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Calibrating engineering graduate capabilities against assessment tasks: a preliminary study

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***Abstract:** This paper investigated the connection between assessment tasks and graduate capabilities. Surveys conducted as part of this study revealed differences in planning for the development of, and student achievement of, graduate capabilities and that assessment tasks were valuable tools to guide and facilitate the development of intended graduate capabilities. Drawing from the obtained data, a prototype framework for curriculum design was proposed, allowing for better alignment of assessment tasks and graduate capability development in systematic subject design.*

Introduction

Generic outcomes of university educational experiences, now commonly referred to as graduate capabilities or attributes, were traditionally considered as ‘by-products’ of a technical and discipline-based training process. In the last decade, the steady increase in global demand for transferable professional skills (OECD 2004) has influenced universities around the world to renew their approach to the outcomes of a university education (Gibbons 1999). This paradigm shift has resulted in the formalization by universities of graduate capabilities as outcomes of university education.

Recent approaches to enhancing the outcomes of university education and preparing graduates for professional practice include the establishment of graduate capabilities by Australian universities. Although slightly different in format and presentation, most Australian universities have developed statements clearly outlining the core graduate capabilities they are targeting (Chanock et al. 2004). These include discipline specific graduate capabilities often stipulated by accreditation bodies (e.g., IEAust for engineering disciplines) and generic graduate capabilities such as communication skills, critical and reflecting thinking, team work (Hadgraft and Muir 2003; Chanock et al. 2004).

Government and other stakeholders of the higher education sector in Australia consider the formal recognition of graduate capabilities as a strategic tool to encourage universities to be more accountable for the extent to which they develop the necessary skills and knowledge for a chosen field of interest (Stone 2006) and for the global economy (DEST 2003). While almost all Australian universities have developed their own set of graduate capabilities, a recent study has found that interpretation of a university’s graduate capabilities by academics was vastly different in qualitative understandings of these capabilities (Barrie 2007). In addition, students’ understanding and awareness of graduate capabilities were quite poor (Barrie 2007).

It is also not clear, however, just how the means for students to achieve these graduate capabilities, and to evaluate their achievement, might be integrated into the curricula of Australian universities. A test to assess skills of graduates from selected Australian universities, the ‘Graduate Skill Assessment’ (GSA), was commissioned by the Department of Education Science and Training and was developed by the Australia Council for Educational Research (Chanock et al. 2004). The aims of GSA were to promote the formulation and implementation of graduate capabilities in universities around the country and to assess the skills level of their graduates. The trial revealed several major challenges associated with the assessment of graduate capabilities. Indeed, the Australian Vice-Chancellors’ Committee rejected the GSA as an unsuitable, unnecessary, and costly instrument for assessing what a

university education contributes to the development of the capabilities of graduates (Chanock et al. 2004).

Quality assurance frameworks to ensure the attainment of graduate capabilities are also lacking (Bath et al. 2004; Treleaven and Voola 2008). There is an implicit expectation that academics, who may or may not be aware of the graduate capabilities set out by their university, will deliver learning opportunities that will develop the intended graduate capabilities in students. Yet a recent study surfaced six qualitative differences in the way academics conceive of generic graduate attributes (Barrie 2007).

This study explores student perceptions of graduate capabilities in relation to a course intended to facilitate the development of specified generic graduate capabilities via assessment tasks. Surveys were conducted to ascertain students' views about their learning experience, particularly with respect to the connection between opportunities to develop graduate capabilities and the assessment tasks.

Background to the study

The Pollution Prevention and Cleaner Production course was a core 3rd year level subject of the environmental engineering program at the University of Wollongong (UOW). However, because no co- and pre-requisites were required, the subject was also taken as an elective by several students from other disciplines such as civil, mining and mechanical engineering. As a result, this subject provided an excellent platform for the development of an array of generic engineering graduate capabilities. The subject was designed to target eight out of the ten UOW engineering graduate capabilities, while ensuring the delivery of the technical subject contents as required by the Environmental Engineering program.

The UOW Engineering Graduate Capability Mapping framework, previously developed by University of Wollongong Engineering academics (Figure 1) was used as a framework to link each graduate capability with one or several specific learning and assessment activities. The capabilities were semi-qualitatively ranked from level 0 (not being addressed in this course) to level 3 (significantly addressed in the course) according to the extent of intended exposure (Table 1).

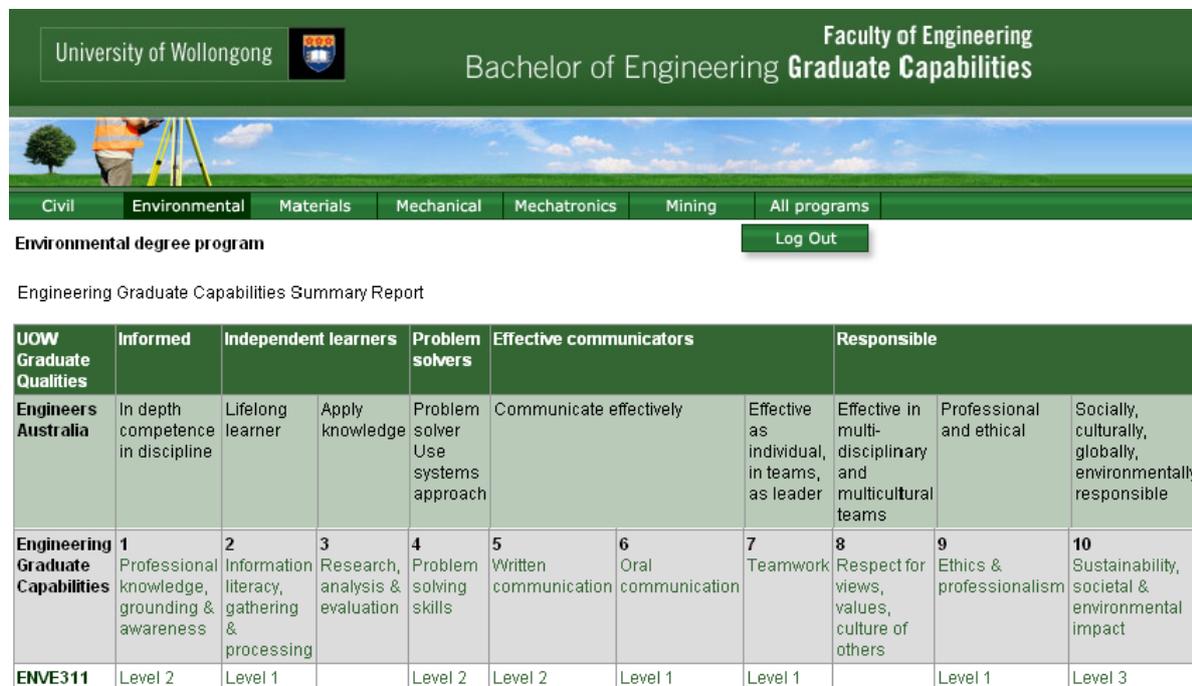


Figure 1: The UOW Engineering Graduate Capability Mapping Program (extracted from map of degree programs across engineering) and graduate capabilities to be developed in the Pollution Prevention and Cleaner Production (ENVE311) course.

Table 1: Graduate capabilities targeted in the subject and supporting learning/assessment activities

Graduate Capabilities	Examples of learning activities	Examples of assessment activities	Level of exposure
Professional knowledge, grounding & awareness	Lab exercise, field trip, in-class discussion	Lab report, field trip report, exams, tutorial assessment	2
Information literacy, gathering & processing	Group assignment	Group assignment assessment	1
Research analysis & evaluation			0
Problem solving skills	Tutorial, in-class discussion	Tutorial assessment, exams	2
Written communication		Lab, field trip, and assignment reports	2
Oral communication	Class seminar	Oral presentation	1
Teamwork	Group assignment	Group assignment	1
Respect for views, values, cultures of others			0
Ethics & professionalism	In-class discussion	Exams	1
Sustainability, societal & environmental impact	In-class discussion, tutorial, field trip	Exams, tutorial assessment, field trip reports	3

Research Methodology

The 39 students enrolled in the Pollution Prevention and Cleaner Production course were invited to participate in two anonymous surveys on a voluntary basis. A preliminary survey was conducted at the beginning of the semester (week 2) to gauge students' awareness of graduate capabilities. This was in the form of a minute paper consisting of one multiple choice and one open question. The preliminary survey was followed by a major survey which was conducted in the last week of the semester. This questionnaire took approximately 15 minutes to complete and can be divided to two parts:

- i. Part 1: The students were asked to indicate capabilities they felt they had opportunities to develop, and the extent of opportunity, ranging from level 0 (not at all) to level 3 (a lot). The students were also asked to indicate the most and least important graduate capability in their own view.
- ii. Part 2: The students were asked a series of questions concerning the effectiveness of assessment in assisting them to develop the specified graduate capabilities. They were asked to select one of five possible responses: Strongly disagree; Disagree; Neutral; Agree; and Strongly Agree. The responses were assigned an integer value ranging from - 2 for strongly disagree to + 2 for strongly agree to allow for a systematic representation of the obtained information.

Results and Discussion

Awareness of graduate capabilities

The preliminary survey conducted in this investigation revealed that more than half of the students being surveyed had no awareness of the Faculty graduate capabilities and the rest did not understand them well (Table 2). While the sample population used in this study was very small and data reported in Table 2 should be interpreted with caution, these results heighten a considerable gap in the knowledge and perceptions of students about graduate capabilities. This data supports the findings of Barrie (2007) that in their study students had little understanding of graduate capabilities.

Table 2: Students' awareness of the UOW Engineering Graduate Capabilities (Preliminary survey taken in week 2; Sample population = 39 students; Response rate = 72%)

How familiar are you with the UOW Engineering Graduate Capabilities?	Response
<i>I have not heard about them</i>	16
<i>I have heard about them, but I do not understand them well</i>	12
<i>I am aware and fully understand them</i>	0

Opportunities for graduate capability development

Eight graduate capabilities were targeted in the design of the Cleaner Production and Pollution Prevention course in this study. Student responses indicate that the perceived levels of exposure were mostly moderate (level 2). Figure 2 shows the extent of graduate capability development opportunities perceived by the students.

Figure 2 shows considerable discrepancy between the academic's expectation of student exposure to and the students' perceptions of the opportunity for graduate capability development. As can be seen in Figure 2, although two engineering graduate capabilities were not integrated into learning and assessment activities, students perceived an opportunity to develop them. For these capabilities (i.e. 'respect for views, values, culture of others' and 'research, analysis and evaluation'), students reported that they were able to realize opportunities to develop these capabilities at a moderate level (Figure 2). It is noteworthy that for the group assignment which was a major assessment task in this subject, the students were asked to form teams consisting of members from at least two different nationalities or ethnic backgrounds. Anecdotal information gathered after the survey revealed that some students regarded the interactions with people from a different background as an opportunity to learn and appreciate the views, values and cultures of others. In this case the use of mixed-culture learning groups supported the development of a particular graduate quality 'respect for views, values and culture of others' which had not been planned in the course design. In the case of the capability 'Research, analysis and evaluation' it is possible that students were referring to the capability 'gathering and processing information' conducted as part of their group assignment. Conversely, the capability 'sustainability, societal and environmental impact' which was planned for at level 3 (a lot) was reported by the students as level 2 (moderate) exposure.

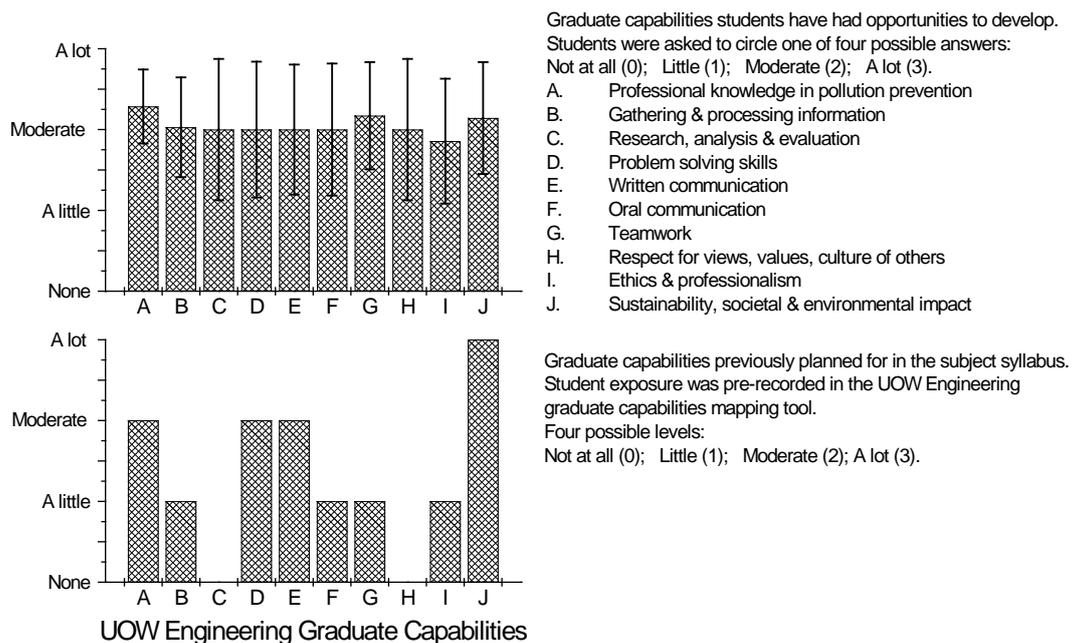


Figure 2: Opportunities for graduate capability development perceived by students (data taken last week of semester, top) and planned by academic (bottom). (Sample population = 39 students; Response rate = 97%. Error bars show standard deviation of all responses.)

These examples of the mismatch between the academic's expectation of student exposure to graduate capability development and the students' perceptions of the opportunity for the development of these capabilities suggest that (a) the opportunity to develop a graduate capability may be unintentionally present in curriculum design, and (b) may not be achieved by the student to the extent the academic has planned. The strength of using student perceptions is that it captures developments that were not intended by the curriculum, and expected or espoused by the teachers (Bath et al. 2004). These differences in awareness, interpretations and perceived achievements of graduate capabilities by both academics and students suggest the need for a framework to support academics in embedding the development and assessment of graduate capabilities into existing curricula.

Role of assessment planned for graduate capability development

In the selected course, assessment tasks were designed to support the development of specified graduate capabilities. All survey participants confirmed that “completing assessment tasks helped them to develop necessary graduate capabilities” with the overall response to this question ranging between ‘agree’ and ‘strongly agree’ (Figure 3). Similarly, most students agreed that assessment tasks were authentic and relevant to the engineering discipline. As a result, they were able to link these assessment tasks to the intended graduate capabilities. Such a clear connection between assessment and graduate capabilities would arguably allow for better understanding and appreciation of the skills being developed. Results reported in Figure 3 suggest that assessment tasks can play a pivotal role in initiating and guiding the development of intended graduate capabilities.

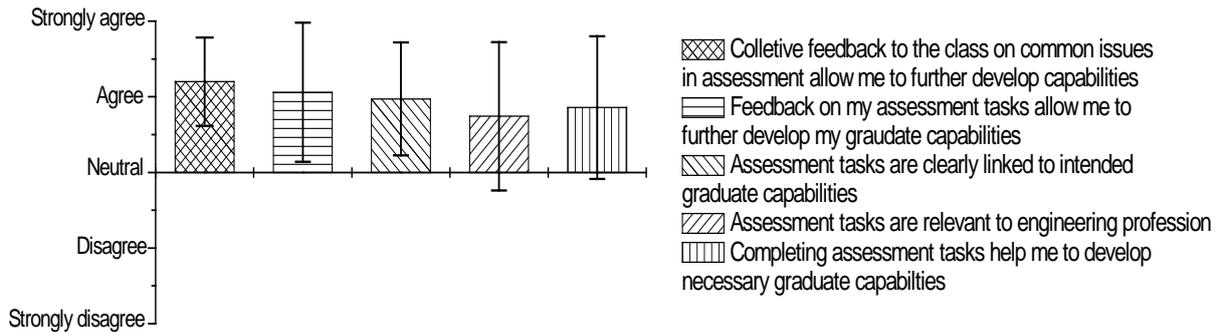


Figure 3: The role of assessment tasks in graduate capability development (Sample population = 39 students; Response rate = 97%. Error bars show standard deviation of all responses)

Feedback on the student’s assessment tasks as well as collective feedback to the class on common issues of the assessment tasks were also proven to be useful for the development of graduate capabilities. Results presented in Figure 3 clearly emphasize the significance of assessment tasks as a valuable navigating tool by the students to achieve not only the technical and discipline based knowledge but also the generic engineering graduate capabilities.

An ‘assessment task guided’ approach

The significance of assessment in the development of graduate capabilities suggests a need for an approach that can be used to embed the development of graduate capabilities in discipline based teaching. Such an approach would allow academics to integrate a range of learning and assessment tasks to facilitate the development of both technical (discipline based) knowledge and transferable engineering graduate capabilities into an existing course. From the procedures utilized in designing the course that is the subject of this study, and following Biggs (2003) principle of strategic alignment, a prototype conceptual framework ‘Assessment Guided Approach for Graduate Capabilities Development’ has been developed for the purpose of embedding the development of graduate capabilities into an existing course (Figure 4).

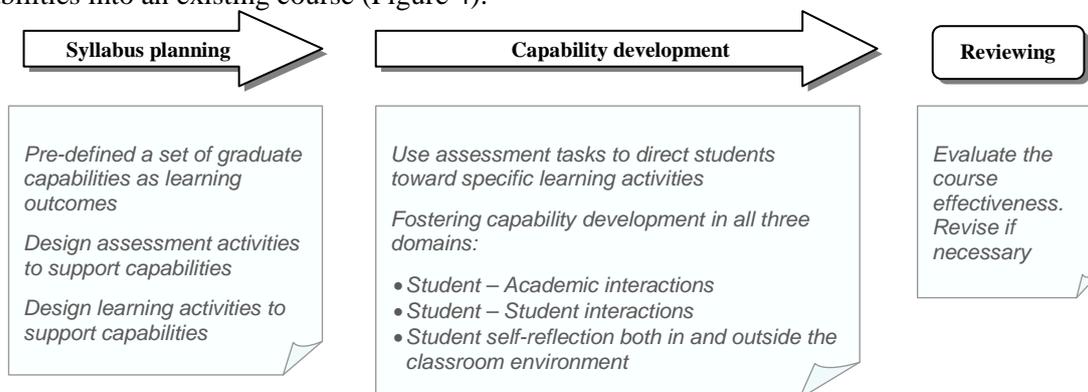


Figure 4: A proposed ‘Assessment Guided’ Approach for Graduate Capabilities Development

In this framework, assessment activities to support a set of pre-defined graduate capabilities are identified together with appropriate learning activities and assessment strategies. Assessment activities direct students towards the development of intended graduate capabilities providing students with

opportunities to develop graduate capabilities beyond the technical content of the subject. Learning activities are not restricted to student – academic interactions but also student – student interactions as well as self-reflection beyond the classroom environment. Although still at a preliminary stage of development, this approach has been proven to be particularly useful for the development of intended graduate capabilities.

Conclusion

This paper investigated the connection between assessment tasks and graduate capabilities. Two surveys were conducted as part of this study. Results reported here revealed that assessment tasks were valuable tools to guide and facilitate the development of intended graduate capabilities. It was shown that students responded positively to opportunities given by the academic to develop the necessary graduate capabilities. Results also show that the opportunity to develop a graduate capability may be unintentionally present in curriculum design. On the other hand, a planned opportunity may not be achieved by the student to the extent the academic has previously anticipated. In addition, results reported here also indicate that the academic's perception of student exposure to and development of graduate capabilities did not always match the students' perceptions. There is an urgent need for a framework to support academics in integrating the development and assessment of graduate capabilities into existing curricula. Such a framework can be used by universities to ensure a systematic implementation of their stated graduate capabilities. The prototype conceptual framework 'Assessment Guided Approach for Graduate Capabilities Development' used in this study will be further developed for the purpose of embedding the development of graduate capabilities into existing courses.

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