PBL subjects in ACME and Electrical Engineering, which meant that the amount of feedback received from students and the quality varied considerably. In the case of the form implemented in 2007, students were required to comment on five different factors, thus the depth of feedback was a lot higher on average. The actual layout is somewhat similar to a proforma by Kosel (2007), although in the later case there are only three main divisions into social attitude, contribution and organisational skills. However, there was no room on Kosel's assessment form for comments, which could be seen as reducing the reliability of results.

In contrast to this study, Li (2001) uses quantitative methods to review student responses and advocates nominalisation of the scoring of individuals within a group to reduce subjectivity. This is a valid approach, although in the case of peer assessment tool herein, comments from students are reviewed in addition to recorded scores and they are further moderated by the observations of staff which is seen as sufficient. It may be useful to include self assessment on the same peer assessment form however as it could help distinguish between hard and generous markers as suggested by Li (2001). This modification has already been adopted in the peer assessment forms used in the subject "Intro to Design", another first year PBL subject in the school of ACME at VU.

Obviously it is important that assessment/evaluation forms used by staff should be aligned with the needs of institutions, staff and students so there is no 'perfect' assessment for all situations. The study presented here has highlighted some important issues in assessment design, particularly concerning peer assessment in a PBL context in Engineering. So hopefully an appreciation of the need to carefully design and review assessment tools could be gathered from this paper.

Conclusion

A peer assessment tool used in three different PBL subjects at Victoria University received favourable feedback from staff when evaluated on a range of factors, namely validity, practicality and reliability. Although there were some suggestions on how the form could be improved, these were relatively minor. It is difficult to produce an evaluation/assessment form that will meet the satisfaction of all staff and students, but it is worthwhile reviewing and building upon assessment methods put into practice to meet the changing needs of the university.

References

- Engineers Australia (1999). *The manual for the accreditation of professional engineering programs*, revised October 1999.
- Gallagher, S. A., & Stepien, W. J. (1996). Content acquisition in problem-based learning: Depth versus breadth in American studies. *Journal for the Education of the Gifted*, 19, 257-275.
- Grellier, J. & Goerke, V. (2006). *Communication skills toolkit: Unlocking the secrets of tertiary success* (pp. 254-265). South Melbourne, Victoria, Australia: Thompson Social Science Press.
- Kosel, B. (2007). *A framework for assessment in a PBL-situation*. Accessed at <http://www.pedc.se/lentec/self_assessment/A_framework_of_assessment_f.doc> on January 9, 2007
- Li, L. K. Y. (2001). Some refinements on peer assessment of group projects. *Assessment and evaluation in higher education*, 26(1), 5-18.
- McConnell, D. (2000). *Implementing computer assisted cooperative learning*. London: Kogan Page
- McNamara, T. (2000). *Language testing*, Oxford, UK: Oxford University Press.
- Margetson, D. (1994) Current educational reform and the significance of problem based learning. *Studies in Higher Education*, 19(1), 5-19.
- Roberts, T. (2006). Self, peer, and group assessment in E-learning: an introduction. In T. Roberts (Ed.). *Self, peer, and group assessment in E-learning* (pp. 1-16). Hershey, PA, USA: Information Science.
- Weir, C. J. (1993). *Understanding and developing language tests* (pp. 1-29). New York: Prentice Hall.
- Wong, K. K. (2006). *Design of quality essay questions for student assessment*. Learning and Teaching Support. Swinburne University of Technology, Victoria, Australia.

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