Designing and mapping a generic attributes curriculum for science undergraduate students: a faculty-wide collaborative project

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Introduction and background

Despite much emphasis in the recent literature (including a special issue of Higher Education Research and Development in 2004), the implementation of generic attributes curricula have been patchy, both within and between universities worldwide (Barrie 2006; Jones 2002; Drummond, Nixon and Wiltshire 1998). However, the benefits of explicitly incorporating generic graduate attributes into the undergraduate curriculum are widely recognised (see reviews by Barrie 2006; Jones 2002): the identification of generic graduate attributes should focus the planning, implementation and evaluation of curricula by faculties and schools so that teaching and learning strategies and assessment activities reflect a commitment to supporting students to achieve generic skills and capabilities, as well as discipline-related knowledge and skills. As a result, students will be better prepared for the workplace, having developed a broad range of capabilities such as problem-solving, critical evaluation and teamwork in addition to discipline-related expertise (Candy 2000).

Effective implementation of a graduate attributes curriculum has, however, been problematic. Leggett, Kinnear, Boyce, and Bennett (2004: p. 298) comment that 'an integrated cross-curriculum approach is essential'. Some science departments have taken an integrated approach to developing students' skills, particularly at first year level. For example, the University of Sydney's first year biology team (Peat, Taylor and Franklin 2005) led an exploration of how the science curriculum could be redesigned to enhance the life-long learning skills of graduates. However development at the faculty or university scale must be driven centrally. This was recognised by the Australian Technology Network (ATN) of five universities, who produced an extensive report on developing university-level programs for embedding what they term 'generic capabilities' into teaching (Bowden, Hart, King, Trigwell and Watts 2000). Murdoch University developed a 'web based graduate attribute mapping tool' as a component of a wider School Development Process, a strategic initiative designed to help Schools review and renew their undergraduate curriculum during the five-year cycle of School reviews (Lowe and Marshall 2004). Their Graduate Attribute Mapping Program (GAMP) facilitates mapping and reporting of where the seven attributes defined by Murdoch University are taught, and how they are aligned with learning objectives in individual units. The process is centrally managed by the University of Tasmania's Teaching and Learning Centre: once all units within a program have been mapped in consultation with teaching staff, a 'study pathway report' can be generated. This initiative appears to have been successful because it is supported by senior management and directly linked to formal school reviews. However Lowe and Marshall (2004) report that uptake and use by individual staff has been very limited, and present evidence that at least some staff saw the initiative as a burden imposed from above.

The Faculty of Science, Engineering and Technology (FSET) at the University of Tasmania is a diverse faculty teaching across fourteen disciplines in twelve schools. In 2004, the Bachelor of Science (BSc) degree coordinator developed a faculty policy on generic attributes (Dermoudy 2004). Development of that policy was informed by a mini-audit of the extent to which generic attributes were currently embedded into the BSc curriculum at the level of the discipline. Information provided

by the Heads of nine disciplines across eight Schools showed that, while there were pockets of good practice within some Schools, and within particular specialist degree programs, there was no systematic incorporation of generic attributes into teaching. This had obvious implications for students enrolled in the broadly based BSc degree course. In his policy paper, Dermoudy (2004) therefore recommended a coordinated approach to the mapping of generic attributes at a school and discipline level, with teaching embedded into units within the curriculum, and reinforced across the years of study – an embedded, incremental and iterative model.

The University of Tasmania has identified five Generic Graduate Attributes (GAs): 1. Knowledge; 2. Communication Skills; 3. Problem-solving Skills; 4. Global Perspective; and 5. Social Responsibility. For each attribute, the University has articulated a series of numbered exemplars. For example:

1.1 *Apply technical and information skills appropriate to their discipline or professional area* (Knowledge);

2.3 *Present well-reasoned arguments, using technology as appropriate* (Communication skills); and

5.4 *Demonstrate responsibility to the local community and society generally* (Social responsibility).

However, such broadly defined generic graduate attributes may fail to adequately capture what Bath et al. (2004: p. 314) describe as 'the vital disciplinary nuances of application that emerge when properly embedded graduate attributes development results in generic skills that are contextualised within the discipline'. Indeed, Bowden et al. (2000) consider that generic attributes have little meaning unless elaborated within the context of a discipline. How could the Faculty ensure, first, that all students are being given the opportunity to develop their generic skills to the levels expected of a university graduate, and second, that these generic attributes (GAs) are perceived as being relevant to their discipline?

Our project took a faculty-wide approach to mapping the teaching of GAs across the Schools contributing to the BSc. An initiative at the School of Music at the University of Queensland demonstrates the power of such an approach for improving students' learning outcomes (Bath, Smith, Stein and Swann 2004). That School went beyond the required mapping and embedding of their university's graduate attributes to an on-going cycle of review, reflection and renewal of their graduate attributes curriculum based on evidence from student and staff surveys. However, many of the perceived barriers to implementation of a generic attributes curriculum, such as questions of duplication of teaching, need to be addressed across programs rather than within disciplines. Our project aims were:

- to develop Faculty-specific exemplars for the University's GAs;
- to facilitate School-level reflection on how the University's GAs could be interpreted in a discipline-specific context, and thus,
- to develop discipline-specific exemplars of the generic GAs;
- to develop a GA curriculum for each discipline/major; and
- to map current teaching against that curriculum as a basis for curriculum review.

The project

Yates (2006) presented an introduction to our project and its scope. Here we report on the next stage of this action research project: implementation of a procedural approach to a policy position. Our approach combined the strategies recommended by the University with the policy and recommendations developed by the Faculty, and was informed by the literature showing that a discipline-focussed approach is most effective (e.g. Barrie 2006; Booth et al. 2000). As a starting point, we used the suite of resources developed by our university to support the integration of generic

attributes into the curriculum (University of Tasmania 2004). Using these resources as a model, the core project team developed a suite of tools (**Forms A, B, and C**) that may be used at school/discipline or degree level. First the 'Aspirations' of each discipline regarding the level of generic skills of their graduates are identified (**Form A**). Second, current teaching is mapped at unit level using **Form B**: this enables individual academics or schools to identify mis-matches between their 'aspirations' and current practice, providing a basis for curriculum review and development. Finally, **Form C** was designed to collate information about each unit taught within a program. It provides an overview of current teaching of GAs at the level of the major (i.e. within a school or discipline's teaching program).

Drummond et al. (1998), reviewing graduate attribute initiatives in the UK, noted that such initiatives are successful only when supported by an individual or group as committed champion(s). Understanding that the best way to improve practice is to involve people in the change process, we took a collegial approach to project design. There is strong evidence that such initiatives are most successful when implemented by a group who believe that such attributes represent valuable learning outcomes for their graduates (Barrie 2006; Sumsion and Goodfellow 2004). Academics are often resistant to change that is initiated outside the context of their own discipline, and a 'bottom-up" approach to curriculum innovation may be most effective (Thomas 2004). Elton (1999) comments that a successful change process depends on ownership of the process by the participants, and notes the importance of beginning with small groups of people and building up momentum. It was important, therefore, to ensure that teaching academics across our Faculty felt they had ownership of the project. We began by identifying School representatives who, ideally, had a history of interest in curriculum design, and then writing to Heads of School asking for their approval of their staff's involvement. These representatives undertook to attend our workshops, and to lead and champion the project at School level. We specifically targeted the Schools that teach into the generalist undergraduate degree, the Bachelor of Science (BSc), but invited all Schools to join the project.

Through a series of workshops, we worked with the School representatives to undertake:

1. Development and actioning of course/discipline-specific exemplars

This involved translation of the generic graduate attributes into discipline/course-specific statements. The discipline/course-related statements can be translated into curriculum 'actions': curriculum design, teaching and learning activities, and assessment.

Workshop 1: developing discipline-specific exemplars

At this three-hour workshop, the School representatives were introduced to the project's aims and scope. They then worked individually to compose discipline-specific exemplars matching each of the University's generic graduate attributes. There was a great deal of discussion about whether there were science-specific graduate attributes that were not covered by the University's GAs and GA exemplars. Some discipline-modified exemplars did closely match University exemplars, and were therefore assigned corresponding numbers to allow cross-referencing between the two sets of exemplars. Compare, for example:

1.7 Learn new skills and apply learning in new and unexpected situations (University exemplar)

1.7 Apply a knowledge of psychology to real life situations outside the classroom to gain a sound knowledge of human behaviour in different contexts (Psychology exemplar)

In contrast, several schools chose to add new exemplars specific to their discipline:

5.5 Develop awareness of occupational health and safety issues surrounding chemical laboratory work (Chemistry: addition to exemplars for Social responsibility)

1.9 Understand the standard scientific method and how to apply it in specific situations (Physics: addition to exemplars for Knowledge).

Following receipt of all School-based exemplars, the project team generated a common list of Faculty exemplars, numbered for easy cross-referencing to the University exemplars.

2. Course level generic attributes design: where do we want our graduates to be?

We next asked Schools to reflect upon and then describe their aspirations for a generic attributes curriculum for their discipline or course. This was an important step in the process as it provided a focus on the ultimate aim of the project. It included specifying at what level, and in which units, each attribute should be taught during each year of the course and, in broad terms, how they should be taught. This process uses **Form A: Degree-level Curricular aspirations**. This form was distributed to participants at the end of the first workshop, with a request that they take them back to their School and coordinate completion of the form for the major discipline(s) taught by the School. To further encourage a whole-of-school approach, the Heads of School were copied into all correspondence with School representatives, and asked for their explicit support of the project (positive support was forthcoming in all but one School).

3. Unit level mapping: where are we now?
This involved unit level mapping of intended learning outcomes against course level exemplar statements, to identify which attributes are currently being developed, and to what level of attainment (elementary, proficient or advanced) at each year level. This process uses **Form B: Unit Level Audit**: this form also allows mapping of whether each attribute is addressed in the learning outcomes for the unit, and to what extent it is explicitly taught and assessed.

Workshop 2: unit level mapping
At this two-hour workshop, we introduced the next stage of the project: auditing current teaching at unit level to determine a pass-level students' level of attainment for each exemplar within that unit. The School representatives also provided useful feedback that allowed us to further refine the design of Form B.

School-based meetings
School representatives were sent the modified Form B, cross-referenced to their discipline-specific exemplars. Their task was to distribute copies of Form B to all unit coordinators in their school, to coordinate completion of these forms for each unit taught by the School, and to return the completed forms to the project manager. Some representatives chose to do this with their School Teaching Committee; in other cases, a whole of school approach was taken. Where a school did not return forms by the indicated date, follow-up messages were sent to the representative and Head of School.

4. Course level generic attributes mapping: where are we now?
This involved identifying which GAs are currently being addressed within a School's teaching at the level of the major, and how each unit contributes to the attainment of GAs across the course curriculum. As a result of this mapping process, gaps, overlaps and/or omissions in GA development may be identified and addressed. This final process uses **Form C: Degree level mapping of Aspirations and Expectations**: this form collates the information for each unit which is detailed in Form B. This stage of the process was done for each School by the project manager; the completed Form C's were returned to the schools, to be used as a reference tool in future teaching development.

Table 1 shows a section of a completed Form C. Note that while there is generally a good match between current teaching of GAs and the School's aspirations for their graduates, the form indicates that some re-alignment of teaching is required before this goal is achieved. This process provides explicit data to each School on their current coverage of GAs in teaching, and illustrates how the project outcomes will feed into, and support, on-going teaching development.

Table 1. Section of a completed Form C for Zoology units: comparing current teaching of generic attributes with the School's aspirations for students at the end of each year of study. Entries are coded as: A= elementary; B = proficient; C = advanced level; N = not addressed in that unit. Blank columns indicate that this school does not use an exemplar matching that code number. Note that in at least one case (1.4), teaching needs to be re-designed so that teaching facilitates students meeting the aspirational level.

		1. Knowledge								
	Unit Code	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**
Year 1	KZA161	A	A	A	A		A	A		N
	KPZ163	A	A	A	A		A	A		A
Aspiration:		**A**	**A**	**A**	**B**		**A**	**A**		**A**
Year 2	KZA211	B	B	A	A		B	A		A
	KZA212	B	B	A	B		B	B		A
	KZA215	A	B	B	A		B	B		B
	KZA225	C	C	C	C		C	B		C
Aspiration:		**B**	**B**	**B**	**C**		**B**	**A**		

Project outcomes

This project took a whole-of-faculty approach to incorporation of generic attributes into teaching. We have achieved:

- identification of Faculty-wide exemplars for each generic graduate attribute;
- identification of discipline-specific exemplars for twelve Schools of the Faculty;
- facilitated the production of a generic attributes design for nine majors; and
- completed the mapping of current teaching of generic attributes for nine majors.

Of the remaining schools, two have expressed continuing interest in the project. One of these, Engineering, had previously completed a similar process within the context of their specialist degree program. However the School of Aquaculture, which had also carried out an extensive mapping exercise using the University's tools, did continue with the project, and did see added value in defining school-based exemplars (Burke, pers. comm.). Only one school within the Faculty opted out completely from the project, citing as the reason a very strong focus on discipline-specific content in their undergraduate teaching programs.

At the broader level, we have developed a resource package to facilitate incorporation of generic attributes within science, engineering and technology disciplines. This Users' Guide, including Forms A, B, and C, will be made available to all Schools within the Faculty. A major strength of this approach is that it allows users to better appreciate how all the units within a discipline mesh together to guide the learning of the GAs deemed relevant to students within that discipline. In the longer term, we anticipate its application to degree-level mapping of GAs in a form accessible to both staff and students. We acknowledge that at this stage of the project we have not yet considered the student voice. Leggett et al. (2004) showed that students of the School of Natural Sciences at Edith Cowan University perceived specific generic skills as more important as they moved through their degree, and that their rating of importance reflected the degree of emphasis on assessment of such skills. That research clearly highlights the need for explicit teaching and assessment of GAs within the science curriculum. Our approach will help to ensure a consistent quality of the student experience across our Faculty, encourage more overt discussions with students regarding the teaching and learning of GAs, and will facilitate reporting of learning outcomes as a 'study pathway' (sensu Lowe and Marshal

2004). In the next cycle of our project, we shall assess staff and student awareness of the GAs, and the degree to which teaching and learning strategies have been modified as the plans formulated during this project are realised.

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