Assessment for Practice Oriented Education

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Abstract

Assessment drives learning. The change to practice oriented education requires not only a curriculum and delivery style change, but a total rethink of the assessment practices. Practice oriented learning, assessed by traditional methods, runs the risk of driving students back to traditional ways of thinking and learning. Traditional assessment methods typically include team based project reports, assignments and examinations. Assessment methods should demonstrate meaningful learning and understanding rather than rote learning and regurgitation. Practice oriented learning should encourage reflection and integration of theory with practice. It is vitally important then that assessment techniques and instruments should also encourage reflection and integration.

As the engineering faculty at Central Queensland University made the transition from a traditional lecture based program to a project based, co-operative education program, many of the assessment problems arose from the fact that the learning experience (the project) was also the assessment tool. It was recognized that in the practice oriented approach to learning, that the freedom to make mistakes, and learn from those mistakes, leading to reflective practice, must be one of the great advantages. However, while being traditionally assessed, students were afraid to take risks and make mistakes, because the assessment penalized them for this. It became vital to decouple the learning experiences from the assessment tools. In other words, the students needed to learn through projects, but not ultimately be summatively assessed on them.

A system of portfolio assessment, including reflective journals has been introduced to project based courses, as the sole summative assessment tool, in the engineering degree at Central Queensland University. This was done to focus students on the necessity to specifically address the course learning outcomes as the criteria for demonstrating satisfactory achievement. The responsibility is on the student to document and demonstrate how, and to what extent, they have met the learning outcomes of a course. The reflective journal is an important tool to encourage and allow students to progressively and reiteratively reflect on their learning and personal and professional development.

The paper will discuss how the assessment style was introduced, and the issues that arose.

Introduction

The focus for the engineering faculty at Central Queensland University, and its predecessor institutions since its inception in 1967, was the design, development and

delivery of engineering programs to specifically meet the engineering practice needs of the Central Queensland region of Australia. This region is the node for the planning, design, operation and maintenance of a number of industries, particularly the state rail system, power industry and coal and other minerals extraction and processing heavy industries.

Central Queensland University's traditionally delivered and assessed Bachelor of Engineering by 1993 had been established as a well regarded professional engineering program and well supported, with its graduates primarily employed in professional engineering practice in the region's industries. Graduates of the program were considered by industry as being at least equivalent (and by most better) to any other graduates in the state in terms of their practical capability and appropriateness for professional employment. The programs were fully accredited by the peak professional body, the Institution of Engineers, Australia in 1992.

Background

To better serve the needs of particularly the local, but also wider state industries and employers in broadening and deepening the graduates' engineering practice knowledge and skills, through their immersion in engineering professional practice, a review was conducted in 1992/3. This review included an extensive investigation nationally and internationally of co-operative education models. The outcome was a proposal in 1993 to introduce Co-operative Education into the professional Bachelor of Engineering program in 1994.

Co-operative Education
The 1994 Co-operative Education Bachelor of Engineering program structure is detailed in Table 1 below.

Table 1 – General Structure of Co-operative Education Engineering program

March – June	July - October
Term 1	Term 2
Term 3	Term 4
Work Placement 1	Term 5
Term 6	Work Placement 2
Term 7	

It was accepted that there would be valuable student learning contributing to the acquisition of professional practice knowledge and skills during the co-operative education work placements, and that students would be formally enrolled in 'Work Placement' with assessable requirements, and study external courses. The distance education courses to be studied had additional benefits, encouraging students to appreciate more the necessity for them to engage in, and develop, lifelong learning skills and attitudes. (Jancauskas, Edwards 1997).

Socio-technically Focussed Program Review
Whilst the introduction of Co-operative Education addressed the major issues that had been identified in the faculty it also introduced its own problems. The problems were

based around the fact that the new BEng(Co-op) program simply used the existing traditional academic elements of BEng program without any curriculum or pedagogical review.

A major philosophical review of the professional engineering program commenced in 1994, in parallel with the introduction of the Co-operative Education program. The goal of this review was to develop a professional engineering program based around the co-operative education concept, and addressing the issues that had been identified. During this review period a national study was also being undertaken by the Institution of Engineers, Australia (IEAust 1996), culminating in a report calling for significant change in how engineering programs in Australia were expected to prepare students as professional engineers.

The Faculty conducted the review in 1996 of the Bachelor of Engineering program in an endeavour to specifically address issues including:

- concerns articulated by employers in general, that engineering graduates were not being properly prepared for the modern workforce
- graduates were deemed to be specifically lacking generic skills such as problem solving, creativity, communication and teamwork.
- assertions that the program was overloaded with technical content, and contact hours (e.g. 29 hours of weekly contact)
- 100% employment of graduates, but no guarantee that the program was delivering what employers needed.
- high attrition rates, especially from the first year of the program was too high. (up to 50%)
- little motivation or enthusiasm for their study with a further three years of 'grind' in front of them. .
- 'tick-a-box' perception of the degree that students were acquiring.
- rare requirement to integrate or utilise material until students graduated and became employed.
- style of student learning was shallow and superficial – apparently minimal retention or understanding.
- course material was taught in isolation and rarely in context.
- vacation work (8 – 10 weeks time period) did not give students or employers enough time to have the students fit in and take on a role of importance
- little opportunity to apply any of their academic learning in the workplace prior to graduation.

The outcome of this faculty review, detailed in (Howard, Jorgensen 2005), was the introduction in 1998 of Project Based Learning (PBL) in conjunction with Co-operative Education.

It was also expected that PBL would better prepare students for their work placements and ultimately professional employment. PBL was also a recognition of the need to respond to significant social changes evident in the Australian engineering profession, especially in the context of sustainability, that graduates needed to be aware of and attuned to.

Project Based Learning (PBL)

The CQU PBL Bachelor of Engineering (Co-op) program was established in 1998, on an overall nominal 50% PBL basis, where half of each term's student load is a single project based course. This structure can be seen in the Table 2 below.

Table 2. PBL Bachelor of Engineering (Co-op) Program Structure (1998)

YEAR	TERM 1	TERM 2
1	Lecture Based Course	Lecture Based Course
	Lecture Based Course	Lecture Based Course
	Project Based Course	Project Based Course
2	Lecture Based Course	Lecture Based Course
	Lecture Based Course	Lecture Based Course
	Project Based Course	Project Based Course
3	Work Experience – Industry Placement & one External Study course	Lecture Based Course
		Lecture Based Course
		Project Based Course
4	Lecture Based Course	Work Experience – Industry Placement & one External Study course
	Lecture Based Course	
	Project Based Course	
5	Lecture Based Course	Graduation
	Lecture Based Course	
	Project Based Course	

Each project based course comprises 50% of the term's offering and twice the 'value' of 'normal' courses.

The curriculum is vertically integrated and partially inverted to allow the generic professional skills to be developed throughout the entire program. The first year of the PBL element of the program comprised two generic professional practice oriented courses, with minimal technical focus, but a specific emphasis on teamworking, communication and professionalism. These first year courses first offered in 1998 are designated: Engineering Skills I and Engineering Skills II. (Jorgensen, Howard 2005). Later year PBL courses would focus on the development and integration of technical and generic professional knowledge and skills.

The first year of the PBL program delivery (Engineering Skills I and II) in 1998 saw many positive outcomes, and was considered a success by the faculty, in terms of student achievement. The major positive outcomes were observed as being the effective team and communication skills that were developed by students and their demonstrated active and independent learning, and a thirst for more knowledge. The students were able to identify what they needed to know, what they did not know, and

were able and willing to search out the information for themselves. Their report writing and oral presentation skills were also at a higher level than many of the students in the higher level of the old traditional program. This was accompanied by an appreciably increased retention rate. However, by the end of the first term, areas for improvement had been identified (Wolfs et al 1998).

Areas considered in need of improvement in the new first year PBL courses were identified by the facilitators involved in the teaching. However the facilitators did not rely only on their own observations to identify areas for improvement in the new courses. It was considered to be beneficial to have an independent review conducted. A visiting South African academic and engineering education authority, Dr. Jeffrey Jawitz, was commissioned to conduct an external evaluation (Jawitz 1998) of the first term course Engineering Skills I, in concert with the offering of the subsequent course Engineering Skills II . The evaluation was conducted in September 1998, during second term with a report submitted in December 1998. At this stage, the students and staff were well into the delivery of the second project course, Engineering Skills II, and could look back at the first course in its entirety as well as consider the delivery of Engineering Skills II.

The major problem areas identified by both the teaching team, and the review report (Jawitz 1998) were the lack of individual assessment within the team, and the inappropriateness of the assessment to ensure students' demonstration of meeting the learning objectives. These issues were addressed in a significant change in course assessment for the start of the 1999 academic year in the first year PBL courses.

Learning and Assessment Issues

The major problem areas identified related to tension between team and individual assessment, and effective assessment of all learning objectives.

Individual assessment within the team

The learning within the 1998 PBL courses was done completely within small teams, where the composition of these teams is changed from project to project. The projects have been designed so that the learning was done collaboratively within the team. Therefore the project outcome was dependant on the ability of the team to effectively work as a team. At that stage within the first year PBL courses, each team was assessed for each project. The individual student's pre moderation grade was simply an addition of each of their team project marks, to which an individual 'moderation factor' was applied. The moderation factor was based on peer assessment of an individual's participation, plus the facilitator's assessment of the individual's participation.

The project assessments were a traditional marking of a traditional, 'technical outcomes' focussed project report. This resulted in the mark being dependant on the success of the project in achieving a technical result. The mark was dependent on the teams technical success (or otherwise) in the project, as opposed to assessing the individuals learning that occurred within the project. This also negatively impacted on student learning as students took the safe and conservative approach looking for the often 'minimalist' 'right' answer rather than taking risks and developing innovative and creative solutions. Students believed if they 'got it wrong' it would impact

detrimentally on their results. This in itself was a hindrance in team process as there was little tolerance of students who were stronger in their command and usage of generic professional knowledge and skills than their technical knowledge and skills. It also encouraged those who were 'high fliers' to be even more independent and do everything by themselves and then complain that everyone else rode on their coattails and got the same good result they did.

There were varying degrees of acceptance from the facilitators in the subjective holistic approach of the moderation of team assessment into individual student grading. Some facilitators felt that they should change the assessment process to team reports with clearly identified individual input or chapters. However this process would have destroyed the aim of a team approach and collaborative learning. If individuals had responsibility only for a particular section of a report, there was no obligation or necessity for learning or understanding the sections that the rest of the team was preparing.

The facilitators were not the only ones concerned with the method of individual assessment. The review report indicated that some students were also uncomfortable. *"I realise the importance of teamwork and working in a group but this has been implied excessively as not one assignment has relied soully (sic) on the individual"* and *"If you are a very smart person in an average group you can only get the mark that the group earns which would be less than the one you could earn yourself*" (Jawitz 1998).

Appropriate assessment to meet the learning objectives

The learning objectives of the first year courses, while including technical objectives, also included professional generic skills such as the development of team skills, communication skills, and problem solving skills. The projects were used as a context for student learning, and consequently it was expected that learning would occur as part of the process of achieving the project goals. The faculty was confident, at the end of the first year of the program, that the learning objectives (both technical and professional generic) had been met, but felt that the assessment outcomes did not reflect the learning that had occurred. While the facilitation of learning had been transformed from a traditional style, the assessment items had remained traditional, in that they consisted of technical reports and oral presentations.

These traditional assessment tools can be useful for assessing technical knowledge, and skills such as verbal and written communication. However, these same tools do not effectively assess team working skills or interpersonal communication and other generic skills. The course included peer assessment of an individual's participation to be used by the facilitator in their subjective assessment, but this addressed participation levels only, not the degree of development of the required knowledge and skills.

Upon reviewing the final results, the facilitators were able to identify students, who by taking a domineering role within the team and acting more as individuals, had achieved high grades based mainly on technical skills. At the same time there were also students who had developed very strong team skills, but were not as strong technically, and had therefore received lower grades. The results did not satisfactorily reflect the achievement of the learning objectives. The facilitators required an assessment method

that would ensure that a high grade indicated high achievement in all the major learning objectives, and that students could be failed for not achieving the major learning objectives. This included the desire to fail students who had not developed and demonstrated acceptable standards in team work and communication, even if they had achieved a suitable technical proficiency.

Discussions within the faculty also identified the desire to be able to assess students on their demonstrated development of a professional attitude. This was increasingly important with the focus within the profession on social responsibility. This could be demonstrated by their commitment to ethics and sustainability.

Changes to Assessment

Changes for 1999

Initially only the first year courses had their assessment processes reviewed. The facilitators wanted to keep report writing, oral presentations and essays as part of the work required, but did not want the summative assessment based on these items. There was however the concern that if these items were not included in the summative assessment that students would choose not to complete them.

The real problem was that collaborative or cooperative learning, as used in our project based courses, is a means of learning not a method of assessment. While many educators are attempting to use collaborative and cooperative learning, and wish to use individual assessment after providing a collaborative or cooperative learning environment, the literature provided very little in the way of tried and true methods. A survey of methods (Lejk et al 1996) provided some possibilities together with information gleaned from a wide range of other sources. From this the facilitators were able to determine and select an assessment method they had not previously used, that appeared would address the problems encountered in assessing the new PBL courses. The method chosen was portfolio assessment. This decision was assisted by advice from colleagues from other faculties within the university and from outside the university who had previously used portfolio assessment.

Portfolio Assessment

Portfolio assessment is not new. It has been an important element, and in many cases the sole method of assessment for typically artistic, musical and creative endeavours such as painting, graphical design and musical composition for a considerable time. Portfolios provide a showcase of such a professional's work. Through the submission of portfolios, evidence through the collation of individual work over an extended period of time, could be tendered, that illustrated a person's knowledge, skills and aptitudes in the context of their professional practice. Whilst initially it was more generally regarded as simply a collection of (the best of) previous works, more appropriate for incorporation in, or in support of, a CV when applying for employment, in the educational context it is able to be much more dynamic. In the educational context, the focus of a student's portfolio must be on their performance and individual demonstration of their own learning and achievement of a course's learning outcomes or objectives. Portfolios are a vehicle to promote reflection and student centeredness

and responsibility, and their demonstration, for action learning and development (Paulson, Paulson, 1994)

The key features of portfolio assessment for project based learning generic professional skills courses that were identified initially, and in some cases subsequently, that made it attractive were:

- decoupling of learning experiences from the assessment tool
- 100% individual student assessment
- assessing the learning
- allowing a diversified range of documented evidence to be presented
- encouraging innovative and creative thinking and solutions
- encouraging risk taking and inquiry in learning and determining solutions
- learning within projects, not specifically their outcomes assessed
- student responsibility to demonstrate learning against specific learning objectives and grade criteria
- students determining themselves areas in need of improvement
- supporting holistic learning and practice
- self and peer assessment could be incorporated
- processes of learning could be measured and documented over the term
- individualistic approaches encouraged in demonstration
- promotion of active learning through reflection
- difficulty in plagiarising
- allows assessment at the end of the term, which is what the grade is meant to indicate, rather than a summation of developing knowledge and skills at various points in the term

Thus it was the portfolio assessment style that was decided upon, with a requirement for individuals to submit a compendium of work at the conclusion of the term. The portfolio is the only piece of work that will be assessed for the final grade. The portfolio was allowed to include any piece of work produced (individual or team) to demonstrate how the individual has met the learning objectives of the course. For team productions presented, it was required that individual students clearly define their specific contribution to and learning from this work. The only compulsory pieces of work initially required to be included in the portfolio were the personal reflective journal and peer assessment of all team members.

Reflective Journal

The student's Reflective Journal is a very important and key part of the portfolio for student learning, and ultimately its assessment. It is a valuable learning tool in its own right, as it contains a record of the student's learning and attempts to assimilate their learning into a context. It is required to be submitted at the end of term as part of the portfolio, as well as checked regularly throughout the the term.

Grading Criteria

Grades for the course were determined based on an individual's performance in demonstrating achievement of the learning objectives, instead of an addition of marks for each project. Students were notified of the following requirements for each grade.

High Distinction - individual student is able to use their learned knowledge and skills in a different context to that in which it was delivered. This will necessitate demonstration of *reflection* on their own work as a team member, *evaluation* of the decisions made within the projects in terms of what they have learned, and thereby *improvement* o*f* their decision making and team skills.

To achieve this grade the individual will display a professional attitude, which may be demonstrated by the *formulation* of a personal theory of team work that demonstrably drives their actions, and the *generation* of new approaches to dealing with team problems on the basis of learned principles and delivered content.

Distinction - individual student can consistently *apply* their learned knowledge and skills in a familiar context, and *recognise* good and poor approaches to team and project work - especially their own. They demonstrably *use* delivered content as a basis for team and project work *Reflection* and *evaluation* of their own work has demonstrated some improvement of decision making processes and team skills, but has resulted in the development of a professional attitude.

Credit - individual students understand the delivered content declaratively, in that they *know about* a reasonable amount of the delivered content, and demonstrate this by the ability to *discuss* delivered content meaningfully. In some instances they can apply learned knowledge and skills, but don't transfer it easily. Evidence of the development of a professional attitude is also a requirement for this grade.

Pass - individual student shows limited acquisition of learned knowledge and skills, and minimal attitudinal change, however there is evidence of reasonable *effort* towards the acquisition of knowledge and skills from the delivered content. This will be demonstrated by little evidence of more than a regurgitation of delivered content.

Fail - fundamental inability to demonstrate the acquisition of learned knowledge and skills, and/or an unprofessional attitude demonstrated by a lack of *effort/involvement* in the course.
(JGFEPS, 1999)

While as individual pieces of work, the project requirements are not graded, they must be handed in and considered acceptable by the facilitator, for the team members to be eligible to be graded at the end of the term. The feedback on the project submissions provides formative assessment for the students.

It was expected that an individual portfolio based on project team work would satisfy the need for individual assessment within a team, and would allow better assessment of all the learning objectives. Portfolio assessment was trialled for the courses Engineering Skills I and II in 1999. The reflective journal was a major part of that assessment.

Results of the Assessment Changes
There were several major identifiable results from the change to portfolio assessment.

- Demonstrated depth of learning

The fact that the portfolio required the students to demonstrate their level of understanding and growth throughout the term, meant that each student had to document their breadth and depth of learning to be awarded the grade.

- Students awareness of knowledge acquisition

  Students through the process of documenting and demonstrating their learning became aware of what they were capable of as an individual. They became aware of what they knew and didn't know.

- Attitudinal change – taking responsibility

  There was an attitudinal change in the students as they had to take individual responsibility for demonstrating their learning.

- Stress for Students

  The process did produce stress, as it was not something that they were used to. As the majority of the class had come straight from high school, they were typically used to, and relatively comfortable with exams. Taking responsibility for and identifying their strengths and weaknesses, and ultimately proving them, did prove stressful to begin with. Many students still wanted the facilitators to tell them exactly how to produce the portfolio.

- Stress for staff

  As the process was new for the staff as well, there was stress involved in encouraging the students to think about how they could demonstrate their learning, and not tell them exactly what to do.

The outcomes of the initial trials of portfolio assessment confirmed the experiences of others. In a student centred approach to teaching such as PBL, a student centred approach to assessment is also needed. It offers the students the benefit of being involved in the assessment process, as it is not teacher driven. In keeping with the trend toward student centred classrooms portfolio assessment is a shared responsibility' (Lankard Brown 1997). The author goes on to quote Willis as saying 'A good assessment model supports students' desire to learn rather than imposing a set of demands and expectations on them which will blight their intrinsic motivation'. Thus the student focus is to address course learning and demonstrate achievement through their portfolio documenting how Course Objectives/Learning Outcomes are met.

Further Development of Portfolio Assessment

The 1999 introduction of portfolio assessment was considered successful enough by the faculty that it was introduced in some of the later year PBL courses and further developed over the next two years. In 2002 portfolio assessment became compulsory in all PBL courses.

There are issues that make grading of portfolios difficult. Some of those issues include (Lankard Brown 1997):

- Portfolios with different pieces for assessment
- Lack of standardization in portfolio components
- Amount of assistance students receive
- Portfolios constructed of 'best pieces' – which don't indicate sustained levels of performance

Many of these issues were addressed in the further development of the portfolio assessment by the introduction of a number of work components. Examples of these are:

- Technical workbooks
- Design journals
- Graphics folios
- Skills audit tests
- Reflective essays
- Reflective journals
- Documentation of laboratory work

These work components form a bank of potential components that individual course coordinators can choose from when giving guidelines to students. The particular components chosen will depend in the type of course and the outcomes required. Some of these components are suggestions to students to help them to demonstrate their learning, while others may be compulsory items. The inclusion of these components was to address the problems that arose in the initial trial. In particular they allow students to demonstrate the development of knowledge and skills over the term, and provide some standardization of the portfolios. Inclusion of components such as design journals and technical workbooks ensure that the work presented is not just the 'best pieces'.

Professional Practice Assessment

The combined PBL/Co-operative education engineering program with its portfolio assessment of PBL courses provides a context for holistic student learning and practice, and an integrated learning environment. The professional practice knowledge and skills are acknowledged elements of the program, however they needed to be made explicit. In 2004 a dual award program, combining a Diploma of Professional Practice with the PBL Bachelor of Engineering (Co-operative Education) was introduced. This professional practice program expressly identified and enabled students to demonstrate, the acquisition of professional practice knowledge, skills and attitudes. This professional practice component of the dual award program, in concert with the PBL and Co-operative Education elements, ensured the students' preparation for, application of, and reflection on these professional practice skills.

With the success and acceptance of portfolio assessment in the PBL courses of the program, it became a natural extension to use portfolio assessment in the Professional Practice component of the dual award program.

Conclusion

Central Queensland University has developed an innovative, integrated professional practice oriented Bachelor of Engineering program, incorporating project based learning, co-operative education and specific development and recognition of professional practice skills. These elements all add up to ensure that the program as a whole, not just the work placement component, is practice oriented education.

It must be remembered though that the change to practice oriented education requires not only a curriculum and delivery style change, but a total rethink of the assessment practices. Practice oriented learning, assessed by traditional methods, runs the risk of driving students back to traditional ways of thinking and learning. Traditional assessment methods typically include team based project reports, assignments and examinations. Assessment techniques and instruments for practice oriented education should encourage reflection and integration of technical and generic professional skills, and the development of a professional attitude. A system of portfolio assessment, including reflective journals has been introduced to project based and professional practice courses, as the sole summative assessment tool, in the engineering degree at Central Queensland University.

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