

## Increasing student engagement with graduate attributes \*

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**SUMMARY:** *It is widely recognised that there is a need to develop a range of generic graduate attributes in engineering students. In order to develop these attributes, universities have employed a number of strategies, including staff development and the adoption of non-traditional teaching methods. However, students also need to have a clear understanding of the meaning of the attributes and why they are important in a professional engineering context. Consequently, student engagement with graduate attributes is also an important factor in their successful development. In this paper, an efficient approach for achieving this is introduced and an example application presented. The proposed approach revolves around a classroom exercise as part of which groups of students discuss and rate the relevance of a set of graduate attributes from the perspective of a practising engineer, about whom they have been provided with relevant background information. Next, the ratings (relevancy scores) given to each of the attributes by the student groups are compared with those provided by the actual engineers, followed by discussion about any similarities and differences between the scores. In addition to increasing student engagement with graduate attributes and student understanding of their importance and relevance, this exercise also provides students with an insight into what “real” engineers do, and what students might expect to be doing once they graduate. Such an exercise was conducted during a single 50-minute tutorial session in the course Environmental Engineering II as part of the Civil & Structural and Civil & Environmental degree programs at the University of Adelaide. A student survey indicated that the exercise was successful in increasing student awareness of the existence of, the need for and the importance of graduate attributes, as well as helping students to gain a better understanding of their meaning.*

### 1 INTRODUCTION

The need to develop generic graduate attributes in engineering students is well documented (eg. Barrie, 2004; Hoban et al, 2004) and the explicit statement/articulation of which graduate attributes are being developed as part of degree programs and courses is now common place (eg. Bullen et al, 2004; Business/Higher Education Round Table, 2003; Nirmalakhandan & White, 2000). In order to ensure these attributes are being developed in students, there has been a focus on staff development (Scoufis, 2000) and the adoption of appropriate teaching approaches (eg. Hoban et al, 2004; Wellington & Clarke, 2004).

However, it is also important to ensure students engage with the concept of graduate attribute development, as student engagement is considered to enhance learning outcomes (Bowen, 2005; Carini et al, 2006; Cleary & Skaines, 2005). This is particularly important in the context of engineering education, as most engineering students dislike “soft” subjects and have an expectation that they will spend most of their time at university learning mathematical and technical skills (Trigwell & Yasukawa, 1999). One approach to engaging students is the use of e-Portfolios (eg. Sargison et al, 2005; Williams & Sher, 2004), which enable students to document which attributes they are developing throughout their studies (and beyond). An alternative is to provide students with the opportunity to reflect on and discuss the meaning, relevance and importance of graduate attributes. In order to achieve this, Zou et al (2004) used a workshop approach to enable students to identify which graduate attributes they consider to be important for their degree program,

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and to compare their responses with those provided by industry leaders and the University of New South Wales. In this paper, an alternative approach is presented, which is less time and resource intensive and can, therefore, be used in a single tutorial session.

## 2 PROPOSED APPROACH

The proposed approach revolves around a classroom exercise that has the following objectives:

1. To demonstrate the relevance and importance of the graduate attributes for a particular degree program or course.
2. To provide the opportunity for students to engage with, discuss and understand these graduate attributes.

As part of the exercise, groups of students discuss and rate the relevance of a set of graduate attributes from the perspective of a practising engineer, about whom they have been provided with relevant background information. This requires students to obtain an understanding of the meaning of the attributes and how they are relevant in a professional context. Next, the ratings (relevancy scores) given to each of the attributes by the student groups are compared with those provided by the actual engineers, followed by discussion about any similarities and differences between the scores. In addition to increasing student engagement with graduate attributes and student understanding of their importance and relevance, this exercise also provides students with an insight

into what "real" engineers do, and what the students might expect to be doing once they graduate.

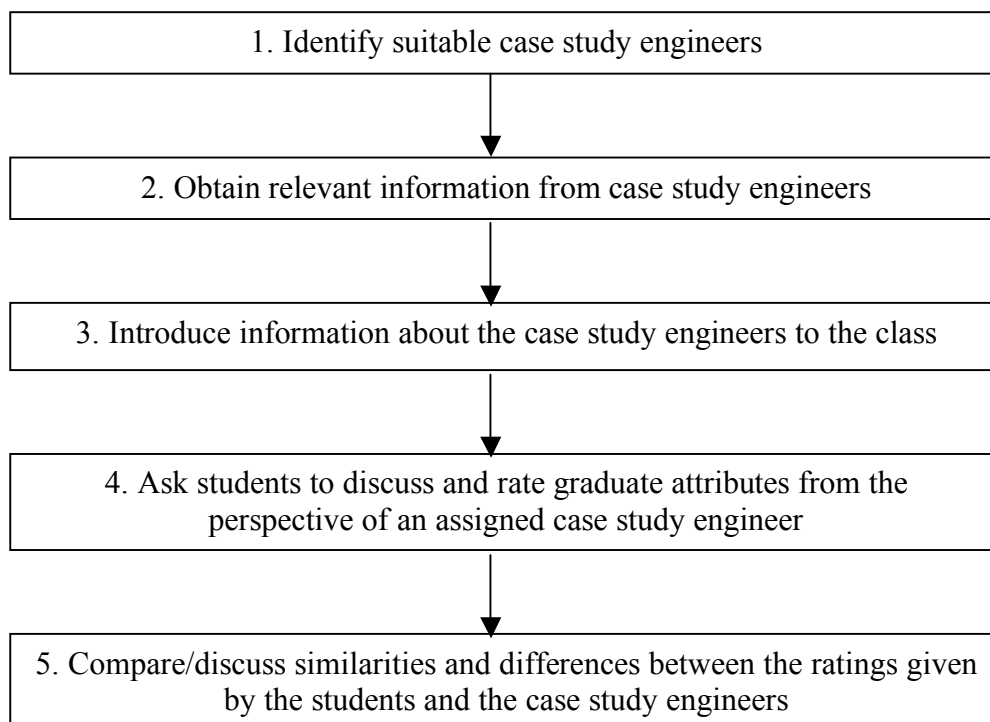
The steps that need to be followed to successfully implement the approach outlined above are summarised in figure 1 and described below.

### 2.1 Identify suitable case study engineers

Ideally, the case study engineers should be people the students can relate to, such as past graduates of the degree program(s) the students are currently enrolled in. In addition, the case study engineers should have different levels of experience and be involved in different types of engineering work (eg. design, construction, etc) to provide students with an insight into the variety of attributes needed by professional engineers and how the attributes are applied in different contexts.

### 2.2 Obtain relevant information from case study engineers

In order to conduct the classroom exercise, information is needed about each of the case study engineers in relation to their personal background, their professional life and how they rate the importance/relevance of each of the graduate attributes. This information can be obtained via the use of surveys or face-to-face/telephone interviews. Personal information, such as the engineers' names, where they have studied, what degree(s) they hold, what level of experience they have and what kind of work they do, is important to enable students to relate to



**Figure 1:** Steps in proposed approach.

each of the case study engineers. The use of photos also helps with regard to achieving this objective. Information about the case study engineers' professional life serves the dual purpose of giving students an insight into what "real" engineers do and of providing students with the background that will enable them to make an informed judgement about the relevance/importance of the graduate attributes from the perspective of the case study engineer they are considering. Finally, the engineers have to rate the relevance/importance of each of the course/program graduate attributes under consideration from their perspective. Ideally, each of the scores should be accompanied by a short description/explanation as to why a particular rating was given. This would be very useful to students, as it would provide them with an insight into why certain graduate attributes are important and how they are used in a professional context.

### **2.3 Introduce information about the case study engineers to the class**

As part of the classroom exercise, relevant information about the case study engineers needs to be presented to the class. As mentioned previously, this gives students an insight into the type of work professional engineers do, as well as providing them with the information required to rate the importance/relevance of the graduate attributes under consideration from the case study engineers' perspective.

### **2.4 Ask students to discuss and rate graduate attributes from the perspective of an assigned case study engineer**

As part of this step, small groups of students (three to five) are assigned to one of the case study engineers and asked to rate the relevance/importance of each of the graduate attributes, given their knowledge of the professional background of the case study engineer they are considering. This requires active student engagement with the attributes, as students have to have a good understanding of the meaning of the attributes in order to make an informed judgement in relation to the degree of relevance/importance of the attributes for the type of professional activities their case study engineer is involved with. It also requires students to make linkages between the attributes and how they are utilised in practice.

### **2.5 Compare / discuss similarities and differences between the ratings given by the students and the case study engineers**

Finally, the student responses are collated and compared with those provided by the case study engineers. This enables students to discuss any similarities and differences between their ratings and

those provided by the case study engineers, as well as the absolute values of the ratings for the various attributes. Insight can also be gained by discussions about differences between the ratings provided by student groups who considered the same case study engineers, as well as the differences in the ratings given to the same attributes by the different case study engineers. Such discussions increase the level of student engagement with and understanding of the attributes and how they are applicable in a professional context.

## **3 EXAMPLE IMPLEMENTATION**

### **3.1 Context**

The proposed approach was trialled in the second year course Environmental Engineering II for students taking the Civil & Structural and Civil & Environmental Engineering degree programs at the University of Adelaide. The number of students taking this course is typically between 55 and 80. The course provides an introduction to environmental systems, sustainable development, environmental decision-making, river regulation and rehabilitation, water quality in rivers and lakes, and air pollution. It also features the Mekong e-Sim (Maier & Baron, 2005; Maier et al, in press), which is an online roleplay simulation based on decision-making surrounding proposed engineering projects (eg. large hydropower dams) in the Mekong region of southeast Asia. As the e-Sim is focussed on developing a number of generic graduate attributes, rather than "hard" engineering content, this exercise is particularly important in highlighting the value and relevance of graduate attributes prior to students' participation in the e-Sim.

### **3.2 Case study engineers**

Three case study engineers were chosen – "Bob", "Emma" and "Grant" (the names of the case study engineers have been changed for the purposes of this paper). Two of the engineers (Bob and Grant) have similar levels of experience (15 years) and work primarily as project managers. The third engineer (Emma) has six years experience and works as an environmental engineer for a consulting company. This was considered to provide sufficient diversity in terms of gender, level of experience and type of work. Although a larger number of case studies would have been desirable from the point of view of exposing students to a greater diversity of professional engineering activities, it was considered that there was insufficient time within a single 50-minute session to discuss more than three case studies in at least some level of detail.

All three case study engineers have graduated from the same degree programs the Environmental

Engineering II students are enrolled in. This is likely to increase the level of relevance of and interest in the exercise, as the students are able to imagine that they could be in a similar position to the case study engineers being discussed some years down the track.

In order to obtain the required information from the three case study engineers, the survey shown in figure 2 was used. As can be seen, the questions

address the main requirements outlined previously, including personal information, information about current work and information about the graduate attribute ratings.

### 3.3 Classroom activity

The classroom activity was conducted as part of a single 50-minute session. At the beginning

*Questionnaire – What does an engineer do all day?*

**Name:**

**Company:**

**Question 1:** What is your job title and how long have you been doing it?

**Question 2:** Can you please briefly explain (< 40 words) what your job involves.

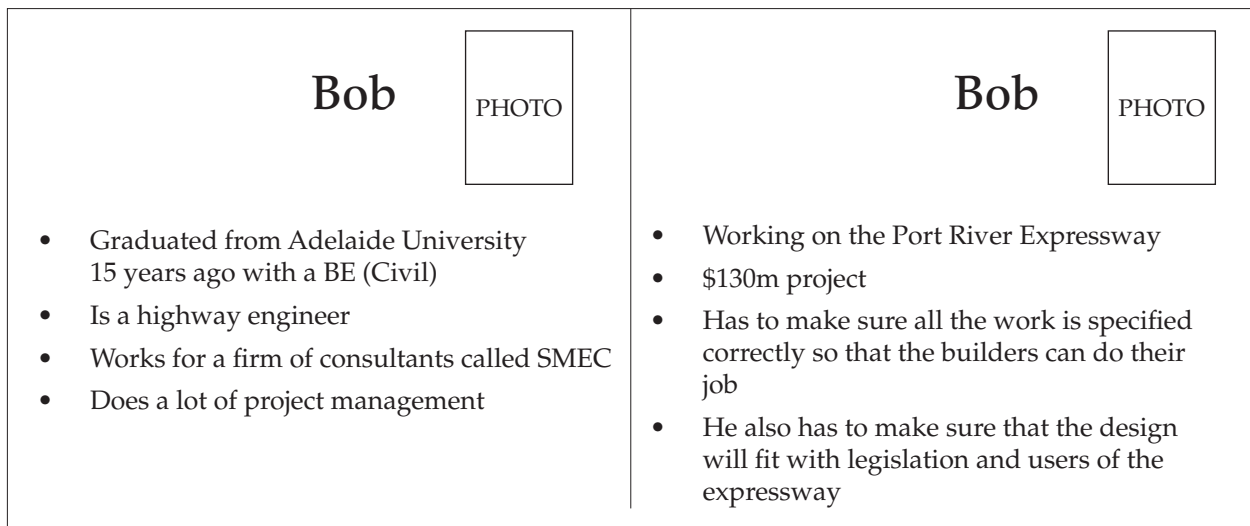
**Question 3:** Which university did you attend and what was the undergrad course you completed? How long was it since you graduated from your undergrad course?

**Question 4:** Have you done any postgraduate study since then? If yes, what course?

**Question 5:** The School of Civil and Environmental Engineering has a set of graduate attributes which are listed below. Can you score each one between 0 and 5 (0 don't need it, 5 couldn't possibly do the work without it) for usefulness to you in your role, or as qualities you'd look for when employing someone to do your job.

- competence in using computers and information technology effectively
- ability to apply an integrative or systems approach to solving engineering problems
- fluency in mathematical approaches used in the relevant engineering discipline
- awareness of uncertainty and recognising limitations of engineering approaches and systems
- awareness for the need for sustainable systems and principles of sustainable design
- awareness of the assessment and the management of risk
- competence in problem identification, formulation and solution
- competence in independent, critical and innovative thinking
- familiarity with project management skills
- awareness of business and financial management
- awareness of human resources management issues
- awareness of legal issues in relation to civil and environmental engineering.
- competence to adapt to a changing society (lifelong learning skills)
- ability to communicate effectively with others in the engineering profession and the community – written, oral and listening skills
- ability to manage effectively the allocation of time in performing tasks
- awareness of engineering ethics
- awareness of the social, cultural, political, international and environmental context of professional engineering practice.

**Figure 2:** Survey form used to obtain relevant background information.



**Figure 3:** Sample slides introducing case study engineers to class.

of the session, reference was made to the course graduate attributes listed in the students' course documentation. The importance of the attributes was stressed as an indicator of "what it takes to be a real engineer" and therefore as goals students should strive for. Next, the exercise was introduced, including the process that would be followed for the remainder of the session. Information about the three case study engineers was then provided by way of a brief powerpoint presentation (see figure 3 for sample slides). This included some personal details (eg. photo, level of experience), as well as a brief description of their professional activities.

Next, the students were asked to form small groups with people sitting adjacent to them and each of the groups was assigned one of the case study engineers. Each group then received a handout on their case study engineer, including some of the background information presented earlier and a list of the graduate attributes to be rated (see figure 4). The students then had the opportunity to rate the various attributes from the perspective of their case study engineer. This required the students to have a good understanding of the graduate attributes, and there was lively discussion amongst many of the groups as to what some of the attributes actually meant and how they would be applicable in the day to day professional activities of their case study engineer. Once all of the groups had completed the ratings exercise, the handouts were collected and the student responses were entered into a spreadsheet. The average of the student responses for a particular case study engineer were then compared with the responses provided by the actual engineer and any similarities and differences discussed. Finally, the scores provided by the various engineers were compared and possible reasons for different relative ratings of the attributes explored.

Overall, there was good agreement between the student predictions and the engineers' responses. Both students and engineers rated most of the

attributes highly, which is comforting from the perspective of the relevance of the attributes set down by the School of Civil & Environmental Engineering at the University of Adelaide. Some of the largest discrepancies occurred in relation to the importance of mathematical approaches, which were rated more highly by the students than the actual engineers. While many students had anticipated that generic skills, such as communication, time management, critical thinking and project management, were critical for the more senior engineers working in project management, they were surprised how highly these attributes were rated by Emma, who had only six years experience and was working as an environmental engineering consultant.

### 3.4 Evaluation

A survey was administered to the students immediately after they had completed the exercise in order to obtain feedback in relation to the perceived usefulness of the exercise. As part of the survey, the students were asked to respond to the following statements using a five-point Likert scale, with a response of 5 corresponding to strong agreement, 3 to a neutral response and 1 to strong disagreement.

1. The exercise has increased my awareness of the existence of graduate attributes in engineering degree programs.
2. The exercise has increased my awareness of the need for graduate attributes in engineering degree programs.
3. The exercise has increased my awareness of the importance of graduate attributes in engineering degree programs.
4. The exercise has helped me to gain a better understanding of the meaning of graduate attributes for engineering degree programs.

In addition, students had the opportunity to indicate

### What skills do you need to be an engineer?

#### Case study: Emma

Emma works for Arup, a international firm of engineering consultants, in their Adelaide office. Worldwide, Arup work on many diverse projects, however, they are best known for completing the structural engineering work on some of the worlds most famous buildings and bridges, such as the Sydney Opera House. In Adelaide, their expertise is in water infrastructure projects and environmental engineering of water systems Their clients include water utilities, private companies and government authorities in Australia and overseas.

Emma graduated from the University of Adelaide with an honours degree in Civil and Environmental Engineering and a Bachelor of Arts six years ago. The projects she works on range from consulting on wastewater, sustainable water use (reuse, recycling, etc), to things like environmental land management, risk analysis of projects on the environment and general sustainability assessment work.

How important do you think the graduate attributes listed below are to Emma in her job? Rate each attribute out of 5. 0 means she would never use it, 5 means she wouldn't be able to do her job without it.

- Competence in using computers and information technology effectively.
- Ability to apply an integrative or systems approach to solving engineering problems.
- Fluency in mathematical approaches used in the relevant engineering discipline.
- Awareness of uncertainty and recognising limitations of engineering approaches and systems.
- Awareness for the need for sustainable systems and principles of sustainable design.
- Awareness of the assessment and the management of risk.
- Competence in problem identification, formulation and solution.
- Competence in independent, critical and innovative thinking.
- Familiarity with project management skills.
- Awareness of business and financial management.
- Awareness of human resources management issues.
- Awareness of legal issues in relation to Civil and Environmental Engineering.
- Competence to adapt to a changing society (lifelong learning skills).
- Ability to communicate effectively with others in the engineering profession and the community – written, oral and listening skills.
- Ability to manage effectively the allocation of time in performing tasks.
- Awareness of engineering ethics.
- Awareness of the social, cultural, political, international and environmental context of professional engineering practice.

**Figure 4:** Student handouts.

whether they were surprised by any of the scores (either high or low) given to particular attributes by the actual engineers and, if so, provide written responses as to which attribute(s) and why.

Of the 63 responses received, there was a strong consensus overall that the exercise was useful, with broad agreement (responses 4 and 5) of 71%, 68%, 65% and 65% with statements 1, 2, 3 and 4, respectively. The majority of the remaining students

were unsure (ie. a neutral response), which might be due to insufficient time to reflect on the exercise. Very few students (1, 3, 2 and 2 of the 63 students surveyed in response to statements 1, 2, 3 and 4, respectively) disagreed or strongly disagreed with the statements. It should also be noted that some of the students in the neutral and broad disagreement categories took the opportunity to write on the survey forms that they were positive about the exercise, but that

because of the wording of the statements, they were unable to answer in the affirmative, as they were already familiar with the attributes and their meaning. The high positive response rate to the first statement also reinforces the importance of activities that try to engage students with graduate attributes, as most students were not even aware of the existence of graduate attributes, despite their inclusion in course outlines, the school website and the student handbook, for example.

The written responses revealed that almost half of the students surveyed (30 responses) were surprised that certain skills were rated lowly by the case study engineers, particularly in relation to a lack of use of mathematical skills. There were also some (7) responses expressing surprise at the relatively high rating of some of the attributes, particularly those related to teamwork, financial management, cultural and social issues, project management, communication skills and ethics. This is in agreement with Zou et al (2004), who found that the attributes considered important by the university, but not by the students, include those related to "an appreciation of and respect for diversity", "a capacity to contribute to and work within the international community" and "a respect for ethical practice and social responsibility".

#### 4 SUMMARY AND CONCLUSIONS

In this paper, a new approach for increasing student engagement with and understanding of graduate attributes is presented. The steps in the general approach are discussed and a case study implementation is presented. Student feedback from the trial implementation indicates that the approach was successful in increasing student awareness of the existence of, the need for and the importance of graduate attributes, as well as helping students to gain a better understanding of their meaning. However, evaluation of the approach has been limited thus far, and further evidence is needed in order to fully evaluate its benefits.

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