Engineering students' perceptions of the importance of personal abilities in relation to career performance, and their perceptions of the extent to which their courses focus on personal abilities

Bruce Moulton, David Lowe

University of Technology, Sydney
bruce.moulton@uts.edu.au, david.lowe@uts.edu.au

Keywords

ability; career performance; cooperative education; internship

Abstract

Over the last decade the relationships between employers, governments and providers of higher education have changed. In Australia, legislation is now in place that enables accreditation authorities to require providers of higher education to demonstrate that they produce graduates that have 'graduate attributes' which include 'personal abilities'. If providers of higher education are to meet these goals, it is necessary to conduct research so that the effects of higher education on people's personal abilities can be better understood. This article presents findings from a pilot study of perceptions about the importance of personal abilities in relation to career performance, and the extent to which the course focuses on personal abilities. 613 students participated in the study, each belonging to one of five groups, each group drawn from a different stage of a course in Engineering at the University of Technology, Sydney. The participants answered eleven questions about the importance of personal abilities for career performance, and eleven questions about the focus of the course. Significant differences between the groups were seen in the responses to six of the twenty-two questions. While the findings indicate that there are group-differences in the participants' perceptions, the possibility the findings are confounded by demand or other characteristics associated with the method is considered. Implications of the findings and limitations of the method and measuring instrument are discussed.

Introduction

Examples of personal abilities are the ability to remain calm when under pressure, willingness to learn from mistakes and understanding personal strengths and limitations. Abilities such as these are highly valued in many professions, and some personal abilities are considered so important that professional accreditation bodies specify them as mandatory. The Engineers Australia (formerly called the Institution of Engineers Australia) National Generic Competency Standards stipulate that professional engineers must have attributes which include ‘manages own time and own processes’, ‘copes with change’, and ‘seeks and values input from internal and external sources’ (IEAust, 1999). These criteria are very similar to those of the Accreditation Board for Engineering and Technology in the USA (ABET 2002), and are indicative of a worldwide trend that has seen providers of higher education increasingly charged with the responsibility of ensuring that professional graduates have abilities such as these.

In the late 1980s, an implicit assumption that universities should equip graduates with the skills necessary for the workplace (an assumption which seems to disregard the responsibility of employers to provide workplace training) led to the formation of the (Australian) Senate Standing Committee on Employment, Education and Training to identify ‘priorities for reform in higher education’. The committee found that universities were producing ‘trained technicians’ whose education ‘does not provide the basis for adequate flexibility’ and who are ‘undereducated in the broader sense of the term’ (Aulich, 1990, p3). The findings of the committee were, perhaps not surprisingly, remarkably similar to those of overseas counterparts. In the United Kingdom, reports urged providers of higher education to accept ‘new realities’ concerning the relationship between higher education and employers (e.g. Harvey, Moon and Geall, 1997; Harvey, 1999). However, employers were less concerned about deficiencies in the knowledge-base of new graduate employees than they were about deficiencies in the generic skills of those new employees. Although the technological demands on new graduates were constantly increasing, employers primarily wanted graduates to be able to learn and apply new material in the workplace (Hesketh, 2000).

In an attempt to accommodate the new demands, many educators have sought to learn if and how such attributes can be understood, measured, assessed and developed. A study of University of Technology, Sydney engineering graduates who had been identified by their employers as ‘highly successful’ was recently undertaken as part of a quality assurance technique referred to as ‘backward mapping’ (Scott and Yates, 2002). In interpreting the findings it is necessary to consider whether personal attributes are developed most efficiently in the classroom, the workplace, or in other situations. John Dewey maintained that ‘education, in order to accomplish its ends, both for the individual learner and for society, must be based upon experience’ (1938, p89), thoughts which influenced the development of Constructivism (commonly attributed to Piaget and Vygotsky), Rogers’s (1961) Personal Thoughts on Teaching and Learning, Kolb’s (1984) model of Experiential Learning, and Mezirow’s (1991) Transformative Learning Theory. An appreciation of the relationship between learning and experience has frequently taken a significant role in the formation of work-based educational programs that are designed to develop professional expertise, variously known as work placement programs, sandwich courses, cooperative education or internships. The educational and professional benefits of work-based learning are strongly recognised in the Faculty of Engineering at UTS, where the vast majority of undergraduate engineering students undertake a combined degree of Bachelor of Engineering, Diploma in Engineering Practice. Students in the program undertake two six-month internships together with six internship-related academic subjects intended to enhance the internship learning experience.

Understanding the effects of internships on learning is an important issue for professions where competence is developed through internships—professions that include architecture, dentistry, education, engineering, law, medicine, nursing, psychology and sociology. Research aimed at furthering knowledge about work-based learning suggests that learning in the workplace is an invaluable part of the learning process (Lave and Wegner, 1991; Harvey Moon and Geall, 1997; Falconer and Pettigrew, 2003; Rowley 2003; Smith 2003; and Powell, Mayson and de Lange 2004). An interesting aspect of these studies is the proportion of learning that is attributed to sources other than the classroom. For example, an analysis by Baker (2004) of a study by Garth and Martin (1993) indicates law graduates reported law school was the primary source of only 25% of their total learning, whereas 75% was attributed to work-based sources. Such results imply that, compared to the workplace, the classroom is not as significant a source of learning as might be expected. Even so, whilst it is clear that both play a role, it is not clear what aspects of learning are best facilitated through each mechanism, which may make it difficult to develop programs that include classroom activities that complement and build on abilities gained at the workplace, and, perhaps to a lesser extent, workplace activities that complement and build on classroom activities.

One approach to understanding the effects of higher education on people's abilities is to longitudinally track how people's perceptions of their abilities change with time. This type of study is relatively resource intensive, as it requires respondents to be retested at different stages of their education. Notwithstanding this, assuming that the testing instrument has an acceptable level of test-retest reliability, the approach allows changes in perceptions to be tracked. Studies employing this approach are relatively rare, partly because it is often considerably more difficult to locate the same respondents on two or more occasions than it is to administer a test to respondents on a single occasion. However, if certain methodological constraints are taken into account, an alternative approach is to administer a questionnaire to different groups of students who are at different stages of their courses. An example is Duke's (2002) study, which compares marketing students from lower divisions of their courses with graduating seniors. Duke found that seniors perceived a comparatively higher importance for speaking in groups, applying the right tools to problems, identifying the relationships between problems, integrating multiple data sources, communicating electronically, comprehending the global environment, and conducting a business meeting. Less important for seniors were skills in explaining technical concepts and managing communication flows. Duke attributes these latter findings to the seniors' greater experience with these issues.

The test instrument used for the present study was adapted from the instrument developed in the backward mapping study of Scott and Yates (2002), which itself was based on a framework of professional capability (Scott, Yates and Wilson, 2001) founded on research into professional competence and expertise which includes that of Gardiner (1995), Goleman (1998), Gonczi, Hager and Oliver (1999), Harvey (2001), Morgan (1988), Schön (1983), Scott (1996, 1999) and Tennant (1991). The study conducted by Scott and Yates (2002) investigates five areas of professional engineering ability: emotional intelligence—personal, emotional intelligence—interpersonal, intellectual capability, profession-specific skills and knowledge, and generic skills and knowledge. Their survey has also been adapted for other purposes including studies of nurses (Scott, 2003a) and school principals (Scott, 2003b). Given this background and prior research, the objective of the present study was to trial the instrument's suitability for measuring changes in students' perceptions, over the duration of their course, of the importance of different personal abilities.

Method

In May and June 2004 approximately 700 UTS engineering students were given surveys to complete during class sessions. Each survey has 6 parts: personal abilities, interpersonal abilities, intellectual abilities, specific skills and knowledge, keeping university learning relevant, and a summary section. The part of the survey that was concerned with personal abilities included the following written instructions:

> *The following items seek your views on how important you believe a range of personal abilities will be in accounting for your successful performance in your early career as an Engineer. Then you are asked to rate the extent to which your current course is focusing on them. For each item please mark the box which best describes your rating for importance and focus. There is space below for you to comment on your ratings and add any other information you think would be helpful.*

Eleven statements followed. For each statement, survey participants were asked to provide two ratings, both on a scale of 1 to 5 (1 = low, 3 = medium, 5 = high). The first rating corresponded to 'importance of this for successful performance in my early career as an engineer', and the second corresponded to 'extent to which my current university course is focusing on this ability'. The eleven statements were:

1. Being willing to face and learn from my errors and listen openly to feedback
2. Understanding my personal strengths and limitations
3. Being confident to take calculated risks and take on new projects
4. Being able to remain calm under pressure or when things go wrong
5. Having the ability to defer judgement and not to jump in too quickly to resolve a problem
6. A willingness to persevere when things are not working out as anticipated
7. Wanting to produce as good a job as possible
8. Being willing to take responsibility for projects, including how they turn out
9. An ability to make a hard decision
10. A willingness to pitch in and undertake menial tasks when needed
11. Having a sense of humour and being able to keep work in perspective

While it is true that these questions are to some extent 'leading' and prone to response bias (in that respondents tend to give responses that they believe the researcher is looking for) and, as such, the questions are not suitable for providing absolute measures of, say, 'perception of the ability to remain calm under pressure', the purpose of the survey was to look at different perceptions between groups rather than absolute perceptions. Five groups of students were surveyed, each drawn from a different stage of the UTS Bachelor of Engineering course.

Results and discussion

A total of 613 surveys were returned by members of five different groups:

EfS 212 students enrolled in the subject *Engineering for Sustainability* – typically undertaken in the students' first stage[1] (first semester of first year).

[1] The standard UTS BEDipEngPrac course is comprised of eight academic stages (two per year) and two six-month internships.

EPP1 142 students enrolled in the subject *Engineering Practice Preview 1* which precedes the students' first 6-month internship – typically taken after stage 2 or 3.

EPR1 103 students enrolled in the subject *Engineering Practice Review 1* which follows the students' first 6-month internship, and is typically taken in stage 3 or 4. For many of the respondents, this is the first stage at which they have work experience, though a significant proportion of the students are mature age and, of these, many have previously spent significant time in the workplace.

EPP2 52 students enrolled in the subject *Engineering Practice Preview 2* which precedes the students' second 6-month internship – typically taken in stages 5 to 7.

EPR2 104 students enrolled in the subject *Engineering Practice Review 2* which follows the students' second 6-month internship – typically taken in stages 6 to 8. Students belonging to this group have completed at least 12 months of full-time work.

The responses are shown in Table 1.

Table 1. Responses to survey questions

Percentages of respondents nominating each rating (1=low, 3=med, 5=high)

Question 1

Item	*Importance to Career*						*Course focus on this*					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	1	0	9	15	75	210	4	7	40	18	30	207
EPP1	0	0	10	17	73	142	4	8	47	22	19	141
EPR1	0	1	13	25	61	100	6	13	47	20	13	98
EPP2	0	0	10	23	67	52	4	13	48	27	8	52
EPR2	0	2	11	24	63	103	11	19	42	18	10	100

Question 2

Item	*Importance to Career*						*Course focus on this*					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	1	1	22	23	53	209	11	13	45	17	14	207
EPP1	0	1	26	30	44	142	7	11	49	19	13	142
EPR1	0	2	25	37	36	100	10	14	42	27	7	98
EPP2	0	0	18	41	41	51	4	16	48	22	10	50
EPR2	0	0	18	33	49	103	10	14	47	16	13	100

Question 3

Item	*Importance to Career*						*Course focus on this*					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	2	4	24	26	44	207	9	14	45	16	16	205
EPP1	2	3	25	27	42	142	15	20	41	14	10	140
EPR1	0	1	28	41	30	96	6	22	51	16	4	94
EPP2	2	4	17	38	38	52	6	31	33	27	4	52
EPR2	0	3	28	29	39	102	15	16	49	14	7	96

Question 4

Item	*Importance to Career*						*Course focus on this*					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	2	2	19	21	56	210	18	20	34	13	14	205
EPP1	2	1	11	30	56	142	18	25	33	18	6	142
EPR1	1	0	19	25	55	96	13	18	45	16	8	93
EPP2	2	4	10	40	44	52	10	33	31	21	6	52
EPR2	1	4	21	26	48	102	21	21	32	11	14	99

Question 5

Item	*Importance to Career*						*Course focus on this*					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	3	2	34	24	36	207	9	16	46	13	17	200
EPP1	3	4	31	28	34	141	11	19	44	16	9	140
EPR1	1	7	26	35	32	98	8	20	48	18	6	96
EPP2	2	2	25	37	33	51	6	27	45	20	2	51
EPR2	0	0	32	34	34	103	18	16	47	9	9	98

Question 6

Item	*Importance to Career*						*Course focus on this*					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	3	2	21	29	45	205	12	15	44	16	13	202
EPP1	1	6	23	26	44	140	11	21	45	17	6	139
EPR1	1	1	25	42	31	97	9	13	48	22	8	96
EPP2	2	2	20	32	44	50	4	16	44	22	14	50
EPR2	0	1	23	32	44	100	11	12	48	19	9	97

Question 7

Item	*Importance to Career*						*Course focus on this*					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	2	1	7	15	75	210	4	8	26	24	38	205
EPP1	0	3	16	18	63	142	4	9	30	33	25	141
EPR1	0	1	10	27	62	99	1	5	35	24	35	97
EPP2	0	0	13	33	54	52	4	16	31	29	20	51
EPR2	1	1	13	28	57	102	8	10	33	30	19	98

Question 8

Item	*Importance to Career*						*Course focus on this*					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	1	1	15	27	55	208	4	8	39	21	28	203
EPP1	1	2	19	34	44	140	4	6	29	35	26	141
EPR1	0	1	14	28	57	99	5	8	34	26	27	97
EPP2	0	0	23	40	37	52	4	8	46	25	17	52
EPR2	0	0	22	31	47	102	6	16	38	22	19	96

Question 9

Item	Importance to Career						Course focus on this					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	1	3	25	22	48	208	11	13	45	16	15	202
EPP1	1	6	27	25	41	142	15	18	34	22	11	141
EPR1	1	7	19	36	36	99	5	17	47	24	7	96
EPP2	0	8	19	42	31	52	10	28	40	20	2	50
EPR2	1	4	24	28	44	101	12	21	42	17	8	100

Question 10

Item	Importance to Career						Course focus on this					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	3	5	37	26	29	208	9	13	39	19	19	202
EPP1	2	6	36	23	33	141	13	21	40	17	10	141
EPR1	1	9	33	26	30	99	9	17	45	23	6	96
EPP2	0	4	38	37	21	52	4	21	44	21	10	52
EPR2	3	1	40	24	33	101	12	26	31	21	9	99

Question 11

Item	Importance to Career						Course focus on this					
	1	*2*	*3*	*4*	*5*	*N*	*1*	*2*	*3*	*4*	*5*	*N*
EfS	2	6	28	25	39	210	21	17	32	17	13	205
EPP1	1	8	20	25	45	142	23	19	25	18	14	142
EPR1	1	3	22	23	51	99	17	19	35	17	13	96
EPP2	0	2	23	25	50	52	13	23	37	21	6	52
EPR2	0	1	19	31	49	103	24	15	34	18	9	100

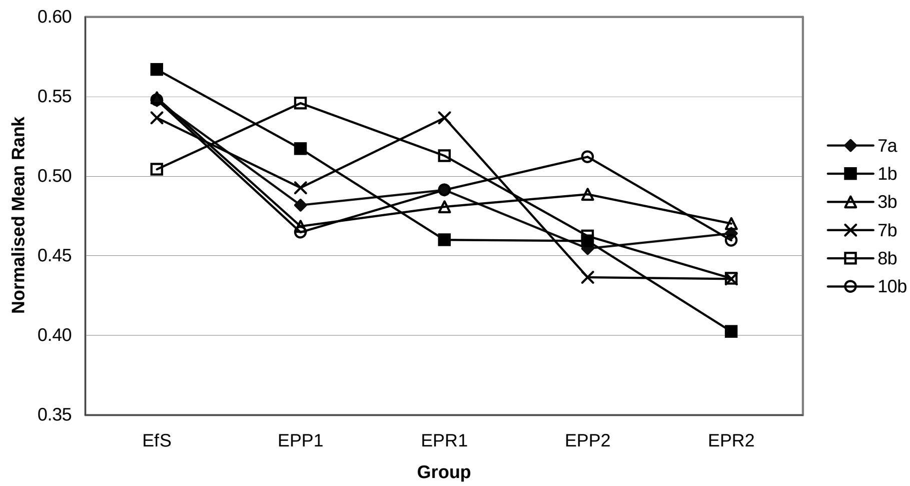
Kruskal-Wallis ANOVAs were conducted to determine if the groups differed significantly on any of the items. The analyses indicated that a significant proportion of the variance is attributable to differences between the groups for items 1b, 3b, 7a, 7b, 8b and 10b. Of the items relating to importance to career, significant differences between the groups were indicated in just one item: question 7a. Respondents' perceptions of the importance of wanting to produce as good a job as possible for successful performance as an early-career engineer tended to be lower in the later stages than the earlier stages (H=12.83, p=0.012). Of the eleven questions relating to the focus of the course, significant differences between the groups were indicated in five. The p-values relating to each item are shown in Table 2.

Table 2. *p*-values for each item

Importance to career	Q	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a
	p	0.065	0.165	0.803	0.493	0.871	0.571	**0.012**	0.063	0.503	0.962	0.052
Course Focus	Q	1b	2b	3b	4b	5b	6b	7b	8b	9b	10b	11b
	p	**0.000**	0.891	**0.038**	0.738	0.081	0.269	**0.010**	**0.037**	0.152	**0.031**	0.943

Figure 1 shows the normalised mean rank for each group for those questions where $p<0.05$. Regarding the extent to which the course is focusing on being willing to face and learn from errors and listen openly to feedback (question 1b), the later stage respondents' ratings tended to be lower than those of earlier stage respondents (H=28.91, $p<0.001$). Given this unexpected finding, it would be interesting to learn whether the educators also perceive the later stages of the course to focus less on these abilities. While it may be quite intentional that the later stages of the course focus less on these abilities, in the absence of further information it would appear that this indicates an area for further enquiry for the course designers. Similarly, later stage respondents' ratings tended to be lower than those of earlier stage respondents regarding the extent to which the course is focusing on being confident to take calculated risks and take on new projects (question 3b, H=10.16, p=0.038). The finding may be attributable to the fact that students in earlier stages of the course spend more time working on new projects, whereas later stage students are more familiar with project-work itself, as well as the types of projects that they work on (within each field of practice). Thus although the finding does not necessarily indicate a problem with the design of the course, it may indicate an area for improvement for course designers and course providers.

Figure 1. Normalised mean rank for each group for the items where $p<0.05$.



Later stage respondents' ratings also tended to be lower than those of earlier stage respondents regarding the extent to which the course is focusing on wanting to produce as good a job as possible (question 7b, H=13.27, $p=0.01$). It may be fair to speculate that the later stage students would have gained more experience with concepts such as 'fit for purpose', the 'triple constraint' (in terms of the trade-off between time, cost and functionality/quality), and the 'quadruple constraint' (scope, time, cost and functionality), and realise that Engineering courses often have a focus on pragmatic concerns of balancing often-conflicting constraints, rather than developing an ideal technical solution (at the expense of the other relevant variables). It is notable that later stage students not only perceive that the course focuses less on doing as good a job as possible, but that they also perceive this to be less important for their early career performance. Finally, later stage respondents' ratings also tended to be lower than those of earlier stage respondents regarding the extent to which the course is focusing on being willing to take responsibility for projects, including how they turn out (question 8b, H=10.22, $p=0.037$) and a willingness to pitch in and undertake menial tasks when needed (question 10b, H=10.62, $p=0.031$).

Response bias may be a factor in these results, especially if (a) later stage students are less prone to response bias, and (b) the above questions elicit greater levels of response bias than the remaining questions. On the question of whether later stage students are less prone to response bias, it could be argued that later stage students are more familiar with being surveyed, have spent more time in classes, and know each other better, hence are less likely to be influenced by 'experimenter demand'. A second argument could be put that older students have self-reporting characteristics that are different from younger students. Evidence exists that may support this second argument. Scores on self reporting instruments such as the ASI, the Approaches to Studying Inventory developed by Ramsden and Entwistle (1981), vary with age; older respondents tend to score more highly on items that relate to deep learning, whereas younger respondents tend to score more highly on items that relate to surface learning (Richardson, 1994). It is possible that the present findings could reflect an interaction between the response characteristics of the questions and age (or some other incidental variable) of the respondents. The questionable validity of self reporting has been shown to be a significant factor in other higher education research; for example, Ross and Conway (1984) describe a study where subjects reported that a course that they had attended was beneficial to them, even after it was demonstrated in a debriefing that their academic performance was no better than students who had not taken the course.

A further limitation of the study is that the Stage 1 students have different population characteristics to those of the other four Stages. All of the respondents of Stages 2 to 5 were studying the Bachelor of Engineering, Diploma of Engineering Practice, whereas some of the Stage 1 students were not taking the Diploma. This being the case, the proportion of international students is slightly higher at Stage 1, because a greater proportion of international students study for the Bachelor of Engineering without the Diploma than do local students. Given that Stage 1 had a greater proportion of international students than the subsequent four Stages, it is possible that the Stage 1 students are less (or more) prone to response bias than the other groups. However, prior research suggests that this is not likely to be a significant factor – for example, Grim & Church (1999) indicate that response bias is stable across cultures. A related issue concerns whether the participants interpreted the questions as intended – conducting interviews might help to shed light on this.

One of the goals of the present study was to gauge the suitability of the measuring instrument for measuring changes in perception, even though the instrument's reliability and validity is yet to be established. Despite the limitations of the approach, it is possible that the findings indicate the existence of real trends in perceptions of the type that are suggested. This being the case, we are interested in further developing this line of research in an attempt to shed light on the many questions that arise. Can we meaningfully compare one item to another, given the different demand characteristics of each item? Are these findings of practical importance? Are these findings potentially helpful as an input for a review of the course? Should differences in the focus of at different stages of the course be explicitly acknowledged in the course design and communicated to students? Can we use this type of study to 'verify' that certain graduate attributes are being attained? Further time and research is required if we are to adequately answer these questions.

Conclusion

Legislative changes require that providers of higher education ensure that their graduates have attributes that include 'personal abilities'. If providers of higher education are to understand more about how to satisfy these requirements, they will require valid and reliable methods for measuring educational outcomes. The present study trials an instrument's suitability for measuring changes in people's perceptions of their abilities. Significant differences between groups were observed for six of twenty-two items. The findings suggest that engineering internship students at different stages of their courses have different perceptions about their abilities and the focus of their courses. Although the results of this preliminary study are consistent with those that might be expected if the measuring instrument is adequate for the purpose of tracking changes in perceptions, further research is required if the validity and reliability of the method is to be established.

Bibliography

ABET (2002). *Criteria for accrediting engineering programs - effective for evaluations during the 2003-2004 accreditation cycle.* Baltimore: Accreditation Board for Engineering and Technology.

Aulich, Senator T. (1990). *Priorities for Reform in Higher Education*. Report of Senate Standing Committee on Employment, Education and Training (Canberra, Australian Government Publishing Service).

Baker, B. (2004). Dissemination of research to reform practice: fishing (and Lawering) to learn. In P. Linn, A. Howard and E. Miller (Eds.), *Handbook for research in cooperative education and internships* (279-300). Mahwah, NJ: Lawrence Erlbaum.

Department of Education, Science and Training [DEST] (2000). *Higher Education Report for the 2001–2003 Triennium*. Retrieved from the World Wide Web, 23 Jan 2005, http://www.dest.gov.au/archive/highered/he_report/2001_2003/

Department of Education, Science and Training (DEST) (2001). *Higher Education Report for the 2002 to 2004 Triennium*. Retrieved from the World Wide Web, 23 Jan 2005, http://www.dest.gov.au/archive/highered/he_report/2002_2004/html/

Dewey, J. (1938). *Experience & Education*. New York, NY: Touchstone.

Duke, C. (2002). Learning Outcomes: Comparing Student Perceptions of Skill Level and Importance. *Journal of Marketing Education*, 24(3) 203-217

Falconer, S. & Pettigrew, M. (2003). Developing added value skills within an academic programme through work-based learning. *International Journal of Manpower*, 24 (1), 48-59.

Gardner, H (1995). *Leading Minds*, Basic Books, New York

Garth, B. & Martin, P. (1993). Law schools and the construction of competence. *Journal of Legal Education*, 43, 469-510.

Gonczi, A., Hager, P. & Oliver, L. (1990). *Establishing Competency Based Standards for the Profession*s, National Office of Overseas Skills Recognition, Canberra.

Golding, B., Marginson, S. & Pascoe, R. (1996). *Changing Contexts, Moving Skills: generic skills in the context of credit transfer and recognition of prior learning* (Canberra, Australian Government Publishing Service).

Goleman, D (1998). *Working with Emotional Intelligenc*e, Bloomsbury, London.

Grim, S. & Church, A. (1999). A Cross-Cultural Study of Response Biases in Personality Measures *Journal of Research in Personality* 33, 415–441.

Harvey, L. (1999). New realities: the relationship between higher education and employment. Keynote presentation at the *European Association of Institutional Research Forum*, Lund, Sweden, August. Retrieved from the World Wide Web, 12 Jan 2005, http://www.shu.ac.uk/research/cre/publications/eair99.pdf

Harvey, L., Moon, S. & Geall, V. (1997). *Graduates' Work: organisational change and students' attribute*s; Retrieved from the World Wide Web, 12 Jan 2005, http://www.uce.ac.uk/crq/publications/gw/

Hesketh, A. (2000). Recruiting an elite? Employers' perceptions of graduate education and training, *Journal of Education and Work,* 13(3), pp. 245–271.

IEAust (1999). *National Generic Competency Standards for Stage 2*, (2nd Ed). Barton, ACT: The Institution of Engineers, Australia.

Kolb, D. (1984). *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Lave, J. & Wenger, E. (1991). *Situated Learning: legitimate peripheral participation* (Cambridge, Cambridge University Press).

Mezirow, J. (1991). *Transformative Dimensions of Adult Learning*. San Francisco: Jossey-Bass.

Morgan, G (1988). *Riding the Waves of Change: Managerial competencies for a turbulent world,* Jossey Bass, San Francisco.

Powell, L., Mayson, S., & De Lange, P. (2004). *Experiential learning: evaluating the experiences of accounting students.* Paper presented at the 2004 Accounting & Finance Association of Australia and New Zealand Conference, Alice Springs.

Ramsden, P., and Entwistle, N. (1981). Effects of academic departments on students' approaches to studying. *Br. J. Educ. Psychol.* 51: 368–383.

Richardson, J. (1994). Mature students in higher education: 1. A literature survey on approaches to studying. *Stud. Higher Educ.* 19: 309–325.

Rogers, C. (1961). *On becoming a person*. Boston: Houghton Mifflin.

Ross, M., & Conway, M. (1986). Remembering one's own past: The construction of personal histories. In Sorrentino, R. M., and Higgins, E. T. (eds.), *Handbook of Motivation and Cognition: Foundations of Social Behavio*r, Guilford Press, New York, pp. 122–144.

Rowley, J. (2003). Action research: an approach to student work based learning. *Education & Training,* 45 (3), 131-138.

Schön, D. (1983). *The Reflective Practitione*r, Basic Books, New York

Scott, G. (2003). Using Successful Graduates to Improve the Quality of Curriculum & Assessment in Nurse Education *Australasian Nurse Educators Conference* 24-26 September 2003 Rotarua, New Zealand

Scott, G. (2003). *Learning Principals: Leadership capability and learning research in the New South Wales Department of Education and Training* University of Technology (UTS) Quality Development Unit

Scott, G (1999). *Change Matters: Making a Difference in Education & Trainin*g, Sydney, Allen & Unwin.

Scott, G. & Yates, W., (2002). Using successful graduates to improve undergraduate education. *European Journal of Engineering Education,* 27 (4), 363-378.

Scott, G, Yates, W. & Wilson, D. (2001). *Tracking and profiling successful graduates, interim report, pilot phase*, QDU, UTS, Sydney. Retrieved from the World Wide Web, 23 Jan 2005, http://www.pqu.uts.edu.au/news/publications.html

Smith, V. (2003). Raising retention and achievement in work-based learning. *Education & Training,* 45 (5), 273-279.

Tennant, M. (1991). Expertise as a dimension of adult development, *New Educatio*n, 13 (2), 49-56.

Workskill Australia (1995). *The Continuous Learning Improvement Program,* Workskill Australia, Sydney (book and film).

Biography

Bruce Moulton is a Lecturer with the UTS Faculty of Engineering, and is a member of the Management, Policy and Practice group. He teaches within the Internship and Core programs, and has previously published research about internships, practice-based education, human-factors and safety-critical decision-making.

David Lowe is the Associate Dean (T&L) in the Faculty of Engineering at UTS. He has active research interests in the areas of engineering education, Web development and technologies, and software engineering. He has published widely in these areas, including two books, and is on the editorial board for a number of international journals. In 2001 he was awarded the AAEE McGraw-Hill New Engineering Educator award.