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A WHOLE NEW BALL-GAME: GENERIC SKILLS IN AN ENGINEERING SCHOOL – ARE THEY TAUGHT, OR MERELY CAUGHT?

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ABSTRACT

This paper explores the self-reported changes in the perceptions of 13 engineering students over a semester-long course, *Communication, Technology and Science*, (CTS) in their degree program. The CTS curriculum builds awareness of students needs for a broad range of lifelong learning abilities through generic skill development in a professional engineering context, and includes opportunities for students to develop such skills.

INTRODUCTION

Griffith University, in common with all Australian universities, recognises the importance of lifelong learning for its students and graduates, and indeed, builds its mission statement on the centrality of lifelong learning to personal and professional development throughout life. Similarly, it is committed to the development of students' generic skills while at university and after graduation, with its sponsorship over a number of years of the Griffith Graduate Project[1] and the primacy given to its statement of graduate skills and attributes in its Strategic Plan (2003-2007):

> Griffith graduates will be known for their expertise and ability to apply their multi-disciplinary knowledge and skills in innovative ways to novel problems. They will possess high levels of skills in: oral and written communication; problem solving; analysis and critical evaluation; information literacy - and the ability to: undertake independent life-long learning; initiate and lead enterprises; work effectively as a member of a team; assume responsibility and make decisions; undertake employment or further study, nationally and internationally - combined with high ethical standards.

This paper will outline one of the ways in which the university's commitment to lifelong learning and generic skills development has taken hold in an engineering school which traditionally, and not unusually for the discipline, has eschewed such notions as "soft" and "irrelevant." It represents a case study of a teaching and learning innovation designed to demonstrate to students the importance of self-awareness, self-knowledge, and self-development by providing structured opportunities for self-monitoring and reflection.

[1] The Griffith Graduate Project is sponsored through the Vice-Chancellor's Strategic Development Fund and has run since 1999 at Griffith University.

THEORETICAL FRAMEWORK

A variety of reports have recognised the need for a broad set of skills in addition to discipline content knowledge for a graduate to be well placed in obtaining employment after graduation. The AC Nielsen Research Services (2000) report, "Employer Satisfaction with Graduate Skills", in particular notes the following, "skill deficiencies in new graduates: creativity and flair, oral business communication and problem solving." The report also cites employers' dissatisfaction with graduates' "communication skills, interpersonal skills and an understanding of business practice." Of particular interest to engineering faculties is the finding that "graduates of engineering are perceived to be poor in many skills, particularly at problem solving and oral business communications and interpersonal skills."

Engineers Australia is the accrediting body for all engineering programs in Australia, and in its 1996 *Review of Engineering Education* (Engineers Australia, 1996) it stated that engineering graduates, while needing a "sound base of mathematics and engineering technology" also must be equipped as communicators, with a broad understanding of, and ability to interact in the broader society in which their profession operates. Indeed, to maintain credibility as an engineer, one must be committed Carnevale's (1990) statement that "In today's workplace, learning is an integral part of every-day life. The skill of knowing how to learn, or learning to learn, is a must for every worker."

These requirements challenge the engineering profession, and it is particularly difficult to engender an understanding of this need in students whose typical and consistent response to classes involving oral or written communication is, "But I'm training to be an engineer. Why do I have to know how to write or speak?" Roman (2002) asserts that "poor communication skills is the Achille's heel of many engineers, both young and experienced – and it can even be a career showstopper. In fact, poor communication skills have probably claimed more casualties than corporate downsizing." As one engineering employer stated during research into graduate skills development in the Griffith Graduate Project:

> I told my English teacher, "I don't care, I'm going to be an engineer and I don't need English skills," and he told me "You'll see that there's a lot more English than Maths," and I can really vouch for that now! … [Universities need to] fix up their [students'] English skills before they get out. (Employer)

Surprisingly, another criticism leveled at engineering graduates, and often engineers in general, is that they have poor problem-solving skills. Briggs & Hodgson (2000) note that "the practicing engineer operates in an environment characterised by uncertainty, where the use of judgment in defining problems and establishing parameters for their solution is more important than the techniques to be used." This need for problem-solving skills, particularly for the engineer, is perhaps the skill that engineering schools believe they most successfully develop in their students with the discipline's heavy reliance on mathematical style thinking with its absolute and replicable results. However, little or no attention is paid to the broader skill of problem solving per se. Many, including Beder (2000), have placed the blame for this perception of engineering students on the fact that engineering is seen as having absolute, black or white, correct or incorrect answers and solutions. For a discipline based on mathematics and physics, this is not surprising and, in fact, technical solutions need to be well grounded in black and white maths and physics. However, as Beder (1999) further asserts, "In the business world, engineers are often seen as being preoccupied with technical issues to the exclusion of all else," and Bradshaw (1985) states that the possession of a degree, while indicating the ability to think at a certain level, is not of itself sufficient for the world of work.

As engineering students move through their academic experience, one would expect they should build an awareness of the generic skills required in professional practice. However, this is largely not the case, as noted by Harvey and Knight (as cited in Toohey, 1999). Academics generally agree with employers on the need for generic skills but they believe students will simply "catch" these skills as they move through university, not realising that unless they themselves place an overtly high value on, and formally "teach" skills, students will neither learn nor value such skills. Bowden, Hart, King, Trigwell, & Watts (n.d.) also comment that to avoid chance playing the major role in the acquisition of generic skills, their teaching should be "explicit rather than implicit".

Toohey's (1999) report on Boyatzys' study also emphasises the fact that the very skills valued by students' teachers, are the skills in which students show the greatest gains between entering and graduation. On the other hand, the skills which teachers did not overly value show little or no change.

BACKGROUND

The School of Microelectronic Engineering at Griffith University has a core course for students, *Communication, Technology and Society* (CTS), in its combined degree programs. This course is one of several within the program which raise students' awareness of a variety of issues related to professional engineering practice and is one of two which overtly address generic skills development. The learning objectives for this course were developed specifically to equip students for on-going, lifelong learning. However, it is the only course which clearly identifies and articulates the need for specific skill acquisition and the role of generic skills across a student's life. Across a semester timeframe, in the second semester of their second year (of a four-or five-year degree), students spend four contact hours per week in lectures, tutorials, and workshops. Lectures address the professional and ethical aspects of modern engineering. Tutorials provide students with opportunities to practise critical thinking, especially in relation to ethical issues, with all students participating in case study debates. Students are allocated to either side of the debate just minutes prior to the debate beginning, so they need to come prepared to argue both sides of an ethical dilemma. On the weeks when they do not participate in the debate, students submit a written list of arguments for both sides of the dilemma. In the workshops, students spend a two-hour session examining specific generic skills in a format that allows for the presentation of theory, real-world practice, debate and dialogue, and activities and simulations which provide opportunities to experience practical associations of the theory presented. Assessment connected to these workshops simulates a board meeting where students prepare for a specific role (e.g., engineer, manager, accountant, safety officer). Thirty minutes is devoted to a "board meeting" in which the students can engage in dialogue about an issue which may confront an engineering organization (for example) and reach a resolution regarding the issue's solution as a group. Students are then required to reflect and comment on the team and meeting processes. The style of teaching in this course specifically aims to respond to research that shows generic skills are "best developed by active approaches" (Moy, 1999, cited in Hager, Holland, & Beckett, 2002). It also responds to Callan (2003) by ensuring that assessment weighting emphasises to students the importance of skill acquisition. It is particularly important that the course provides this opportunity, as there is strong resistance to including generic skills assessment in the content-specific discipline courses in the rest of the degree. The method of teaching also responds to Bowden et al. (n.d.), Toohey (1999), and Boud, Cohen, & Walker (1993) in ensuring contextual variety, simulation of situation, the engagement of students in the process, and reflection. While ethics and communication are widely taught across the university and, of course, have their own specialty areas, it has been felt by the School of Microelectronic Engineering that its students need to be taught communication and ethics in an engineering-specific environment; a belief also held by Bowden, et al. (n.d.), who state that "the development of generic capabilities has little meaning until they are elaborated within the context of a discipline" and only take on "life and practical meaning when interpreted and elaborated within specific disciplines or fields of study."

METHODOLOGY

In Week 11 of second semester, 2003, 16 students completed elements of the Self-Assessment of Generic Capabilities (SAGC) prepared by Dr Alf Lizzio as part of the Griffith Graduate Project[2]. The SAGC measures students' perceptions across 14 domains of generic skills and abilities. An accompanying booklet succinctly describes each of the domains. After students have rated themselves on four subsets for each of the 14 domains, they then indicate the relevance of the 14 domains to three environments – their present course at university, their future work, and their personal interest in further developing the skill. The ranking of the subsets and domains are on a 7-point Likert scale, with 1 being *Not at all characteristic of me* and 7 being *Very characteristic of me*. Students were asked to mark the point on the Likert scale with a square

[2] This instrument can be accessed at: http://www.gu.edu.au/centre/gihe/griffith_graduate

box to indicate where they felt they were at the commencement of the semester, and to use a circle to rank their perceptions in this regard at the time of completing the survey.

The 14 domains in the survey are Interpersonal Skills, Self Management, Learning and Adaptability, Problem Solving, Conceptual and Analytical Skills, Oral Communication, Team and Group Skills, Information Literacy, Written Communication, Career and Vocational, Organisational Membership, Community and Citizenship, Personal Effectiveness, and Professional Effectiveness. Of the 16 survey responses, only one student ranked their perceptions at the commencement of semester. Two other students put the box and circle over identical numbers on the scale for each of the three environments in all 14 domains. These two students handed their survey in at the same time, so collusion is assumed. Hence 13 surveys were collated.

RESULTS

The survey was applied only once, towards the close of semester. Once the data from 13 surveys were collated, the following results were ranked by students' relative interest in further developing the skill at the time of the survey and the difference, or growth in awareness, between the two rankings. After 11 weeks of teaching, the survey results showed all domains to be more relevant to future work than to students' present course at university. This replicates the findings of Lizzio and Wilson's (2004) research. Results from the two surveys are shown in Table 1.

The most notable increases in awareness were in the domains of Interpersonal Skills, which had a 1.76 aggregate rise across the three environments; and in the need for Oral Communication and Written Communication in the future work environment. Another domain of interest is Information Literacy, which students ranked as being highest priority in the environment of present course (6.30) and future work (6.53), yet ranked at only 4.84 in interest in further developing the skill.

DISCUSSION

Two students from the class were asked to comment on the data and they gave their insights into the results. They noted that the highest ranked domain for further development at the close of semester was Personal Effectiveness and the second highest was Self Management, which they believed reflected the fact that they were most interested in developing skills that related to them as people, rather than as future workers. Brennan et al. (1993, as cited in Hager, 2002) note that there is a "demand amongst graduates themselves for a greater emphasis on a broader general education in those skill areas which can be seen to make for a 'competent person'."

Lizzio and Wilson's (2004) research argued that "the value students place on capabilities is the key factor in influencing their level of motivation for further development," and, furthermore, that "…students' perceptions of the relevance of capabilities to future work was the strongest predictor of levels of interest." In this study, while it was true in the domains of Self Management, Problem Solving, and Oral and Written Communication skills, it did not follow in the domain of Learning and Adaptability, which fell from equal first place in importance to future work, to 10th place in interest in further developing the skill. Information Literacy also fell from equal first to 14th, or last place in further developing the skill. Students' comments on this ranking showed that because they were studying to be engineers, the students were well aware of, and highly valued, information-literacy skills, but almost certainly, regardless of the description given about Information Literacy in the SAGC instrument, they perceived it to be largely to do with technology and, "being engineers after all," were already highly proficient in that domain. They also commented that while they could recognise the relative importance of Interpersonal Skills, both to present study and future work, it was perhaps the "personality," or nature of engineers which mitigated against them being interested in further developing those skills.

	How relevant you consider skill to doing well in your **present course** at university.			How relevant you consider skill will be in your **future work.**			How personally interested currently in **further developing** the skill.		
Skill	**Prior**	**Close**	*Diff*	**Prior**	**Close**	**Diff**	**Prior**	**Close**	**Diff**
Information Literacy	5.15	6.30	**1.15**	5.46	6.53	**1.07**	3.69	4.84	**1.15**
Community & Citizenship	3.46	4.15	**.69**	3.53	4.84	**1.31**	2.76	5.0	**2.24**
Interpersonal Skills	3.69	5.76	**2.07**	4.30	6.38	**2.08**	3.92	5.07	**1.15**
Oral Communication	3.84	5.30	**1.46**	3.92	6.23	**2.31**	4.0	5.15	**1.15**
Learning & Adaptability	4.76	6.07	**1.31**	5.23	6.53	**1.30**	4.76	5.38	**.62**
Conceptual & Analytical Skills	4.92	5.30	**.38**	4.84	5.92	**1.08**	4.53	5.46	**.93**
Career & Vocational	3.76	4.38	**.62**	5.15	6.0	**.85**	4.53	5.46	**.93**
Team & Group Skills	3.84	5.07	**1.23**	5.07	6.15	**1.08**	3.92	5.53	**1.61**
Organisational Membership	4.15	5.0	**.85**	5.15	6.23	**1.08**	4.15	5.53	**1.38**
Problem Solving	5.07	5.92	**.85**	5.84	6.53	**.69**	5.07	5.61	**.54**
Written Communication	4.53	6.15	**1.62**	4.15	6.23	**2.08**	4.23	5.61	**1.38**
Professional Effectiveness	4.15	5.38	**1.23**	5.30	5.84	**.54**	4.3	5.69	**1.39**
Self Management	5.0	5.76	**.76**	5.23	6.53	**1.3**	4.15	5.84	**1.69**
Personal Effectiveness	4.5	5.33	**.83**	5.16	5.83	**.67**	5.0	6.16	**1.16**
TOTAL – All skills	4.32	5.39	**1.07**	4.85	6.08	**1.23**	4.19	5.39	**1.20**

Table 1. Results from SAGC surveys conducted in 2003.

In commenting on the overall increase in awareness of the existence and importance of each of the domains, the students indicated that the hands-on, experiential methods of the tutorials and workshops were highly effective. As one of their assignments required them to examine the relevance of two, self-selected, generic skills to their future professional careers, the students noted that in investigating any of these skills, it soon became apparent that many of the skills were closely linked, reflecting the finding of Bowden, et al. (n.d.) that it is "difficult to differentiate, say, between teamwork, communication and problem solving in a real-life project. The idea of working with others to deal with a real situation necessarily implies all three." In reality, the different skills – while they can be looked at individually, "overlap and interweave like the threads in a carpet" (Hager, et al., 2002).

Students from the class had the opportunity, in a variety of ways, to comment on the relevance of the course structure and teaching methods. The two students who were interviewed while this paper was being written made comments; all students in the degree have an opportunity to rank and comment on the course at the end of each year of their study; and students who undertook the course in 2002 were specifically invited to give feedback. A mid-semester ranking in 2003 on the content of lectures and style of delivery gave a result of 9.02 on a scale of 1-10 (with 0.9 standard deviation).

Comments included,

> My first reaction to having to prepare for both sides of a debate was that it was unfair, but it forced me to look at both sides. It also prepared me better to argue for my preferred side because I was better able to rebut arguments for the other side of the debate.
>
> The hands-on experiential exercises we did in teams were effective. During the exercise I was able to relate them to the list of other skills.
>
> [I am now] very aware of the importance of generic skills and not to avoid them.

Comments on the effectiveness of workshop style of delivery included the following.

> I think the combined [workshop] format tended to bring the group closer together.
>
> Very effective as instead of listening to a lecturer ramble on while we sleep, we all became involved in conversation and discussion.
>
> I think it was very effective as we were more likely to come as if we didn't we missed both [lecture and tutorial] for the week.

CONCLUSION

This research showed a substantial increase in students' awareness of the relevance of generic skills in a one-semester period. This was as a result of their exposure to the overt teaching of, and emphasis given to, the need for the skills, and the interactive, experiential style of learning involved. Despite this course being one which most students perceive, prior to their involvement, as being irrelevant to their future careers as engineers, it received a ranking in 2003 of 8.5 on a scale of 1-10 for overall appreciation of the subject. Given that most engineering-content courses have little significant focus on generic skills development, this course has provided a mechanism to raise student awareness and skill levels, and to build their awareness of the "individual worth" placed on them by the university with "experiences that satisfy more than students' technical accomplishment" (Bowden, et al., n.d.*)*.

Some of the positive benefits from undertaking this course can be found in the words of students on completing the subject.

> I used to think that my job as an engineer would not involve much communication. I used to really fear oral presentations, but now I know how important communication is for an engineer, and I have a better understanding of its complexities.
>
> The best way for students to learn how to work effectively in teams is to work in teams to complete small tasks in a situation where there is little or no pressure. Basically, just like we have been doing in CTS …Investigating the different roles that people play within teams and seeing how teams can work both positively and negatively (as we have been doing during this course) an also help students to learn good teamwork.

As the SAGC survey was administered only once, close to the end of semester, it is intended that this survey will be replicated across a wider group of students, both at the beginning and end of semester in 2004. We anticipate that the methods adopted in this course will continue to attract high student ratings and to generate positive graduate outcomes, though it will only be possible to measure these longitudinally. As Fallows and Steven (2000) state,

> It is the adoption of innovative teaching methodologies which blend skills provision into the academic content which is perhaps the most exciting and likely to have the greatest long-term impact on teaching and learning.

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SUCCESSFUL STRATEGIES FOR CONTRIBUTING TO LIFELONG LEARNING IN REGIONAL, RURAL, AND REMOTE COMMUNITIES

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ABSTRACT

The ability to be a lifelong learner is a quality that the University of South Australia seeks to develop in its graduates. Its only regional campus also contributes to the lifelong learning of community groups outside the university through a range of initiatives providing expanded educational and networking opportunities.

INTRODUCTION

The University of South Australia is committed to developing in its graduates various generic qualities: the ability to operate with a body of professional knowledge, a commitment to lifelong learning, problem-solving ability, the ability to work individually and in teams, a commitment to ethical action and social responsibility, the ability to communicate effectively, and the possession of international perspectives (University of South Australia, 2001). Here we focus on the ability to be a lifelong learner and the development of this attribute in community members beyond the university.