Supporting Critical Reflection of Professional Practice Competencies within a Work-Integrated Learning Course

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BACKGROUND

The Industry Affiliates Program (IAP) is a Work-Integrated Learning (WiL) course which is available to students enrolled in degree programs within the Science, Environment, Engineering and Technology (SEET) group at Griffith University. The IAP course integrates both undergraduate and postgraduate students into the workplace by providing the opportunity for students to develop "work-ready" skills through the completion of an industry based project designed to deliver meaningful outcomes for both students and industry partners. Assessment includes both scholarly assessment based on the technical aspects of the project undertaken and critical reflection of the development of professional practice competency. The critical reflection of this competency has been implemented through a structured professional practice report, which has been modelled on the Engineers Australia Stage 2 competencies. The structured professional practice report asks students to explicitly address a set of defining activities, which form elements within the professional practice competency.

PURPOSE

The objectives of this research project are to i) identify the efficacy of the professional practice report as a means of assessing the students' development of their professional practice competency while undertaking their WiL project and; ii) investigate the effectiveness of the resources that have been provided to students in the preparation of the report.

DESIGN/METHOD

The research project included an anonymous survey questionnaire of engineering students who undertook the IAP course in semester 1, 2012, to investigate their perceptions of the assessment process related to the professional practice competency that students have been asked to describe. The survey questionnaire asked students to provide demographic information on themselves plus their responses to a set of eight (8) statements relating to their perceptions of the professional practice competency assessment item, using a five point Lickert type scale ranging from Strongly Disagree to Strongly Agree. The results of the data were statistically analysed to identify student perceptions of the professional practice competency assessment and the resources provided.

RESULTS

The project results have identified that the professional practice report is a valuable component of the IAP course assessment and that the structure of the report helped students to describe their professional practice competency. The students identified that the narrative style of the report and the template made it easy for them to reflect on this competency. However, there was no statistical significance between the responses reported from different demographic groups within the cohort, except for students with prior work experience who found the electronic resources more useful than those with less prior work experience. Also, students who undertook internal projects reported that the workshops were more useful than students who undertook an external industry project.

CONCLUSIONS

The current study has identified that the development of a professional practice competency by students within a WiL course is an essential component of the assessment process. Although engineering students find the production of the narrative within the professional practice report challenging, the structured nature of the elements and defining activities helped students in the identification and articulation of the professional practice competency they have developed as part of the IAP project.

KEYWORDS

Professional practice competencies, work-integrated learning, reflective practice.

Introduction

Higher education within engineering has traditionally been focussed on a class room based education paradigm that relies on building a basic and advanced knowledge base around discipline related areas of study. To support this educational approach, most engineering providers also require students to be exposed to practical laboratory and field applications, often through or in conjunction with a work experience component. In many cases this work experience component will form a compulsory requirement for accreditation of the degree program by a professional body such as Engineers Australia. However, Vest (2007) identifies that this 'traditional' approach to engineering education is relatively new and was the result of the "engineering science revolution" which originated at MIT from "...their experiences gained by developing radar systems during World War II". Over time this focus on "...engineering principles and analytical capabilities..." through a class room based education paradigm has meant that many academic staff have seen work-based education as not providing the same rigorous technical educational experience for the student.

Work-Integrated Learning (WiL) or Work Based Learning programs are increasingly being adopted across a range of educational programs within the Science, Environment, Engineering and Technology disciplines. Costley (2007) have identified that these programs have resulted from the move towards "...more knowledge-based or innovative economies" and they are more "...learner-centred and experience-led". Furthermore, students benefit from this educational approach as it requires more focus on "...self-direction of learning (rather) than being formally taught by teachers".

Critical reflection of a student's learning against defined competencies is seen as an important aspect of higher education in general and WiL programs in particular (Palmer, 2004 and Walker and Finney, 1999). Indeed it is this ability to be aware of one's own knowledge, skills and limitations within a professional context that makes a university graduate a desirable commodity for employers. However, engineering students and professional engineers are generally more comfortable with a science and mathematics based communication paradigm which focuses on quantitative skills (Batley, 1998 and Pinelli *et al.* 1995). This often makes it difficult for them to critically reflect on their own learning. This is further complicated by the nature of professional competencies which focus on professional skills, relationships and attitudes, rather than the technical domain which is the focus of most undergraduate assessment for these engineering students (Radcliffe, 2005, Shuman, Besterfield-Sacre and McGourty, 2005 and Walther and Radcliffe, 2007).

This study aims to investigate the efficacy of a professional practice report as a means of assessing the students' development of their professional practice competency while undertaking a WiL project. The paper describes a survey of engineering students who have undertaken a WiL project as part of the IAP course to identify their perceptions of the assessment task and the resources provided to help them undertake this assessment. The study has identified that the assessment of the professional practice competency is facilitated though the use of assessment criteria with clearly articulated levels of proficiency. It has also identified that engineering students require support through a structured reporting mechanism and examples of appropriate narrative styles as part of the reflection of their professional competencies.

Professional Competencies in IAP Course

Assessment in the course

The IAP is a WiL course which is available to students enrolled in degree programs within the SEET group at Griffith University. The IAP course integrates both undergraduate and postgraduate students into the workplace by providing the opportunity for students to develop 'work-ready' skills through the completion of an industry based project designed to deliver

meaningful outcomes for both students and industry partners. The emphasis is on both the academic and professional aspects of modern engineering, environmental studies, science and technology applications and practice within a professional work placement.

The course incorporates a major capstone project, which is designed to allow students to develop and demonstrate professional skills within their discipline of study. The projects undertaken range from applied research, through to the specification and/or prototyping of a product or process. Students undertake the project with an industry partner who provides supervision of the project within the industry environment. An academic advisor within the university provides academic leadership to the student for the successful completion of the industry based project.

Project placements can be with an external industry partner or with a research centre or academic staff member within the university. In general, the internal IAP projects tend to focus on the practical application of research within an engineering context, rather than theoretical research. Engineering students undertaking an internal project are also required to attend professional practice workshops and visit one of the industry partner work sites to facilitate their exposure to professional practice. The guest speakers at the professional practice workshops are engineers from external organisations who present discussions on working as an engineer in their organisation.

The course forms a core component within the undergraduate engineering, marine science and environmental management programs and is an elective course for the other degree programs within the group. The Bachelor of Engineering students undertake a full-time placement (5 days per week) for a full academic semester load. Students who are enrolled in other programs only undertake a half-time placement (2.5 days per week) and must complete two (2) other courses to complete their full academic semester load. The majority of students undertaking the IAP course are engineering students, with 205 enrolled during semester 1, 2012 and only 30 students enrolled from the three (3) other disciplines within the group.

Newman, Lilley and Crawford (2009) have identified a range of assessment types that would be considered appropriate for WiL courses. They note that assessing work placements is one way to ensure that placements are adequately distinguished "...from casual work experience". Therefore, the assessment in the IAP course includes both scholarly assessment based on the technical aspects of the project and assessment of the student's professional practice within the work placement. A summary of the assessment items adopted during semester 1, 2012 is shown in Table 1 along with their relative weighting towards the overall course mark.

Table 1: Assessment items within the IAP course

#	Assessment Item	Weighting
1	Project Planning Report	10%
2	Mid Semester Seminar Presentation	10%
3	Professional Practice Report	5%
4	Poster and Technical Defence at Project Expo	10%
5	Conduct or Program - Industry	10%
6	Final Project Report	55%

Assessing professional competencies

As part of the assessment of their professional practice, students are asked to critically reflect on the way in which they have met a set of professional competencies within a structured professional practice report. The professional competencies adopted are modelled on a selected set of the Stage 2 competencies described by Engineers Australia (2009). They have also been modified where appropriate to make them generic enough to be applied to all of the disciplines who undertake the course. As the IAP course is designed to allow students to develop beyond the university into the workplace, the professional practice report has been designed to help facilitate a pathway for the engineering students to begin their professional development towards these Stage 2 'Practice Competencies'.

The structured professional practice report requires students to demonstrate the way in which they have met the professional practice competencies, by addressing four (4) units. The first three (3) are core units which must be addressed by all students in the course. Students must also include one (1) unit that is to be selected from the six (6) elective units. This structure is similar to the Engineering Practice Report described by Engineers Australia (2009). Each unit includes a set of defining activities, which form elements within each professional practice competency unit. These defining activities provide a means by which the student can explicitly identify the way in which they have developed their professional practice competency while undertaking their WiL project. The three (3) core professional practice units include:
- Unit C1:   Professional Practice;
- Unit C2:   Self-Management in the Workplace; and
- Unit C3:   Research or Technical Development.

The four (4) elective professional practice units include:
- Unit E1:   Project Management;
- Unit E2:   Project Operations;
- Unit E3:   Environmental Management;
- Unit E4:   Investigation and Reporting;
- Unit E5:   Product or Process Development; and
- Unit E6   Workplace Health and Safety.

During semester 1, 2012, a trial of the structured professional practice report was adopted, which only required students to complete Unit C1: Professional Practice. The Professional Practice unit includes the following elements and defining activities:

C1.1   Presents and Develops a Professional Image.

    a.   Practises in a discipline within Science, Environmental Science or Management, Information and Communication Technology or Engineering as a significant part of normal work duties.

    b.   Demonstrates use of appropriate techniques and tools

    c.   Produces outcomes that require innovative thought and intellectual rigour.

    d.   Demonstrates an awareness of environmental / community / political issues.

C1.2   Integrates Practice with Other Professional Input.

    a.   Interacts with appropriate professionals and specialists to achieve agreed outcomes and develop broader knowledge.

    b.   Seeks a range of information sources to develop and strengthen project outcomes.

Offerings of the course in future semesters will see the enlargement of the report to include all four (4) units. This will also include an increase in the weighting of this assessment item

to 15% of the final mark for the course. As part of this change, the project planning report and the mid semester seminar presentation will be reduced in weighting to 5% each.

This professional competency unit requires the student to demonstrate that they have applied a professional approach to their work placement project. They are also asked to describe their awareness of community values and the way in which they have worked with other professionals while undertaking their WiL Project. Students are asked to address each of the defining activities with a narrative writing style, using the first person singular to describe their specific contribution. This narrative should emphasise the problems identified and the problem solving techniques utilised by the student as part of overcoming these problems. In particular the narrative should clearly identify:

- the student's personal contribution and responsibilities;
- the problems faced by the student;
- the solutions found by the student to address these problems;
- the professional judgements made by the student; and
- the impact the solutions and judgements made.

The professional practice report was marked using two separate assessment criteria. The first covered the structure of the written document and the effectiveness of the presentation, which included the organisation of the narrative as well as the spelling, grammar, writing style, clarity and appropriate use of diagrams and figures. The second criterion covered the overall level of competence demonstrated by the student. This criterion was measured against levels of proficiency adapted from those used within the CDIO syllabus at MIT, as presented by Armstrong (2007). These levels of proficiency were considered to be more appropriate for this professional competency than proficiencies based on the modified version of Bloom's taxonomy presented by Krathwohl (2002). The five (5) levels of achievement included:

- **Poor: (0% - 20%)** There is inadequate discussion provided which requires significant further development or no evidence has been provided.
- **Unsatisfactory: (20% - 40%)** The discussion demonstrates that the student has experienced or been exposed to the professional practice competency.
- **Satisfactory: (40% - 60%)** The discussion demonstrates that the student has been able to participate in and contribute to the professional practice competency.
- **Good: (60% - 80%)** The discussion demonstrates that the student has been able to understand and explain the professional practice competency.
- **Excellent: (80% - 100%)** The discussion demonstrates that the student has been skilled in the practice or implementation of the professional practice competency.

Methods

The efficacy of the professional practice report as a means of assessing the students' development of their professional practice competency was investigated using an anonymous survey questionnaire of engineering students. This was undertaken to investigate the students' perceptions of the assessment process related to the professional practice report assessment item and the professional practice competency that they were asked to describe in that report. This study forms a "cross-sectional, explanatory study", using the classification system for non-experimental quantitative education research described by Johnson (2001). The survey questionnaire was administered at the Project Expo, which was held at the completion of the course at the end of Semester 1 in 2012.

The survey questionnaire asked students to provide demographic information, including gender, English language, age category, estimated current level of academic achievement within their degree, amount of previous industry experience and location of their WiL project. Students were also given a set of eight (8) statements shown in Table 2, which relate to their perceptions of the assessment process for the professional practice report assessment item and the professional practice competency. They were asked to respond to these statements

using a five point "Lickert" type scale ranging from (1) **Strongly Disagree** to (5) **Strongly Agree**.

Students were advised that there was no right or wrong answer to the statements presented, and that their response would depend on their own perceptions. Participation in the anonymous survey was voluntary and students were advised that none of the collected data would identify them as participants. Furthermore, their decision whether or not to participate in the survey would in no way impact upon their relationship with the University, and they were free to withdraw from the study at any time. Each student response was analysed by determining the mean, median, standard deviation and distribution of the response scores for each of the statements identified in Table 2. The analysis also included the statistical assessment of the links between any of the demographic groups within the student respondents and the distribution of the responses provided.

Table 2: Details of the Student Survey Statements

#	Statement
1	The description of professional competencies through the professional practice report is a valuable component of the IAP course.
2	The structure of the professional practice report helped me to describe the professional competencies I developed during my IAP work placement.
3	The defining activities included within the report were appropriate for professional practice within my IAP work placement.
4	I found it easy to reflect on my professional competencies using the narrative writing style.
5	The professional practice report template helped me to address the assessment criteria for the professional practice report assessment item.
6	The narrative example helped me to successfully complete the professional practice report assessment item.
7	The information provided on the course web site was appropriate for me to successfully complete the professional practice report assessment item.
8	The information provided during the workshops was appropriate for me to successfully complete the professional practice report assessment item.

Outcomes of the Survey

Survey results

The questionnaire was administered to 215 students who attended the Project Expo, which included 192 engineering students. The remainder of the students were enrolled in different degree programs from across the SEET group. Although the Expo was held at the end of the semester after submission of their professional practice report, this was prior to the students receiving any marks or formal feedback on this assessment item. Responses were received from 72 of the engineering students, which represents a 37.5% response rate. There did not appear to be any gender bias in the response rate, with 19% of the respondents being female students, compared to 17% for the whole engineering student cohort. Students from an English as a Second Language (ESL) background represented 43% of the respondents, and 68% identified that they were less than 24 years of age. The distribution of respondents appears to be similar to the general engineering student

population, with 54% identifying that their Grade Point Average (GPA) was less than 5.0 on a 7 point scale. The students' industry experience prior to undertaking their WiL project was less than or equal to 12 months for 82% of the respondents, while 60% undertook their project with an industry partner which was external to the university.

Table 3 shows a breakdown of the responses to each of the statements shown in Table 2, including the mean and standard deviation of the response distribution. The median response for all of the statements was (4) **Agree**. There were 72 valid responses for all of the statements except for statements 5 and 6 which each had only 71 responses. Table 3 also shows a summary of the distribution of responses for each statement. The Standard Deviations were relatively high and were consistently in the range 0.93 to 1.15 for all of the statements. However, for each of the statements, more than 60% of the engineering students' responses were in the (4) **Agree** or (5) **Strongly Agree** range. Furthermore, less than 25% of the students' responses were in the (1) **Strongly Disagree** and (2) **Disagree** range. This indicates that the mean and median responses are representative of the overall feeling of the engineering student cohort to each of the statements presented.

Table 3: Summary of Student Responses

#	Mean Response	Standard Deviation	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1	3.60	0.938	3%	10%	26%	47%	14%
2	3.49	0.986	4%	15%	17%	56%	8%
3	3.51	0.972	3%	15%	21%	50%	11%
4	3.69	0.952	3%	8%	24%	47%	18%
5	3.62	1.03	6%	7%	24%	46%	17%
6	3.72	1.04	6%	7%	17%	51%	20%
7	3.71	0.949	1%	11%	22%	46%	19%
8	3.50	1.15	7%	17%	13%	47%	17%

Analysis of results and discussion

Analysis of student results in the professional practice report is beyond the scope of this current paper. However, anecdotal evidence from semester 1, 2012 indicates that the marks awarded to individual students for this assessment item correlate with their overall mark for the course. This may indicate that despite the relatively low weighting of this assessment item, the students' motivation for the preparation of this report matches that for their overall output for their IAP project. Students may also be motivated by the requirement to submit all assessment items to receive a pass grade in the course. These issues require further research to fully identify the motivational factors influencing students' involvement in the assessment process in WiL courses.

The responses from the overall population were compared to the demographic information for the student respondents. No statistically significant differences were found in the distribution of responses between any of the identified groups and the overall population for each of the statements, except for statements 7 and 8. The mean response from students who had undertaken more than 12 months work experience before starting their WiL project was 4.15 for statement 7, compared with a mean of 3.60 from students with less than 12 months experience. Students who undertook their WiL project placement with a university

research centre or academic staff member reported a mean response of 3.89 for statement 8, compared to a mean response of 3.27 for students who undertook their project placement with an external industry partner. The high response rate of the survey questionnaire, the apparent lack of gender bias in the responses and the similarity between the distribution in GPA for the respondents and the general engineering student population allows for the results to be confidently extrapolated to the general engineering student population. The results also suggest that except where previously identified, the responses to each of the statements is essentially the same regardless of the students' gender, English language background, age, GPA, prior industry experience or location of their WiL project placement.

Overall the students have recognised that the description of the professional practice competencies through the professional practice report is a valuable component of the IAP course and that the defining activities were appropriate for their work placement. They have also clearly identified that reflective assessment items such as the professional practice report must be scaffolded using appropriate examples of the expected writing style. This scaffolding also should include structured formats which allow the engineering students to develop their communication skills, which has been identified by Pinelli *et al.* (1993) as being very important for "...their professional success". In fact all of the resources provided were seen by the students as supporting their completion of this assessment item.

The demographic information identifies that although these resources are important, students with more professional experience find the web-based learning resources as being more useful. This may be because students with more experience within the work place will be more confident in their own abilities to undertake independent investigation using on-line sources than students who have relied on more passive teacher-led investigations through lectures and workshops. Students who undertook their project within the university also found the information provided through workshops was more useful than students who undertook their project with an external industry partner. No doubt this was because attendance at the university workshops is more difficult for students who are undertaking their work placement in a location remote from the campus. However, the differences in responses from these groups indicate that these issues require further research to help identify the motivational factors that affect the way in which students from different demographic groups engage with learning and teaching resources in WiL courses. This future research will facilitate the implementation of more effective learning and teaching practices in WiL courses.

The students' responses to statement 1 clearly show that the students feel the professional practice report is an 'authentic' assessment item as defined by Svinicki (2005), which should be based on activities that replicate the way a professional will perform within their professional environment. Biggs (1996) also note it is essential that the assessment items and the assessment criteria adopted are directly related to and align with the learning objectives for the course. Furthermore, Newman, Lilley and Crawford (2009) shows that assessment within WiL courses requires clearly articulated assessment criteria and should provide evidence of achievement by the student. The students' responses to statement 5 show that the structured professional practice report template helps them to address the criteria that have been set for this assessment item. The student survey has indicated that the trial version of the structured professional practice report can be confidently expanded to include all four (4) units of professional competence. However, this must be supported through appropriate on-line and workshop-based resources which provide example narratives that help the students address the assessment criteria.

Conclusions

This study has evaluated the student perceptions of the development of professional practice competencies through a structured professional practice report assessment item within a WiL course. The study has identified that development of a professional practice competency by students within a WiL course is an essential component of the assessment process.

Although engineering students find the production of the narrative within the report challenging, the structured nature of the elements and defining activities helped students in the identification and articulation of the professional practice competency developed as part of the IAP project. The student survey outcomes provide confidence that the full structured professional practice report can be implemented in future, as long as appropriate support is provided through workshops, on-line resources and example narratives.

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