

## Reflective writing by distance education students in an engineering problem based learning course \*

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**SUMMARY:** *The University of Southern Queensland (USQ) is a regional university and is also Australia's largest provider of distance education, winning national and international awards for its flexible programs. Currently in the university, over three quarters of the student body are enrolled in the distance mode and study off campus. The USQ Faculty of Engineering and Surveying in a curriculum review introduced a strand of four courses using problem based learning (PBL). PBL is a successful concept implemented in a number faculties and disciplines worldwide, largely in response to criticisms of traditional engineering education. However, there are few references to PBL being delivered entirely to distance engineering students working in virtual teams. The role of reflections and the reflective process was seen as critical to the success of student learning in a PBL course and was integrated into the assessment schedule. The reflections of the distance education students in the first PBL course were analysed for evidence of learning and depth of reflection. Results indicated that neither students nor facilitators (the academics providing support for each team) had a clear understanding of the process of reflection. Initially students wrote mostly in the "retell" mode. Little evidence of critical analysis or evaluation of the team project, team processes or individual learning was evident in their reflections. A significant discrepancy between markers and a clear understanding of the requirement and benefits of reflective writing was also apparent. Possible solutions to these issues are discussed.*

### 1 USQ GENERAL INFORMATION

USQ began 40 years ago as an Institute of Advanced Education and gained university status in 1990. The University has five faculties: Engineering and Surveying, Science, Education, Arts, and Business. The University has approximately 26,000 enrolments, of which some 35% are international students. Students can choose between three modes of study: on-campus, distance and online. The majority of students, approximately 77%, study off campus by distance education, making USQ an international leader in distance education (USQ, 2005).

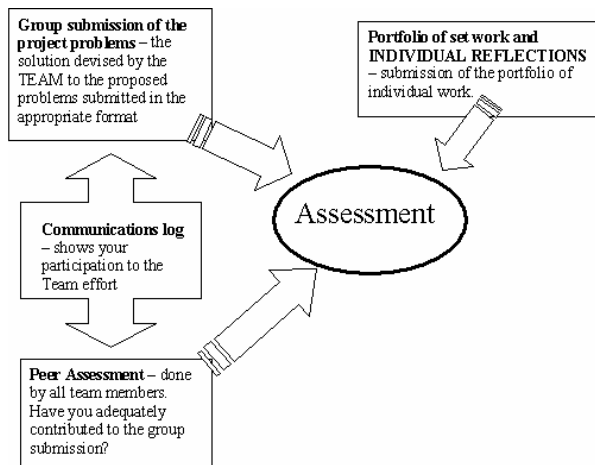
The Faculty of Engineering and Surveying (FOES) has approximately 2600 students, of which approximately 600 study on campus. The remaining students use

the flexible education offered by the university to work and study simultaneously at locations across Australia and the world. The faculty offers 26 programs of study over 1, 2, 3, 4 and 5 year (double degree) programs through to doctoral studies. There are 9 majors offered, including agricultural, spatial science/GIS, electronic, civil and mechanical engineering (USQ 2006).

In early 2000, the FOES embarked on a major review and restructure of its programs to prepare for the re-accreditation of its programs by the Institution of Engineers Australia (now Engineers Australia). Recent reports from major engineering accreditation and professional bodies have prioritised the need for problem solving skills, teamwork and communication skills in graduates (IEAust, 1999; IEEE, 2002; ABET, 2003). This has been in response to criticisms that programs failed to equip graduates with collaborative problem-solving skills required for life long learning and the reality of the work place (Wilkerson & Gijsselaers, 1996; Boud & Feletti, 1997; Brodeur et al, 2002; Felder & Brent, 2003). Fundamental aspects of

\* Paper D07-019 submitted 11/05/07; accepted for publication after review and revision 13/09/07.

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**Figure 1:** Assessment strategy (Brodie, 2002a).

engineering education – multidisciplinary teamwork, communication, problem solving, *application* of knowledge and the skills for lifelong learning – are ideally suited to problem based learning (PBL). As a result of the review and in light of these required attributes, the faculty introduced four new courses or subjects using PBL (Porter & Brodie, 2001).

This paper discusses the results from the reflective writing exercises undertaken by the distance education students in the first PBL course over three offers delivered in semester 1 of the academic year.

## 2 PBL, REFLECTION AND ASSESSMENT

PBL is a pedagogical strategy where students are presented with open ended, contextualised, real world situations. They develop content knowledge, application of knowledge and problem solving skills by defining the problem, sourcing resources (including prior knowledge and experience of team members) and identifying gaps in their own knowledge (Mayo et al, 1993). PBL is now a widespread teaching method in disciplines where students must learn to apply knowledge, not just acquire it (Wilkerson & Gijsselaers, 1996; Brodeur et al, 2002).

Student learning occurs within small group discussions and the academic assumes the role of a facilitator, not a lecturer (Aspy et al, 1993; Barrows, 2000). Thus the amount of direct instruction is reduced and students assume a greater responsibility for their own learning (Bridges & Hallinger, 1992). As they can share prior knowledge and experience with the group, mentoring and peer assistance assumes a more prominent role in the student learning experience and helps build a learning community. This shared and interdependent learning experience can be successfully done in an online or virtual environment given appropriate scaffolding. The novel approach taken by the FOES in delivering PBL

to distance education students supports learning in virtual teams and develops problem solving skills (Brodie & Gibbings, 2007; Gibbings & Brodie, in press).

In addition to the standard problem solving process, PBL adds the steps of abstraction and reflection (Koschmann et al, 1994; Hmelo-Silver, 2004). Reflection is a very important part of the learning process and the theory on learning and reflection comes from a number of different sources. It is grounded on Kolb's (1984) work on the learning cycles and Schon's (1987) ideas about reflection. Students must be given time to synthesise their new knowledge and reflect upon what they have discovered. This is particularly important in PBL where learning is sometimes covert – problems are solved and projects completed without the student being aware that skills and knowledge have been acquired and enhanced. Students must be allowed, and prompted if necessary, to reflect individually and as a group. Reflection, therefore, should become a key part of assessment.


Figure 1 overviews the assessment strategy adopted for the first course in the PBL strand at USQ. The assessment strategy varies slightly for each of the four PBL courses. In the first course, students were assessed on four team projects and the project mark was modified to an individual mark based on peer and self assessment reports. This constituted 75% of the total mark for the course with the final 25% from an individual reflective portfolio.

The intention of the reflective portfolio is to use the writing process as an effective means to facilitate students' critical thinking about the aspects of course content, issues, group dynamics and individual learning.

Norris & Ennis (1989, pp. 176) define critical thinking as "reasonable and reflective thinking that is focused upon deciding what to believe or do". Keefe (1992, pp. 123) notes "Reflective reasoning moves beyond simple rules, relationships, and principles to higher frameworks of meaning – analogy, extrapolation, evaluation, elaboration, invention". These skills and behaviours are the basis of Bloom's work where he catalogued six levels of learning beginning with the lowest level, knowledge, through to the highest level – evaluation as shown in table 1. The last three of these skills – analysis, synthesis and evaluation – are indicative of critical and reflective thinking.

Initially, students focus on knowledge, comprehension and application of subject matter. These three levels of learning are the easiest, especially if the application is in a limited context, eg. worded problems from a text book. For higher levels of learning, application of knowledge in real world problems, students must be able to analyse, synthesise and evaluate. Reflection is a key part of moving into these higher levels of learning (Kanuka, 2005).

**Table 1:** Bloom’s six levels of learning (Bloom, 1956).

Increasing difficulty 	Process	Explanation
	Knowledge	Recognition and recall of information and facts – describing events
	Comprehension	Interprets, translates or summarises given information – demonstrating understanding of events
	Application	Uses information in a situation different from original learning context
	Analysis	Separates wholes into parts until relationships are clear – breaks down experiences
	Synthesis	Combines elements to form new entity from the original one – draws on experience and other evidence to suggest new insights
Evaluation	Involves acts of decision making or judging based on criteria or rationale – makes judgements about	

**Table 2:** Seed questions for reflective portfolio (Brodie, 2002b).

Project	Aspect	Seed questions
Project 1	Teamwork	How well did your team work together? What worked well and what caused problems? How can these problems be rectified and how can you capitalise on the strengths? Reflect on the Code of Conduct and Cooperation your team developed – did it help, did your team stick to it, etc, why/why not?
Project 2	Timelines and project management	Did you personally and your team meet the timelines for the project? What did you learn about time management? What tasks that you took responsibility for did you find difficult? Did the team function as a cohesive unit and achieve more than an individual member could have? In what ways was this achieved and how can things be improved?
Project 3	Problem solving	What have you learned about problem solving and problem solving as part of a team? What have you learnt about project management/timelines/resource management? What have you learned about how to use or apply the technical content of this course?
Project 4	Resources	Discuss briefly how you feel a standard text book approach to a problem helped or hindered the finding of a solution to this problem. Discuss briefly the technical content and complexity of this problem. Discuss briefly the resources used, why where those particular resources used, were they useful, what helped most?

The reflective portfolio was submitted individually at the end of each project. In the course guide (printed resource provided to all students), general guidelines were given regarding the content of the portfolio. Students were required to prepare a short essay in which they considered three aspects of learning – content, context and process – by addressing the basic questions of:

- What have you learned about the topic?
- How does this learning fit into your life’s goals, both professionally and personally?
- What have you learned about how to learn, particularly as it relates to open-ended questions?

In addition to these guidelines, students were given “seed” questions to prompt their thinking about certain aspects of the project, as outlined in table 2.

Examples and specific information on reflective writing and the reflective process were provided in a student resource book (printed resource) and students were encouraged to source further information if required.

At the end of the course, students were required to prepare a short essay (1000 words minimum), which reflected on the entire course. In preparing the submission, they were asked to consider the following questions:

- What key ideas or information have you learned?
- What have you learned about how to use or apply the technical content of this course?
- In which areas do you have the most and least confidence? Why do you suppose this is the case?

- What experiences have you been able to integrate, within or external to this course?
- What have you learned about the human dimension of the subject, either regarding yourself and/or your interaction with others?
- What did you learn about yourself as a problem solver?
- What have you learned about how to learn?

It was anticipated that the students, particularly the mature age distance students, would be able to synthesise and evaluate their experiences, building on their prior knowledge and life skills. While a large number of students wrote cohesively and persuasively, analysis of the results showed that relatively few students achieved what could be called true reflective writing. This is discussed further in the following section.

### 3 INITIAL RESULTS

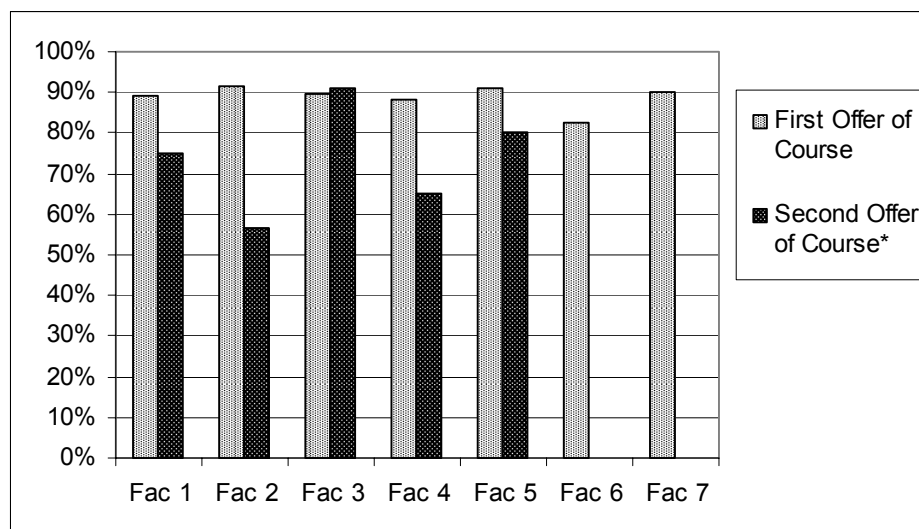
Grading of the reflective portfolios revealed that facilitators, as well as students, were not comfortable with reflective writing. Facilitators were uncomfortable with the concept of grading personal thoughts and feelings. How can you mark a student wrong or deduct marks? Students, despite being given information on reflective writing, were still unsure of how to go about achieving it and exactly what was required. In the first offer (offer 1) of the course, 165 distance students were enrolled. 68% of the students submitted a portfolio (submission of the reflective portfolio was not compulsory). The average mark for the portfolio was 89.6%. The majority of students could effectively retell events and can add some key reflective phrases of "I learned ...", "I felt..." and "I thought...", but struggled to achieve deep reflection by being able to critically analyse, state opinions and apply new understandings. This

average mark was high given the overall level of reflection from the cohort of students. This showed facilitators reluctance to "grade" reflective writing and their lack of understanding on what constitutes "reflection" at a deep level.

Analysis of the writing showed that approximately 82% of the student wrote mainly in the "retell" mode, ie. summarising information and identifying key concepts. Only approximately 2% of students were able to *reflect*, as identified in the marking criteria, ie. showed an understanding and gained original insights. A qualitative analysis showed that most facilitators believed that students were writing "what they thought we wanted to hear", rather than an accurate reflection of individual learning and team process.

Therefore the examiner (course leader) had no way of determining if students had actually learnt new skills and knowledge, or expanded and built on prior knowledge. Survey results showed that students believe they had met the course objectives, but there was no accurate way of determining if individual learning goals had been set by the student or met. Based on an in-depth evaluation of student learning outcomes and facilitator feedback, several strategies were implemented to scaffold the reflective writing tasks for both facilitators and students.

For the next offer (offer 2) of the course, more guidance and marking scales with keywords were provided. Facilitators were given extra resources and training to help students undertake the portfolio and reflective writing tasks. In this offer, 145 students were enrolled and nearly 88% of students submitted a portfolio. With this assessment guidance, the average portfolio mark was more in line with the average mark for the projects at 73.6%, but there was still a significant difference when the marks were analysed by facilitator, as shown in figure 2. The range of average marks by individual facilitators was



**Figure 2:** Individual average facilitator marks for portfolio prior to staff training and reflective writing guides (\* only 5 facilitators were required due to lower student numbers in this offer).

approximately 56% to 91%, compared with a range of 88% to 91% from the previous course offer. Clearly facilitators still had differing ideas and standards on what constitutes *reflective writing* and differing levels of comfort with grading it.

Analysis of the student writing showed marginal improvement, with approximately 76% of the students continually writing in the retell mode. Approximately 10% of students achieved a high level of reflection, and increase from 2%. The remaining students were able to relate incidences and events to prior knowledge or experiences to varying degrees.

While there had been some improvements in both student competences in reflective writing and facilitator understanding and assessment, it was clear that additional guidance was required for the full benefits of this learning practice to be realised. An in-depth review of the literature and the authors own reflection "on and in action" highlighted the need for a reflective writing guide for both course facilitators and students.

#### 4 REFLECTIVE WRITING GUIDE FOR STAFF AND STUDENTS

Dr L Dee Fink (2001) of the University of Oklahoma carefully distinguishes between substantive writing and reflective writing. Substantive writing refers to writing that is focused on a topic and attempts to present information and ideas the writer has about that topic. Reflective writing focuses on the writers experience itself, and attempts to identify the significance and meaning of a given learning experience. Its "value is in its ability to help the candidate become more self-conscious of his or her own learning" (Loyola University Chicago, n. d.).

To guide students through this process, the author developed a reflective writing guide. A similar guide for staff was also written to enable staff to assist students and effectively assess the submissions.

The reflective writing guide articulated aims to guide students, not only through the reflective writing tasks, but also through the reflective process. Students are asked to set:

- individual learning goals for the entire course, considering their prior knowledge and experience and the course objectives. They must also plan how these goals will be met, resources required and an effective evaluation strategy.
- individual goals for each project in line with personal learning goals identified above
- team goals in discussion with team members, focusing on team process, as well as team outcomes.

Once goals have been set, students and teams were required to reflect during, as well as after, the

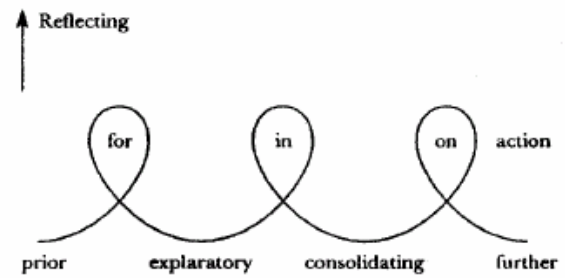


Figure 3: Cowan diagram – Kolb coils (Cowan, 1998).

completion of each project to determine areas for improvement, learning achieved and the process undertaken. This concept of reflection before, during and after is based on John Cowan's work where he combined Kolb's "learning cycles" and Schon's ideas about reflection to devise what is known as the Cowan diagram or Kolb coils (as cited in Helbo et al, 2001). This work defined the three reflection stages to enhance the learning process (figure 3):

- **before** (*for*) the project decide what the learning process will be to meet needs (personal and team)
- **during** (*in*) the project to consider how the process and learning goals are being achieved, and what action needs to be taken
- **after** (*on*) the process to decide if goals have been met, what could have been done better, etc.

The different stages of reflection are: retell (set the scene, summarise information, state the main ideas and identify key concepts); relate (make new connections, apply personal experience, compare and contrast, etc) and reflect (draw conclusions, apply judgement, state opinions, new understandings, etc). To help students through these stages, they are asked initially to fill in a table in dot points rather than complete an essay (see table 3). In subsequent tasks in the portfolio, these dot points were expanded until students could complete an "essay" submission.

To guide both staff and students on assessment, marking and feedback rubrics were developed for each topic of submission. The goal was to provide a quick and consistent method of giving feedback to students. Over future offerings of the course, examples at each level of the rubric will be collected to give further assistance to facilitators on marking. A sample rubric is shown in table 4. In addition to the reflective writing guides, a staff training session on reflective writing and its assessment was developed. This training aimed to gain a consensus between facilitators and ensure consistent and regular feedback and information was given to students.

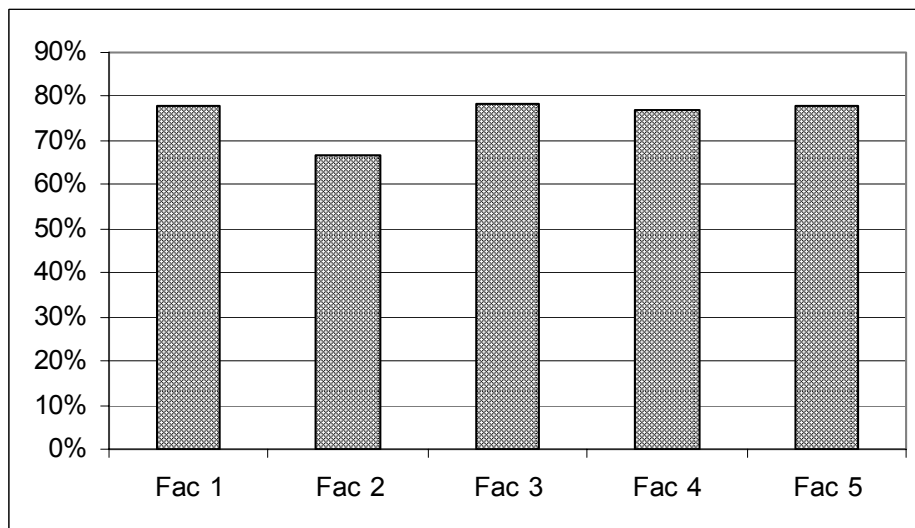
The following results are based on a student cohort of 164 students in offer 3 of the course. The submission rates were increased to 98% and the average mark

**Table 3:** Personal reflections (Gibbs, 1988).

<b>Description</b>	Describe what happened and set the scene
<b>Feelings</b>	What were your reactions and feelings?
<b>Evaluation</b>	What was good and bad about the experience?
<b>Analysis</b>	What sense can you make of the situation and your experience?
<b>Conclusions (general)</b>	What can be concluded, in a general sense, from these experiences and the analyses you have undertaken?
<b>Conclusions (specific)</b>	What can be concluded about your own specific, unique, personal situation or ways of working?
<b>Personal action plans</b>	What are you going to do differently in this type of situation next time? What steps are you going to take on the basis of what you have learnt?

**Table 4:** Rubric for individual reflection on projects.

<b>Level 1</b>	Little/no effort; insufficient
<b>Level 2</b>	Presentation of basic facts, but some may not be relevant to reflection. Feelings/thoughts are simple obvious statements and no attempt to elaborate on ideas. Basic plan, but does not address relevant issues or in sufficient detail. May need to take more care with spelling and grammar – these errors detract from comprehension.
<b>Level 3</b>	Presents relevant facts, but does not go deeply into reflection, uses concrete detail and poor generalisations. Simple generic language. Personal action plans are not thoroughly planned. Reflections do not relate to evaluation and analysis of the events listed.
<b>Level 4</b>	Presents relevant facts and records personal observations. Relates experiences and observations. Presents strong connection between the events of the project and experience(s). Analyses the experience by looking at more than one angle. Uses specific details to make reflections clear. Uses precise language. Can analyse own behaviours. Minimal spelling and grammatical errors.
<b>Level 5</b>	Presents relevant events in context. Shows great depth of thought, deep insight and effective conclusions and action plan. Depth of analysis of own and others behaviour. Appropriate language, minimal or no spelling and grammatical errors.



**Figure 4:** Individual facilitator marks for portfolio after staff training and reflective writing guides.

for the portfolio was 75%. Analysis of the writing tasks showed that students who could demonstrate a high level of reflection, ie. level 5 on the rubric increased, to 32.5%. The result of staff training and development can be seen in figure 4. There was much closer correlation in the assessment marks between

facilitators 1, 3, 4 and 5, with a variation of only 1.5%. It is interesting to note that the one exception (Fac 2) did not attend the training session.

Over subsequent semesters, the portfolio tasks, reflective writing guides and staff training have been slowly evolving. More scaffolding tasks have

been incorporated into the portfolio and qualitative analysis shows that this is having an impact on student's appreciation of reflective writing and the role it plays in their learning as illustrated by the following comments.

*"The idea of reflection has been one of the positives in my list of goals. I have never really reflected on my learning ... or about any of the past subjects that I have completed. I believe that this will definitely help me as I proceed with my degree."* – Student comment.

*"The course also gave us invaluable knowledge about ourselves and how to learn at university ... I personally have gained a lot from the experience."* – Student comment.

*"This reflection really started me thinking. It is helping me to examine not only what and how the course is teaching, but how I am performing, my shortcomings and what I need to work on."* – Student comment.

*"Completion of reflective writing task[s] strengthened the meaning of each experience allowing students to truly reflect and learn from the course."* – Team reflection comment.

## 5 SUMMARY

Table 5 shows a summary of results from three offers of the course. Only the results from distance education students have been included in the analysis. The implementation of scaffolding, including the production of reflective writing guides for both staff and students, and staff training strategies, has significantly and consistently increased submission rates and the number of students who can critically reflect and evaluate their learning through a PBL course.

Students embarked on the reflective writing tasks with varying degrees of enthusiasm. Initially there was some resistance, especially from the mature age students. Comments such as "but I enrolled in an engineering degree" and "these tasks are more suited to younger students" were common. However, as the reflective writing tasks developed and became more integrated into student projects and assessment, the link between *reflecting*, learning and professional development became easier for students to see and appreciate.

**Table 5:** Key statistics of PBL course offerings.

Course offer	Number of DE students enrolled	% students submitted portfolio	Average mark % of the portfolio	Percentage of enrolled students who achieved "deep reflection"
1	165	68.0	85.0	2.0
2	145	88.0	73.6	10.0
3	164	98.0	75.0	32.5

*"Another important part of the course that has really stood out to me is the life long learning. Until now I had always thought that uni was going to be the end of my educational years. I have now learnt that I am not going to uni just to learn how to be an engineer, but also to learn how to learn ..."*

– Student comment.

Unfortunately facilitators, on the whole, see reflective writing as tedious to mark, even given substantive rubrics. While they can see the overall benefit to student learning, the general feeling is that examinations and assessments with "calculations" are easier to mark. However, the ability to reflect has an association with higher levels of learning and perhaps should be encouraged in more courses. King (2002) states that "reflection is indicative of deep learning, and where teaching and learning activities, such as reflection, are missing only surface learning can result". Perhaps the introduction of more reflective tasks across the curriculum would contribute to more students seeing the benefit of reflection, as well as the development of this key skill.

## 6 CONCLUSIONS

PBL is well established as an effective teaching and learning method in many professions, especially those where knowledge must be applied, not simply acquired. The emphasis that employers and accreditation bodies are now placing on the core skills of teamwork, communication and problem solving places additional impetus on academics and universities to change their teaching paradigms. Where PBL, in whatever form, has been adopted, reflection must play an important part of the learning process. In addition, the benefits of reflective writing in achieving *deep* learning make it a useful, and perhaps necessary, tool in every course regardless of the teaching method.

However, reflective writing and the reflection process are not easy skills to acquire, as shown by initially poor submission rates and low levels of deep reflection. Evidence from numerous offerings of the PBL course shows that guidance, feedback and continuous monitoring for staff and students is required. To begin the reflective writing sequence, students must, however, "set the scene" by retelling

events. The majority of students effectively retell events and can add some key reflective phrases of "I learned ...", "I felt ..." and "I thought ...", but to achieve true reflective writing students must be able to critically analyse, state opinions and apply new understandings. This skill, as much as any technical competencies, must be demonstrated to the students and avenues for constructive feedback found. Deep reflection is not a skill that comes easily to most first year students, particularly those in engineering and surveying disciplines. The results from the introduction of the comprehensive reflective writing guide for staff and students and appropriate staff training provide another step in the process of helping students to be independent and lifelong learners.

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