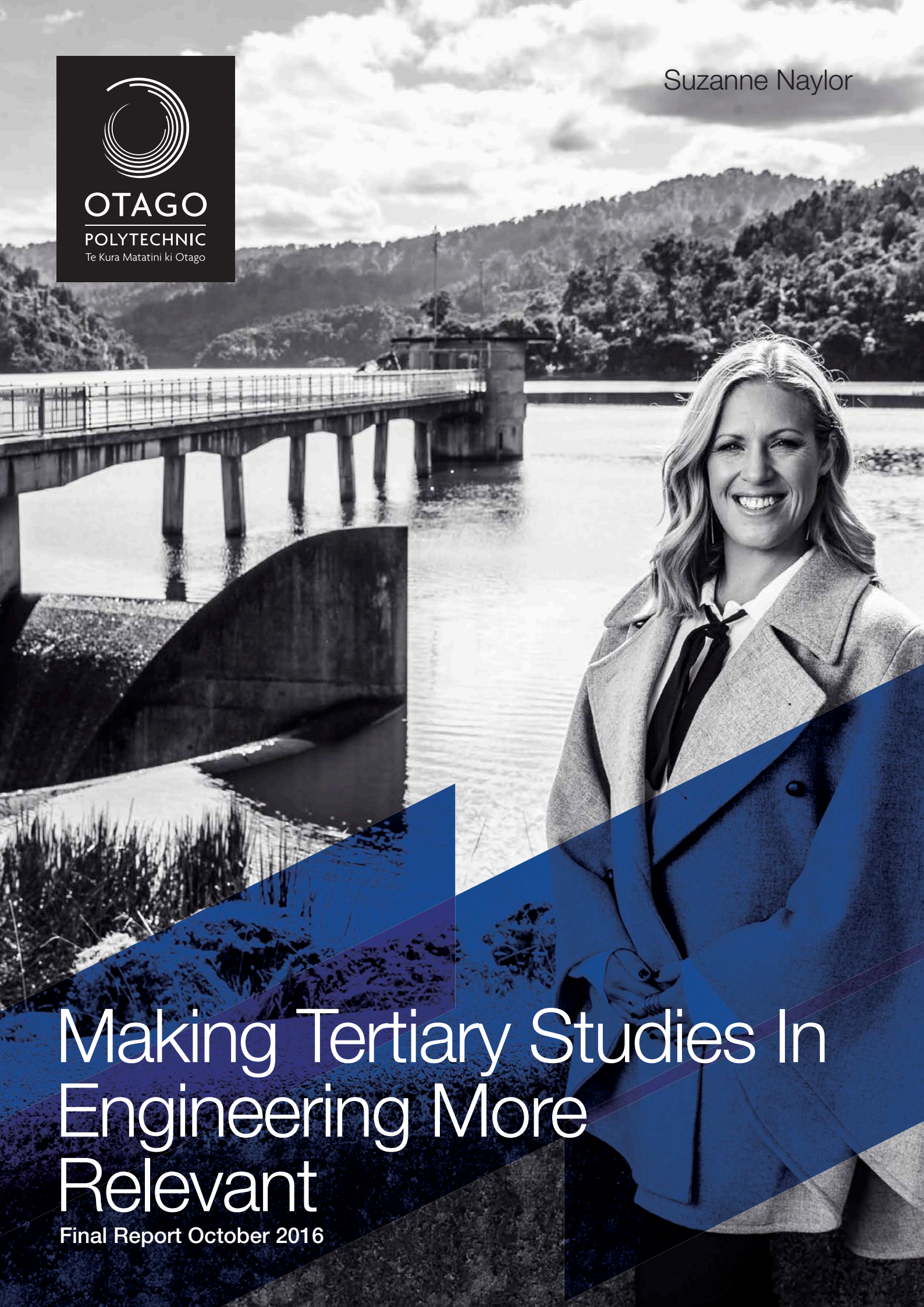

OTAGO
POLYTECHNIC
Te Kura Matatini ki Otago

Suzanne Naylor

Making Tertiary Studies In Engineering More Relevant

Final Report October 2016

Acknowledgements

The Otago Polytechnic research team (Dr Barry Law, Researcher; Sharon Wagg, Project Manager; Stuart Terry, Online Survey Designer) acknowledges the advice and guidance from Steering Group members:

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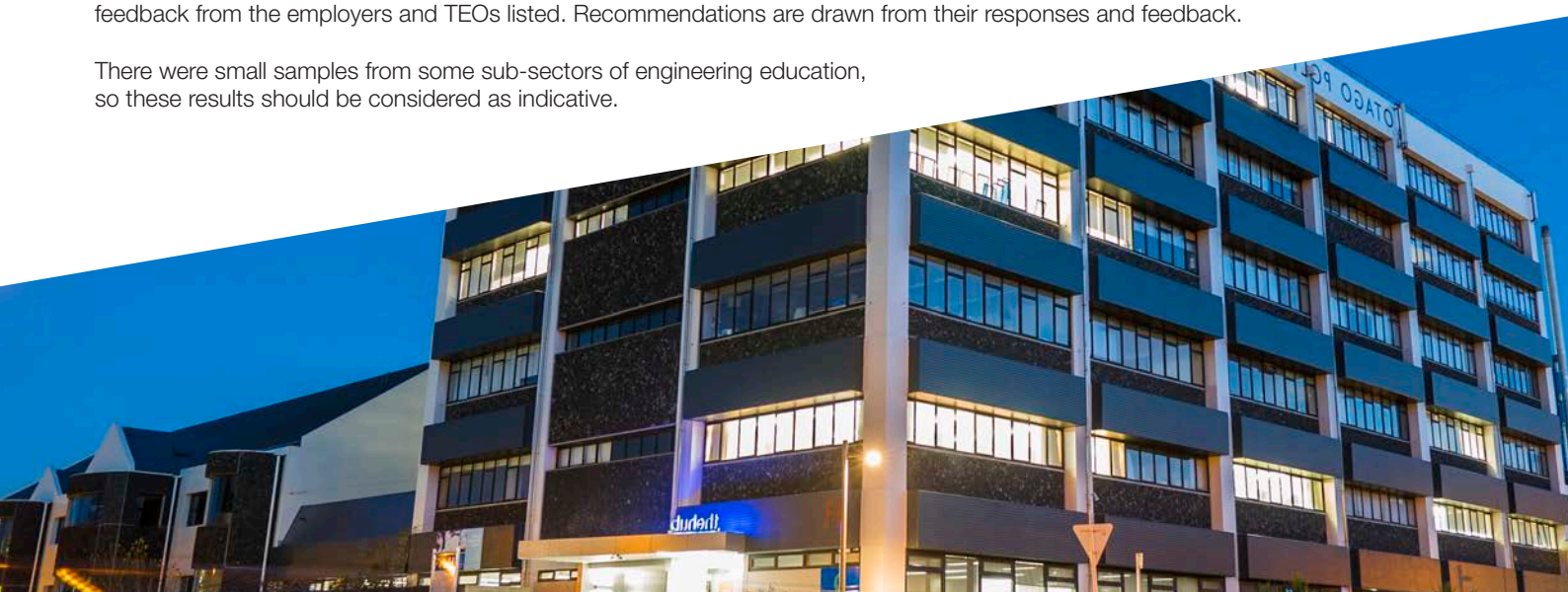
Tertiary education organisation (TEO) participation in the research by:

Otago Polytechnic engineering staff, Ara Institute of Canterbury, Unitec, Wintec, WelTec, Southland Institute of Technology, Queens Academy, the Open Polytechnic, Manukau Institute of Technology, Northtec, Auckland University of Technology, University of Waikato, University of Canterbury and the University of Auckland.

Limitations

This report is a “snapshot” based on the results of an online survey of engineering graduates (which had a 61% response rate) and feedback from the employers and TEOs listed. Recommendations are drawn from their responses and feedback.

There were small samples from some sub-sectors of engineering education, so these results should be considered as indicative.



Contents

Executive Summary

The purpose of this research is to improve tertiary education providers' understanding of what employers need from engineering graduates.

Employers attending the Engineering E2E *Talking with Employers'* workshop (June 2015) recommended an engineering graduate study based on the Professional and Graduate Capability Framework by Professor Geoff Scott[1] be conducted in the New Zealand context.

An online survey used for graduates with three to five years of experience in Australia was adapted for New Zealand engineering graduates and aligned with the attributes from engineering graduate profiles required for international accreditation of the two-year diploma, three- and four-year degrees[2].

Researchers focused on gaining a representative sample from the engineering graduate population i.e., ethnically diverse, male and female graduates from large and small, geographically well-spread engineering companies that provided services or developed products in a range of disciplines.

- Data analysis revealed that graduates require not only the technical knowledge and skills to perform well in the workplace but also personal, interpersonal and cognitive capabilities.

- Graduates rated the importance of the knowledge, skills and capabilities and the extent of their focus in study. Their qualitative comments gave insight into their ratings.

- Graduates' ratings of strategies to keep higher education relevant showed that work placements; problem-based assessment rather than memorising facts; real-world case-studies; and projects that developed personal, interpersonal capabilities delivered by teaching staff with current industry experience were highly important but rated low on their extent of focus in study.

- Graduates described challenging situations they have experienced at work. More than 80% of graduates were challenged when things go wrong in the workplace on: their professional/ethical capabilities; time management; problem-solving; decision-making skills; and coping with stress.

Further analysis of subsets from the data showed variations on a range of variables between university and institutes of technology and polytechnic (ITP) graduates and between graduates with one to two years of experience and three or more years of experience.

- University graduates had completed a full-time four-year degree in large classes and were more likely to have entered directly from school.

- ITP graduates were more likely to have entered from a variety of pathways and attended smaller classes.

- Scott's earlier study (Scott and Yates, 2002) of successful earlier career graduates in Australia focused on graduates with three to five years

[1] Emeritus Professor of Higher Education and Sustainability, University of Western Sydney
[2] The Institution of Professional Engineers New Zealand (IPENZ), as a signatory to the Dublin, Sydney and Washington Accords, implements the accreditation process.

of experience whereas the New Zealand study included graduates with one to two years of experience.

- TEOs were most interested in the responses from the latter group because they are still developing their capabilities and have stronger memories of their study experiences.

The findings from each subset showed small variations in the ratings on importance and extent of focus of items in the Professional Capability Framework. The rankings between the subsets varied depending on graduates' educational experiences and level of work experience. For example:

- Graduates with one to two years of experience rated most important "using real-life workplace problems identified by successful graduates as a key resource for learning".

- Graduates with three or more years of experience rated most important "include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession".

- Some items ranked in the top 12 capabilities for graduates with one to two years of experience were not ranked highly by graduates with three or more years of experience e.g. Having the courage and persistence to follow a course of action to its conclusion ranked at 10= and 22= respectively.

The findings from this study align with Scott's earlier study of engineering graduates in Australia (Scott and Yates, 2002) and the consolidated study by the University of Technology Sydney (Vescio, 2005).

- Eight of the top 12 capabilities and competencies rated on importance are the same for both Australian and New Zealand graduates.

- The top five items ranked on importance by engineering graduates in New Zealand and the rankings from the University of Technology Sydney consolidated study of nine professions showed four of the same items are in the top five from both studies.

Participants from tertiary education providers, industry and professional associations attended workshops to discuss the preliminary results.

- All participants acknowledged the need for closer tertiary/industry collaboration and identified physical, logistical and legislative road blocks hampering collaboration.

- They commented on the need for further research in five years to measure progress on graduates developing capabilities and competencies during study to be work-ready plus for tomorrow's challenges.

Recommendations

Tertiary Education Organisations

Recommendation 1

TEOs provide support processes and guidance to smaller engineering organisations prepared to offer internships and work experience to current students.

Recommendation 2

Within five years, TEOs replicate this research with sub-groups of their successful early-career graduates to identify the needs and priorities of graduates in each discipline and of priority groups such as women, Maori and Pasifika.

Recommendation 3

To support the introduction of the suggested improvements in assessment and learning delivery, Ako Aotearoa develops a programme to build staff capability in designing assessment tasks and delivering learning. There is a focus on programme level, integrated assessment tasks that test all of the key capabilities in combination using real-world dilemmas identified by successful early career engineers, real-world cases, practicums in which the lecturers look at how well the student applies the top 12 capabilities identified in this study when faced with situations when the unexpected happen.

Note: FLIPCurric could provide a framework for testing the relevance and utility of the findings.

Recommendation 4

TEOs use digitally-enabled learning and blended learning and delivery in the NZDE and BEngTech programmes to ensure that:

- assessments reflect feedback received about the focus on capabilities required in the engineering workforce
- learning provides the opportunity for the development of the capabilities to be assessed through strategies such as:
    - o multi-disciplinary project based learning
    - o real-world scenarios provided by graduates
    - o problem-based activities that develop and formatively assess the top 12 capabilities identified in the study.

Recommendation 5

TEOs include the personal capabilities, interpersonal capabilities, intellectual (cognitive) capabilities and generic skills and knowledge listed in the Conclusion in integrated curriculum design, experience and assessment to ensure graduates are work-ready for the future.

Universities

Recommendation 6

University engineering programmes enable students to practise and self-test key skills and knowledge where there are 'right' answers using digitally-enabled learning and other self-teaching and assessment modules out of class, thereby leaving room for integrated, real-world, case studies and problem-based activities to develop and formatively assess higher order capabilities.

Recommendation 7

Early career graduates are used as resources for the development of real-world scenarios and case studies and invited to speak to students about their experiences.

Institutes of Technology and Polytechnics

Recommendation 8

ITPs work closely with engineering organisations to enhance work experiences and part-time work to enable students to develop and be tested on the top 12 capabilities identified by ITP graduates in this study.

Employers

Recommendation 9

Employers collaborate more closely with TEOs to support the suggested improvements in assessment and learning delivery by:

- transferring good practice through lecturer engagement with industry experience
- taking on students for meaningful work experience and requiring students (and tutors) to tackle real work-related problems
- providing more final-year projects
- promoting engineering as an exciting career through site visits, guest presentations and contact with early career graduates in action.

The Tertiary Education Commission

Recommendation 10

A pilot is funded for closer TEO/industry collaboration on learning and delivery that builds on the secondary/tertiary pathways' projects; aligns with vocational pathways; and enables students to have exposure to a diverse range of engineering jobs and people in engineering industries.

Recommendation 11

Further research on successful early career engineering graduates is undertaken in five years (2021) using this research as a benchmark to determine if there are changes to the work-readiness of graduates.

A small commissioned set of interested Polytechnic and University engineering programme leaders and their teams undertake to work collaboratively in 2017-18 to test out the relevance and utility of the findings of the study for:

a. reviewing and enhancing the relevance of current programme level outcomes in the engineering qualification which they teach;
b. enhancing their current approaches to the use of integrating capstone assessment tasks and grading;
c. enhancing the design of their engineering program; and
d. aligning this work with the field tests of the proposed New Zealand Capability Development (currently called 'Assessment') framework for New Zealand TEOs.

The Productivity Commission

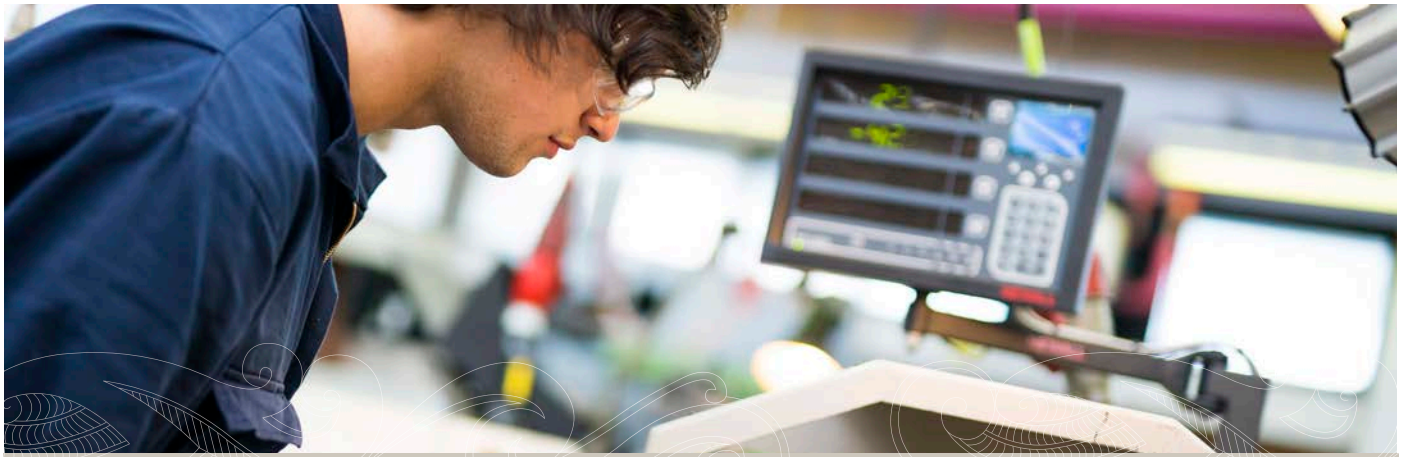
Recommendation 12

The Commission adopt a similar 'Successful Graduate' research process to field test the proposed New Zealand Capability Development Framework to identify the skills relevant to a changing job market and how these might be integrated into assessment processes.

The Ministry of Business, Innovation and Employment

Recommendation 13

MBIE note the potential of the 'Successful Graduate' research process to improve engagement between employers and academics, improve tertiary education providers' understanding of what employers need from new graduates and identify where changes can be made to the curriculum to make graduates more effective in the workplace.



Introduction

One of the recommendations from the Engineering E2E Talking with Employers' workshop in June 2015 was to conduct an engineering graduate study in the New Zealand context based on the Professional and Graduate Capability Framework by Geoff Scott, Emeritus Professor of Higher Education and Sustainability at the Western Sydney University. Otago Polytechnic was invited to undertake this research.

Background

- Hannah Klein

Talking with Employers' Workshop Outcomes

Thirty employers attending the workshop defined successful engineering graduates as being work-ready for today when they have key skills and knowledge and also work-ready plus for tomorrow when they also have a wide range of personal, interpersonal and cognitive capabilities that enable them to work effectively in different situations. These graduates continuously develop their competencies and capabilities (Engineering E2E Report, 2015).

Employers reviewed Scott's Professional and Capability Framework to identify the key capabilities and competencies of successful engineering graduates (see **Appendix 1)**. Many of these employers provide advice to individual TEOs through their industry advisory groups. However, they identified the need for nationwide research that builds on their views to provide valuable insights:

- from graduates on the capabilities and competencies required for their work
- into how TEOs can keep tertiary education relevant from the graduate perspective.

Examples of other studies have occurred internationally on generic capabilities of graduates and capabilities of specific groups in engineering such as *Graduate Employability – The Views of Employers (Archer and Davison, 2008) and A Graduate Capability Framework for Environmental Engineering Degree Programs – A Guide for Australian Universities* (Dowling and Hadgraft, 2013). However, employers attending this workshop agreed Scott's Professional and Capability Framework was transferable to the New Zealand context.

Professional and Capability Framework

Development and use of the Professional and Capability Framework has occurred over the last 20 years. Following on from a programme developed in the mid-1990s for Australia's Skill Olympians, researchers from the University of Technology Sydney (including Scott) tested the Professional and Capability Framework with 200 successful recent graduates in pilot studies of nine professions[3] in Australia between 2000 and 2005.

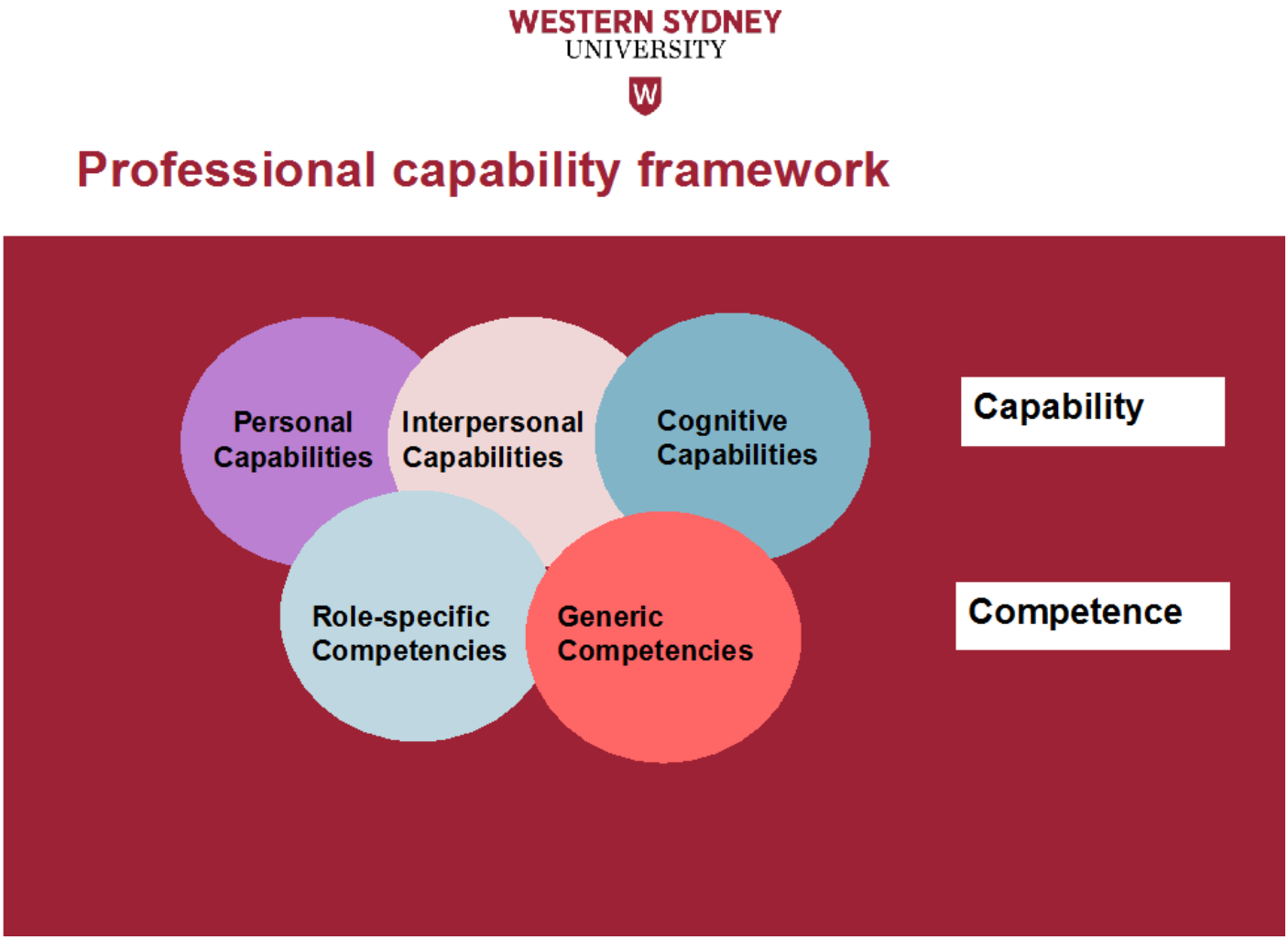
[3]Accounting, architecture, education, engineering, information technology, journalism, law, nursing and sports management

Graduates were asked to rate the most and least useful aspects of their tertiary experience to develop their capabilities and competencies for the early part of their careers. These findings could be "backward mapped" to the assessment and curricula of tertiary education programmes to improve their relevance and connectedness with the professions (Scott, Chang, Grebennikov, 2010).

In the Professional and Capability Framework, competence relates to specific and generic skills and knowledge required for a role and capability relates to the emotional and cognitive intelligence required to apply these skills and knowledge. Competencies can be taught however, capabilities can only be learned in a tertiary setting through solving real-world dilemmas, dealing with the unexpected and reflecting on what has or has not worked in a situation (Scott et al, 2010).

- Diagram 1 summarises this framework which consists of five interlocking dimensions and ten sub-scales.
- Table 1 identifies the sub-scales which each have a set of operationally clear, user-validated items[4].

Diagram 1:



[4]http://flipcurric.edu.au/sites/flipcurric/media/107.pdf

Table 1 Professional Capability Dimensions and Sub-scales:

Component	Dimension	Sub-scale
Capability	Personal	Self-awareness or regulation Decisiveness Commitment
	Interpersonal	Influencing Empathising
	Cognitive	Diagnosis Strategy Flexibility and responsiveness
Competence	Generic	Transferable skills and knowledge
	Role or discipline specific	Skills and knowledge necessary for effective role practice in the specific discipline or profession

For the full set of validated items that make up the factor analysed sub scales in Table 1 and the research that underpins them please see **Appendix 10**.

FLIPCurric

An outcome of this work is the development of an online practitioner's guide as part of Scott's Australian Learning and Teaching National Senior Teaching Fellowship (2014-16) which provides practical tips and resources to prepare graduates for the social, cultural, economic, resource and environmental challenges in the future (http://FLIPCurric.edu.au/).

The guide is a result of feedback from about 3700 Learning and Teaching leaders from Australia, New Zealand, the Pacific, East Asia, Europe, the UK and North America. Feedback from these leaders was for TEOs to ensure that programme outcomes are relevant and necessary and graduates are able to perform in their professional work as well as contribute to the social, cultural, economic and environmental sustainability of the world.

To achieve this, when teaching staff design or review programmes, they should flip the curriculum by starting with the careful validation of programme outcomes using a validated graduate capability framework and multiple reference points, before then mapping courses to their outcomes, ensuring assessment in each course is valid and reliable then selecting learning resources and methods that assist students to perform in course assignments and assessment (Scott, 2016).

Method

The starting point for this research was that graduates need not only to be work-ready for today but also work-ready plus for tomorrow and that, to equip them for this, they will need to develop and be validly assessed on the key personal, interpersonal and cognitive capabilities identified by successful early career practitioners as enabling them to work effectively in a wide range of contexts and productively with change[5].

Instrument and Procedure

The methodology involved reviewing and adapting Scott's online survey used for Australian graduates. Scott's original conceptual framework and research method that underpins this research can be found in Section 2 of Vescio's 2005 report (pgs 3-8).[6]

The New Zealand focus was to:

- expand the demographics to include gender and ethnicity
- adapt the items in the capability and competence tables to the New Zealand context and tertiary engineering education for Level 6-8 qualifications
- add in questions aligned to the graduate attributes stated in the *Requirements for Accreditation or Recognition of Engineering Education Programme* (IPENZ, 2014). These questions asked graduates to comment on the importance and extent of focus in tertiary study on:

    > commitment, energy and passion
    > professional ethics and understanding cultural issues
    > skills in health and safety, sustainable practice and project management.

[5]http://flipcurric.edu.au/about-143/about/using-the-guide-and-getting-started?r=/about-143/about/using-the-guide-and-getting-started& Sections 3.1 and 3.2 provide more information on the hypotheses and conceptual frameworks behind this research.
[6]https://www.westernsydney.edu.au/__data/assets/pdf_file/0019/7363/UTS_Succ_Grads_project_report_J.Vescio_2005.pdf

- ask graduates to explain any key themes in their course or qualification experience that helped then to increase their capability to be work-ready as well as list any aspects missed that they believed were important.

The Otago Polytechnic Research Ethics Committee reviewed and approved the project.

The online survey collected three forms of data:

1. Demographic data were analysed for frequency and percentage (see **Appendix 3** for the full results).

2. The six tables on judging effectiveness at work, personal, interpersonal, intellectual capabilities, key skills and knowledge and keeping tertiary education relevant had Likert scales (1 Low-5 High) which graduates used to rate the importance of each item in the tables to them and the extent of focus in tertiary study. Whenever appropriate, respondents were asked not only to rate an item on importance for effective early career practice but the extent to which this had been given focus in their professional studies. The Statistical Package for the Social Sciences (SPSS) was used to calculate the mean of each item for importance and extent of focus, then these means were ranked.

3. Qualitative data were analysed to identify themes and reasons why graduates rated items in the tables.

4. The online survey was followed up with workshops with employers, senior engineering staff from Schools of Engineering in TEOs, Project Steering Group members and representatives from the Institution of Professional Engineering New Zealand (IPENZ) to test the veracity of the data produced; discuss the key findings, highest rating attributes of successful engineering graduates and other results; and to identify the key implications of the findings.

The data were triangulated against the:

- outcomes of the Engineering E2E Talking with Employers' workshop
- data collected from the graduate survey
- earlier studies of graduate capabilities in Australia
- standard for the Accreditation/Recognition of Engineering Programmes (IPENZ, 2014)
- feedback from post-survey workshops with industry, TEOs and Steering Group members.

Participants

A total of 58 geographically well-spread companies from a range of engineering disciplines (Civil, Electrical and Mechanical) in the service and wealth-creating sectors were invited to participate in the research. Forty-two large and small companies selected successful two-year diploma and three- and four-year degree graduates with up to five years of work experience from a range of ethnicities.

Companies that declined the invitation reported not having suitable graduates, or were smaller companies that needed their graduates for high volumes of work during the time of the survey.

The aim was to obtain a representative sample of graduates from the engineering graduate population by gender, ethnicity, TEO, company size, location and discipline. From the 205 graduates invited to participate in

the research, there were 124 useable responses or a response rate of 61%.

Within the sample:

- over 70% of graduates had studied their main qualification at a university.
- 51% of all graduates had majored in Civil Engineering. Some graduates stated in their qualitative comments that they had attended both an ITP to study a diploma before proceeding to a university. Percentages were not calculated because graduates listed only their main qualification, not all qualifications.
- 79% of graduates were based in the major cities of Auckland, Wellington and Christchurch with 65% of all graduates being employed by companies with over 200 employees.
- women were well-represented (22%) compared with the percentage representation in the engineering profession as a whole
- there was sufficient diversity to gain responses from a wide range of ethnicities including Maori (5.6%) and Pasifika (2.4%).

The data for engineering qualification completions between 2009 and 2014 from all New Zealand TEOs are shown in Table 2. Graduates participating in this research completed their qualifications between 2009 and 2016. Completions from all TEOs were unavailable for 2015 and 2016. The highest percentage of qualification completions for diplomas were in Electrical (34%) followed by Civil (17%); for Bachelors' degrees Electrical (37%) then Other (16%); and for Honours Degrees, Post Graduate Certificates/Diplomas Other (32%) followed by Civil (20%).

The following factors affected the demographics and responses in the survey:

- graduates identified their main qualification for the job not all qualifications. If they had studied a diploma followed by a BE(Hons) their main qualification was the BE(Hons)
- employers employ more graduates with BE(Hons)
- the Civil Engineering discipline in this research includes Environmental Engineering whereas in Table 2 Environmental is part of the "Other" category
- graduate work commitments at the time of the survey. Large organisations particularly in the civil sector were more likely to have graduate programmes and could release their graduates for the survey.

Table 2 Engineering Qualification Completions 2009-2014

Engineering/Discipline	Diploma (Levels 5-7)	Bachelors Degrees	Hons Degrees, Post-Graduate Certificates /Diplomas
Process and Resources	3%	6%	15%
Mechanical	13%	12%	15%
Civil	17%	11%	20%
Geomatic (Surveying)	1%	11%	1%
Electrical/Electronic	34%	37%	18%
Aerospace	15%	10%	1%
Maritime	11%	0%	0%
Other (Environmental, Biomedical, Fire, Rail)	3%	16%	32%

(Education Counts, 2016)

There are limitations in the demographic data collected from the survey by discipline which could be addressed in a future replication of the study.

A review of the qualitative data identified a recurring set of themes across all categories of respondent. These included the requirement for project management skills; the importance of being able to manage 'contingently' clients/suppliers/stakeholders; and a need to know Health and Safety regulations (see the Results Section, for the full range of themes).

Although Scott's previous research has focused on graduates with three-five years of experience, this research includes graduates who have recently entered work (one-two years of experience). Feedback from TEOs attending workshops to review the preliminary findings from the survey was that these graduates have a fresh perspective on work and still remember the details of their recent tertiary experience so their feedback is important for the New Zealand context.

Results

The quantitative results for the complete Professional and Capability Framework are in **Appendix 2**. The capability (personal, interpersonal and intellectual) and competence (key skills and knowledge) components of this framework consisted of 42 items.

Respondents are invited, in the light of their early career experience, to rate each item on a five point Likert scale (1-low to 5-high) first on its importance for effective performance at work and then on the extent to which it was given focus in their university/ITP studies.

The criteria for high importance and performance used in this study are as follows:

- Very high importance: greater than 4.5/5
- High importance: importance ratings between 4.0/5 and 4.4/5
- High performance: 3.8/5 and above (indicates more people are marking agree or strongly agree than neutral, disagree or strongly disagree)
- Performance requiring monitoring: performance ratings between 3.0/5 and 3.7/5
- Performance requiring immediate improvement action: performance ratings less than 3.0/5

Indicators used by respondents to judge their own effectiveness at work

Respondents were asked to rate the importance and extent of focus in study of a range of effectiveness indicators. The results are presented in Table 3 with the top ranking items highlighted.

Table 3 Judging Your Own Effectiveness at Work

Importance for work		Judging Your own Effectiveness at Work	Extent of focus in study	
Mean	Rank	Items	Mean	Rank
4.35	3	1. Helping ensure my clients (internal and external) get the right support	2.47	11
4.53	2	2. Successfully finishing the jobs I have to do on time	3.95	1
3.75	8	3. Receiving positive feedback from my supervisor	2.83	7=
4.02	6	4. Receiving positive feedback from my (internal/external) clients	2.72	10
3.57	9	5. Receiving positive feedback from colleagues	2.83	7=
4.11	5	6. Achieving goals set for my professional development	3.21	3
4.15	4	7. Establishing a collegial working environment	3.15	4
4.64	1	8. Achieving successful outcomes	3.94	2
2.32	11	9. Winning awards for my work	2.74	9
3.16	10	10. Being invited to discuss my work with others	3.14	5
3.85	7	11. Successfully implementing new initiatives	3.00	6

Items 8 (Achieving successful outcomes) and 2 (Successfully finishing the jobs I have to do on time) were ranked highest on importance (4.64, 4.53). They also attracted high performance ratings (3.94, 3.95). These emerge as areas of good practice in New Zealand Engineering which warrant continued emphasis in the Engineering curriculum.

Item 1 (Helping ensure my clients (internal and external) get the right support) is ranked third on importance (4.35) but has a very low performance rating (2.47). This identifies an important area for improvement attention.

Items 7 (Establishing a collegial work environment) and 6 (Achieving goals set for my professional development) are ranked fourth and fifth on importance (4.15, 4.11). Their performance ratings 3.15, 3.21) identify them as areas which may warrant follow-up in the Engineering curriculum.

Item 11 (Winning awards for my work) and 10 (Being invited to discuss my work with others) attract very or relatively low importance ratings. This suggests that they are of comparatively lower significance to students.

Capability/competence items rated high on importance but lower on focus during study

The items in this section and the next give highlights from the full set of results presented in **Appendix 2**. The following codes are used to indicate the domain from which the item comes:

PC	Personal capabilities	**Cog**	Intellectual capabilities
IP	Interpersonal capabilities	**KSK**	Key skills and knowledge

Respondents were asked to rate the capability and competency items in **Appendix 2** first on their importance for effective early career practice and then on the extent to which this area had been given focus in their university/college studies. Table 4 presents the top 12 highest ranked capability items and their associated ratings on focus in their professional studies (performance).

Nine items emerge as warranting improvement attention in the Engineering curriculum. These have an importance rating of more than 4.3/5 and a performance rating less than 3.5/5. These are identified in blue text in Table 4:

- Personal Capabilities (PC) - 3 items (1, 4 and 6)
- Interpersonal capabilities (IP) - 3 items (3, 5, 2)
- Intellectual capabilities (Cog) – 3 items (10, 3, 2)

No key skills and knowledge were identified as areas for improvement.

- Tristan Sansiquet

Table 4 Capability/competence items rated high on importance but low on focus during study

Rank	Domain	Item	Importance	Performance
1st	KSK	12. Being able to organise my work and manage time effectively	4.70	4.01
2nd	PC	1. Being willing to face and learn from my errors and listen openly to feedback	4.69	3.31
3rd	Cog	10. Being able to understand internal or external client requirements and respond appropriately	4.59	2.79
4th	Cog	8. Being able to set and justify priorities	4.57	3.65
5th	PC	4. Being able to remain calm under pressure or when things go wrong	4.56	2.99
6th	Cog	3. The ability to use previous experience to figure out what is going on when a current situation takes an unexpected turn	4.48	3.12
7th	PC	7. Wanting to produce as good a job as possible	4.44	3.79
8th	PC	6. A willingness to persevere when things are not working out as anticipated	4.43	3.44
8th	PC	8. Being willing to take responsibility for projects, including how they turn out	4.43	3.6
8th	IP	3. Being able to develop and use networks of colleagues to help me solve key workplace problems	4.43	3.25
8th	IP	8. Being able to develop and contribute positively to team-based projects	4.43	3.75
12th	Cog	2. Being able to identify from a mass of detail the core issue in any situation	4.41	3.47
13th	IP	5. Being able to work with senior staff without feeling intimidated	4.39	2.71
14th	IP	2. A willingness to listen to different points of view before coming to a decision	4.37	3.41
15th	KSK	6. Being able to use Information & Communications Technology (ICT) effectively to communicate and perform key work	4.36	3.76

Capability items rated low on performance and high on importance

Table 5 shows the 15 items ranked lowest on performance and high on importance. The items in blue text identify areas that warrant improvement attention in the Engineering curriculum. The spread of these areas for enhancement is as follows:

- Personal Capabilities (PC) - 4 items (9, 11, 3, 4)
- Interpersonal capabilities (IP) - 2 items (4, 5)
- Intellectual capabilities (Cog) – 1 item (10)
- Key skills and knowledge (KSK) - 1 item (3)

Table 5 Capability items rated low on performance but high on importance

Rank	Domain	Item	Performance	Importance
Lowest	KSK	5. An ability to communicate the range of services offered by the firm according (or tailored) to the needs of the client	2.19	3.45
2nd lowest	KSK	3. Understanding how organisations like my current one operate	2.22	4.29
3rd lowest	IP	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	2.45	4.29
4th lowest	IP	7. Being able to motivate others to achieve great things	2.56	4
5th lowest	KSK	4. Having an understanding of the current issues in my professional field	2.7	3.88
6th lowest	IP	5. Being able to work with senior staff without feeling intimidated	2.71	4.39
7th lowest	Cog	10. Being able to understand internal or external client requirements and respond appropriately	2.79	4.59
8th lowest	PC	5. Having the ability to defer judgment and not to jump in too quickly to resolve a problem	2.78	4.17
9th lowest	KSK	8. An ability to chair and participate constructively in meetings	2.79	4.04
10th lowest	IP	6. Being able to give constructive feedback to work colleagues and others without engaging in personal blame	2.82	4.17
11th lowest	KSK	2. Understanding the role of risk management and litigation in current professional work	2.85	4.05
12th lowest	PC	9. Having an ability to make a hard decision	2.86	4.29
13th lowest	PC	11. Having a sense of humour and being able to keep work in perspective	2.92	4.21
14th lowest	PC	3. Being confident to take calculated risks and take on new projects	2.96	4.21
15th lowest	PC	4. Being able to remain calm under pressure or when things go wrong	2.99	4.56

When one's capability as an engineer is most tested

Respondents were asked to describe a professionally challenging situation in the last two or three years when they found their professional capabilities to be most tested. They were invited to describe how the situation occurred; what was most challenging about the situation; the stakeholders involved e.g. managers, peers, clients; where this situation occurred; their approach to dealing with the issues; and how well this worked.

They were then asked to rate when they had found their capability as an Engineer to be most tested, with the following results:

- when things are not going well (84%)
- when there is business as usual (9%)
- when things are going well (7%).

The recurring themes which emerged from the challenging situations included challenges to respondents' professional/ethical capabilities, time management, diagnosis of what was going on and problem-solving, decision-making skills and coping with stress. They noted that their capacity for creativity and innovation is most tested when things go well.

Workshop participants from industry, TEOs and professional bodies reviewing the preliminary findings identified the six most relevant and testing situations from the 77 responses (see **Appendix 4**).

Strategies for making tertiary education learning relevant: Importance and performance ratings

Respondents were invited to rate a set of items that related to making tertiary education as relevant as possible and the extent to which this had been effectively addressed in their tertiary studies. The top rating items on importance are presented in Table 6. **Appendix 2** gives the full set of results.

- Kimberley Buckley

Table 6 Strategies for making tertiary education learning relevant: Importance and performance ratings

Rank	Item	Importance	Performance
First	2. Use real-life workplace problems identified by successful graduates as a key resource for learning	4.38	2.77
Second	10. Make assessment more real-world and problem-based and less focused on memorising factual material	4.34	2.76
Third	6. Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession	4.32	3.03
Fourth	9. Ensure that teaching staff have current workplace experience	4.16	2.71
Fifth	3. Make work-placements which test out the capabilities identified as most important in this study a key focus in each course	4.15	2.98

These results identify potential areas for quality improvement in learning design and assessment in tertiary Engineering programs.

The online practitioner's guide FLIPCurric (2016) is one source of practical tips, resources and examples to address three of the five strategies identified as important for keeping tertiary education relevant.

In terms of item 10 (Make assessment more real-world and problem-based and less focused on memorising factual material), the "right assessment" section of FLIPCurric identifies the key tests of "powerful, integrated and fit-for-purpose assessment"; the assessment types; and a wide range of successfully used assessment types and exemplars, including guidelines and examples of how to use dilemma-based assessment tasks and other forms of 'real world' assessment from not only engineering but also from a wide range of other professional study areas.

To address Item 2 (Use real-life workplace problems identified by successful graduates as a key resource for learning) and Item 6 (Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession); examples, of these types of case studies and work-place problems are in the "powerful assessment" section of FLIPCurric. An important resource for learning and assessment are the challenging situations submitted by graduates in the online survey. Stronger links between employers and TEOs would enable employers or their graduates to provide further real world work-place challenges for dilemma and problem-based learning in TEOs.

In terms of Item 3 (Make work-placements which test out the capabilities identified as most important in this study a key focus in each course), one way in which to address this area which has been effective in other courses, is for workplace supervisors to be briefed on the top 12 highest rating capabilities and, when a student is on placement, to look for moments when the trainee is most challenged and for both the supervisor and the student to discuss the extent to which each of these top rating capabilities was evident in resolving the challenge. The student then writes up an evaluative report on their perceptions against the top 12 capabilities and those of the supervisor and identifies key areas for improvement.

Qualitative comments

After respondents rated the effectiveness and capability items on both importance and performance they were invited to comment on the key themes in their ratings and list any aspects that were missing. Indicative comments from the respondents (representative of the range provided) are in italics. The data in the tables in **Appendix 2** align with these comments.

Judging Effectiveness at Work

Respondents observed that there often can be more emphasis on technical competence and passing exams in tertiary studies than on preparing them for the workforce – S*tudies put more emphasis on the technical/professional side of engineering, with less opportunities to learn about the working environment and client interface.* However, respondents did note that this was offset to some extent by group and project work and extra-curricular activities. Important skills to be effective in the workplace identified in these data included effective client management; constructive teamwork; and efficient time management.
Graduates allocated comparatively high importance (4.35/5) to Item 1 (Helping ensure my clients (internal and external) get the right support) but a much lower performance rating for this area in their tertiary studies (2.47/5).

Personal Capabilities

A key personal capability which a range of respondents identified as not being well developed during tertiary study was decision-making. As one respondent observed - *higher education didn't teach …… having the ability to make a hard decision, being responsible for an area of work, taking on new projects/tasks with no prior experience and learning quickly from my mistakes.* Their studies were seen by some as emphasising problem-solving, work ethic and individual grades as opposed to real-world, practical application. This comment is confirmed by the importance rating of 4.69/5 for Item 1 (Being willing to face and learn from my errors and listen openly to feedback) which ranks second in importance out of the four capability and competence tables. Its performance rating (3.31/5) indicates continued monitoring and enhancement attention would be useful.

Respondents stated their personal capabilities developed after their tertiary studies – *soft skills have mostly been learned through on-job training and employer-run courses.*

Commitment, energy and passion

Respondents identified commitment, energy and passion as being very important at work – *in order to build client relationships, and create a vibrant and positive work environment.*

Interpersonal Capabilities

Respondents reported a range of experiences in their tertiary studies in this area. Some reported limited focus on team work situated in real-world contexts and challenges and noted the focus was mainly on individual achievement. Others said they had been involved in many group projects which gave them an insight into dealing with the many varied challenges and personalities they have had to deal with at work. As one respondent observed:

Project work was largely limited to my specific discipline. Work is different in this respect and includes a much wider spectrum of stakeholders from different backgrounds.

Two capability items attracting a comparatively high importance rating of 4.43/5 confirm these comments

– Item 3 (Being able to develop and use networks of colleagues to help me solve key workplace problems) and Item 8 (Being able to develop and contribute positively to team-based projects). The performance rating of 3.25 for item 3 indicates improvement attention would be useful. The higher performance rating for item 8 identifies and area of good practice warranting wider dissemination.

Professional ethics and understanding cultural issues
Both professional ethics and understanding cultural issues were identified as being important for effective workplace performance and were reported as being generally well-covered during tertiary study, especially

when embedded in group work. As one respondent noted these are - *critical issues for engineers to be aware* of which become more real once graduates enter the workforce.

Intellectual Capabilities

A wide range of respondents recommended that projects/problem-solving in tertiary study need further development to include real-world scenarios that deal with ambiguity, a range of human as well as technical influencing factors, shifting goals, and the separation of the causes from symptoms. As one respondent powerfully observed: - *Generally a … course/test/project has an expected outcome, a 'right' answer, and differing from that means you lose points. In business it usually is a 'better' or 'worse' answer; there is hardly ever a 'right' and a 'wrong'. …….taught … to plan, set priorities and identify key issues but not necessarily how to respond to changing circumstances.*

The items relating to these comments are Item 6 (the ability to use previous experience to figure out what is going on when a current situation takes and unexpected turn) which attracted a mean importance rating of 4.48/5 and Item 5 (An ability to trace out and assess the consequences of alternate courses of action and, from this, pick the one most suitable) which was rated at 4.35/5. The respective performance ratings for these two items of 3.02 and 3.34 indicate that further improvement attention would be useful.

Key Knowledge and Skills

Respondents in their qualitative comments identified the following areas of key skill and knowledge as warranting more focus in their tertiary studies:

- learning how an organisation works
- designing to standards
- communicating with non-technical people
- people management

Some respondents reported that they would have liked more opportunities to apply skills in industry during their studies. Others suggested that they gained more technical knowledge than was necessary for the job. As one respondent observed: *Whilst the core technical knowledge was broadly focused on during my course, a lot of the non-technical aspects of working in industry were not.*

Item 1 (Having a high level of current expertise relevant to my work area) was rated at 3.76/5 on performance, indicating an area of good practice. Item 3 (Understanding how organisations like my current one operate) attracted a comparatively high rating on importance (4.29) but a very low rating on performance. This identifies an important area for improvement attention in the curriculum.

Health and Safety, Sustainable Practice and Project Management

Respondents reported finding issues associated with health and safety, project management and sustainable practice to be important at work. They reported varying levels of attention to each of these areas during their studies. As one respondent noted: *These skills are somewhat learnt during the final year projects however the formal education is nowhere near sufficient.*

Keeping Higher Education Relevant

The qualitative comments support the strategies in Table 6 for making tertiary education relevant. Respondents reported that they would appreciate the inclusion of more real-world scenarios in courses, lecturers drawing upon current industry experience in order to prepare them for the professional and working environment. The following comment from one respondent is indicative: *using previous students, problems, successes and teachers with current work experience would benefit students. Teaching needs to be far more about the interesting concepts, ideas and different management styles behind projects rather than learning that Q = VA. In most workplaces, calculations etc. are automated.*

The recurring themes in respondents' comments on the tertiary experiences that most helped increase their capability to be work-ready included: learning the technical knowledge for engineering in context; work experience/placements; large and small group projects which helped develop interpersonal

and communication skills; learning how to learn; developing problem-solving skills; time management; engineering management; and logical and critical thinking.

The least useful aspects of tertiary study identified by respondents included memorising theory and facts for examinations. As one respondent noted: *Memorising facts is not critical to engineering (though it's handy).* What's more important is knowing where to look for solutions, and to have an inquisitive mind. ….. in the workplace, you have access to any resource you need; it's just a matter of the successful application of this. Other respondents observed that some of the basic skills and knowledge to be memorised can be either out of date or no longer relevant to the current business environment: *numerical problems/memorisation, research and heavily theory based topics…. design processes that are out of date or not relevant in a commercial environment.*

The following respondent summarised many of the recurring themes in the qualitative feedback from respondents on what is most relevant to effective performance in the first five years of professional work as an Engineer as follows: *Practical application and examples of the theory in use, guest lectures from entry level graduates, how to operate effectively in teams, communication skills, contractual and client understanding, financial context, industry related knowledge, more on site experiences, encouraging curiosity and reducing fear of failure, good work experience placements, projects as opposed to tests*.

Scott has reviewed the results of the survey and stated in an email communication (11 August, 2016) these findings show the importance of:

- using a proven professional and graduate capability framework when seeking to validate programme level outcomes with a wide range of key reference points – including, as demonstrated in the present study, the importance of using successful early career graduates as one of these key reference points. The present study once again confirms that all of the domains, subscales and items that make up the framework used are valid – i.e. every capability (personal, interpersonal and intellectual) item has attracted an importance ranging from 3.97/5 to 4.7/5
- giving focus to all of the key capabilities that count for successful early career practice not just a few
- giving focus to developing graduates who are not only work-ready for today but work-ready plus for tomorrow
- recognising that key skills and knowledge are necessary but not sufficient for effective professional practice
- assessing less but better – by giving focus to programme level, integrated assessment tasks that test all of the key capabilities in combination using real-world dilemmas identified by successful early career engineers, real-world 'wicked' cases, practicums in which the lecturers look at how well the student applies the top 12 capabilities identified in this study when faced with situations when the unexpected happens
- getting students to practice and self-test on key skills and knowledge where there are 'right' answers using self-managed online learning and other self-teaching and assessment modules out of class, thereby leaving room for integrated, real world, tricky, in-class case and problem-based activities to develop and formatively assess higher order capabilities.

Triangulation of Data

To test the veracity of the above findings the results were tested against data from a range of other sources, specifically:

- the outcomes from the *Talking with Employers'* workshop (Engineering E2E, 2015)
- earlier studies of successful graduates in engineering and other professions in Australia (Scott and Yates 2002, Vescio 2005, and Scott et al, 2010)
- the findings from Scott's Australian National Senior Teaching Fellowship (2014-16) with 3700 higher education learning and teaching leaders from around the world.

In Table 7 the rankings of key capabilities and competencies from an earlier study of the successful early career engineering graduates in Australia (Scott and Yates, 2002 and Vescio, 2005) are compared with the rankings of the top 12 capabilities and competencies from this research.

Eight of the same capabilities and competencies (in red text) were ranked in the top 12 by engineering graduates in both the Australian and New Zealand studies. The first and second most important items ranked by New Zealand graduates were the second and third most important items for Australian graduates.

A review of qualitative comments from Australian supervisors and engineering graduates (Scott and Yates, 2002) shows they experience similar issues to New Zealand graduates:

Being able to work in a team environment is of the utmost importance. People who are loners or who have difficulty discussing problems with others generally fail in this industry and are of no use to me…. Problem solving, initiative, perseverance as well as practicality are all important.

It's no good having technical expertise if you can't use it properly. And to do this you need to be able to figure out what is going on, listen to people, see the situation from their perspective, build a team, carry out a plan of action, use your networks and think laterally. It's the whole mix that counts not just the technical bit.

Problems in university subjects generally have a singular result (i.e. right or wrong. The workplace often has multiple solutions to problems, none of which are obviously the best. Personal judgement and opinion always come into play. The ability to judge each solution on its merits and to communicate this to others is very important in my role.

It should be noted that the university course is a small part of the whole "university experience". Learning interpersonal skills in a course is usually not effective. Allow more time for hands-on project work using real-world problems, allowing students time to evaluate different solutions and gain an understanding that there are different ways of doing things.

Table 7 Comparison of Top 12 Capabilities and Competencies by importance

Rank NZ	Importance in NZ	Rank Australia	Items	Domain
1	4.70	3	12. Being able to organise my work and manage time effectively	KSK
2	4.69	2	1. Being willing to face and learn from my errors and listen openly to feedback	PC
3	4.59	-	10. Being able to understand internal or external client requirements and respond appropriately	Cog
4	4.57	8	8. Being able to set and justify priorities	Cog
5	4.56	5	4. Being able to remain calm under pressure or when things go wrong	PC
6	4.48	-	3. The ability to use previous experience to figure out what is going on when a current situation takes an unexpected turn	Cog
7	4.44	-	7. Wanting to produce as good a job as possible	PC
8=	4.43	6	6. A willingness to persevere when things are not working out as anticipated	PC
8=	4.43	7	8. Being willing to take responsibility for projects, including how they turn out	PC
8=	4.43	11=	3. Being able to develop and use networks of colleagues to help me solve key workplace problems	IP
8=	4.43	1	8. Being able to develop and contribute positively to team-based projects	IP
12	4.41	-	2. Being able to identify from a mass of detail the core issue in any situation	Cog
20	4.31	4	2. Understanding my personal strengths and limitations	PC
24=	4.21	9	3. Being confident to take calculated risks and take on new projects	PC
33	4.08	10	1. Knowing there is never a fixed set of steps for solving workplace problems or carrying out a project	Cog
32	4.10	11=	Being able to manage my own ongoing professional learning and development	KSK

A review of the top five items ranked on importance by engineering graduates in New Zealand and the rankings from the 2005 consolidated study of nine professions undertaken by the University of Technology, Sydney (Vescio, 2005) showed four of the same items are in the top five ranked items on importance in both studies (see Table 8).

Table 8 Keeping Tertiary Education Relevant

Rank on Importance in NZ	Rank on Importance in Australia	Items	Importance	Performance
1st	2nd	2. Use real-life workplace problems identified by successful graduates as a key resource for learning	4.38	2.77
2nd	1st	10. Make assessment more real-world and problem-based and less focused on memorising factual material	4.34	2.76
3rd	4th	6. Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession	4.32	3.03
4th	3rd	9. Ensure that teaching staff have current workplace experience	4.16	2.71
5th	8th	3. Make work-placements which test out the capabilities identified as most important in this study a key focus in each course	4.15	2.98

Post-Survey Feedback from Employers and TEOs

A post-survey workshop with TEOs and employers on the preliminary survey results centred on reaffirming the attributes of successful early career graduates identified in the *Talking with Employers'* workshop in June 2015 **(Appendix 1**); discussing the broad themes from the quantitative and qualitative results and commenting on the validity, reliability and limitations of the data. In addition to the key capabilities and competencies identified in **Appendix 1**, employers in the workshops commented on the level of verbal and written communication skills required by graduates i.e. *a good understanding of their field to be able to 'speak the same language' as the experienced engineers they work with; to communicate results clearly and collaborate with the team* (email communication with employer, 29 August 2016).

It is, they suggested, important to teach communication skills across programmes rather than in isolation. Employers also suggested making projects more real-world by having budgets/pricing requirements, set numbers of hours, and students completing timesheets so they experience business reality.

Employers and TEOs reviewed a summary of the qualitative data and confirmed that the key emerging themes included the need for students to:

- have work experience and projects in teams
- understand business i.e. commercial risk, internal hierarchy and structures, networking
- understand the relevance of what they learn – it may not be used immediately in the workplace
- readily learn new systems in the workplace
- understand ethics and ethical conduct

- understand that changes in the Health and Safety legislation have resulted in personal and corporate liabilities
- be more aware of the range of jobs in the engineering profession
- be resilient when learning from mistakes and overcoming challenges
- remain calm under pressure
- understand diversity and a global business environment
- have real world dilemmas/case studies to solve, guest speakers from industry and site visits in their programme of study
- have lecturers with current industry experience
- have an attitude of commitment and passion.

Employers commented that while graduates want more preparation for entry to the workforce, they will still experience a steep initial learning curve once they commence employment. They observed that, employers need empathy for new graduates. They noted that studying key skills and knowledge is no longer enough and opportunities are necessary during tertiary study to develop key personal, interpersonal and intellectual capabilities. The results of the survey have confirmed these views.

Alignment With Productivity Comission Research

One of the findings in the Productivity Commission's draft report on New Models of Tertiary Education (September, 2016) is that:

> Tertiary education qualifications that equip graduates with transferable skills are desirable in that they retain their relevance in a changing job market. Several providers noted they are focusing on developing transferable skills; however, in some cases, these skills are poorly integrated into assessment processes.

This finding aligns with the top five items in Table 8 Keeping Tertiary Education Relevant.

- Tristan_McCallum

Employer Quotes from Post-Survey Workshops

Quote 1

A successful graduate has the ability to:
solve problems – they realise the importance of understanding the problem before jumping to a solution communicate well verbally and in writing. Their understanding is sufficient to be able to 'speak the same language' as the experienced engineers they work with organise and manage their own time.

Quote 2

Graduates need to expect they will have a steep learning curve when they start in industry but in my view this will be OK if their course has prepared them with problem solving, communication, team-work, organisational skills. However... practical projects / exposure to industry are important.

Quote 3

Workplace flow. At teaching institutions, no concept of number of hours it takes to do a job. In a work situation, health and safety/deliverables on another- maybe in one of the tasks that students do put them in a real world job situation set number of hours and do time sheets for that job. A review of this process so students understand time and costs involved.

Quote 4

Dealing with senior staff without being intimidated. The senior does have to make the final decision. Tertiary provider managing expectations and making sure graduates know that once in the real world there are structures and hierarchy in place.

Quote 5

Internships are usually offered during the summer vacation – could the academic year be adjusted to increase the summer/work placement time?

Quote 6

Learning quickly from mistakes – I think we need to explore resilience in graduates and provide case studies where failure is guaranteed. Real life scenarios – where human errors were made. Not about commercial loss but fatalities, media coverage, loss of public trust etc. Engineers must keep the public, the end user in mind at all times.

Also - when we interview we ask questions where we ask for an example of how they have overcome a challenge/dealt with a difficult personal situation. This is not a trick question – we are seeking an understanding of their resilience and their ability to 'bounce back'

Quote 7

Soft Skills - how about partnership with Toastmasters? Seek organisations that would partner with the faculty to develop presentation skills etc? Make Futureintech ambassador roles mandatory? Be graded on your work with schools to showcase engineering etc?

Quote 8

Interpersonal capabilities - Exposure to work experience/academic project in a multidisciplinary team is essential. We would even suggest partnership with a different faculty. For example the arts faculty - design and build a theatre/museum/ gallery– using arts students as the client? Encourage relationship building and challenging client meetings right now!

Quote 9

Zero harm training/study is critical. This could be a risk assessment/risk management paper with a requirement to work on an industry case study. Practical hours are required with an engineering company – perhaps part of the 400 hours could be more specific around working with the zero harm team or conducting on site induction/site registration of sub-contractors etc

Discussion

While TEOs and employers recognise closer collaboration and working in partnership is most desirable to prepare graduates for the workplace, physical, logistical and legislative constraints create dilemmas for both parties.

These include:

- mis-alignment between the academic year and business financial year which compromises partnerships on industry projects
- industry and TEO contacts changing. Maintaining the relationship becomes critical to productive ongoing relationships between industry and TEOs
- the current Health and Safety Act requiring sufficient measures are in place to accommodate students in industries. With this additional work, providing student work experience has less priority during high volumes of work. It is also more difficult to show engineering machinery on-site to students.

TEOs report having problems finding work placements for students and industries note the importance of TEOs being able to fit in with their needs. University engineering students studying four-year degrees must complete 800 hours of work experience. Universities report having developed a range of strategies: including the enhancement of their local networks; engaging staff to place students in industries; setting up databases with industry contacts; and advertising in industry journals.

Large classes of 200 or more young school leavers in university courses are also reported as presenting challenges. These students enter engineering often because they are good at Maths and the Sciences and their parents/caregivers/school career advisors have recommended engineering. They may be unaware of the challenges of working productively in the engineering sector. When they graduate at 22 years of age, they may not have well-developed capabilities and competencies identified as most important in the Professional and Capability Framework. All parties agreed that their early career graduates have a steep learning curve on entry to the workplace. Graduate programmes in large

organisations can help to address these issues however many small to medium enterprises have fewer resources so graduates must learn on the job. ITPs report similar challenges in finding projects and work experience for their students. Work placements are not mandatory for the completion of the three-year degree or two-year diploma. However courses are structured so that students may work part-time and there are opportunities for credit recognition of work experience. Smaller class sizes were reported as enabling some flexibility in course delivery. Students attending ITPs come from: a wide age group; other qualifications; industry, outside New Zealand; and school. They are suited to the practical nature of vocational education.

Feedback from employers was that knowledge and skills are very important but so are the key capabilities identified in this study. They observe that knowledge and skills or the ability to find out the technical information may be called on during graduates' work, but a balance with capability development is necessary for a graduate to be work-ready plus.
In order to make the findings more directly relevant to universities and ITPs the researchers analysed the data for each subset. Analysis of the data for the subsets of graduates with one to two years of work experience and three or more years of work experience was also undertaken to allow direct comparison with the findings from the earlier Australian study.

Subset Findings – Universities and Institutes of Technology and Polytechnics

Full quantitative results are in **Appendix 5** (Universities) and **Appendix 6** (ITPs). The analysis in the report identifies any key differences between the subsets and overall data.
Further analysis suggests alignment between the items requiring improvement action (in blue text) in Tables 9 – 12 with the Standard for Accreditation/ *Recognition of Engineering Programmes* (IPENZ, 2014) in **Appendix 9**[6]. This Standard sets out the key items from the knowledge profiles (K), types of problems solved (P) and graduate attributes, programme design and student achievement (A) for each programme under the relevant Accord in the International Engineering Alliance.

The following abbreviations with the appropriate number of the item in the Standard are used in Tables 9-12:

- BE(Hons) - Washington Accord (WK, WP, WA)
- Bachelor of Engineering Technology – Sydney Accord (SK, SP, SA)
- New Zealand Diploma in Engineering – Dublin Accord (DK, DP, DA).

All items requiring improvement action (in blue text) for both universities and ITPs potentially align with items in graduate attributes, programme design and student achievement (A). One item (being able to understand internal or external client requirements and respond appropriately) triangulates with types of problem-solving (P) too.

Universities

Judging your own effectiveness at work

The ranking of items (1-11) on importance is the same as in the overall data in **Appendix 5**. There is one small variation in the rankings on the extent of focus in study. Item 5 (Receiving positive feedback from my colleagues) ranked 7th= with Item 3 (Receiving positive feedback from my supervisor) in the overall data however, Item 3 ranked 8th in the data for universities.

Top 15 Capability/Competence items for Universities on importance

In Table 9, items in blue text are identified as warranting consideration for improvement action. This is because they have an importance rating of more than 4.3/5 and a performance rating of less than 3.5/5

[6] Excerpt only of key items from the knowledge profiles (K), types of problems solved (P) and graduate attributes, programme design and student achievement (A). The complete Standard may be viewed at:

https://www.ipenz.nz/home/professional-standards/accredited-qualifications

Table 9 Capability/competence items rated high on importance but low on focus during study

Rank	Domain	Item	Importance	Performance	Washington Accord
1st	PC	1. Being willing to face and learn from my errors and listen openly to feedback	4.69	3.32	WA12
2nd	KSK	12. Being able to organise my work and manage time effectively	4.68	4.04	
3rd	PC	4. Being able to remain calm under pressure or when things go wrong	4.56	3.00	WA9
3rd	Cog	10. Being able to understand internal or external client requirements and respond appropriately	4.56	2.79	WP6, WA9, WA10
5th	Cog	8. Being able to justify and set priorities	4.52	3.64	
6th	PC	8. Being willing to take responsibility for projects, including how they turn out	4.46	3.59	
7th	PC	7. Wanting to produce as good a job as possible	4.44	3.73	
8th	Cog	3. The ability to use previous experience to figure out what is going on when a current situation takes an unexpected turn	4.43	3.08	WA2, WA4
8th	Cog	2. Being able to identify from a mass of detail the core issue in any situation	4.43	3.38	WA2
8th	Cog	5. An ability to trace out and assess the consequences of alternate courses of action and ,from this, pick the one most suitable	4.43	3.27	WA3
11th	PC	6. A willingness to persevere when things are not working out as anticipated	4.41	3.48	WA9
12th	IP	5. Being able to work with senior staff without feeling intimidated	4.40	2.74	WA9
12th	IP	2. A willingness to listen to different points of view before coming to a decision	4.40	3.39	WA10
14th	IP	8. Being able to develop and contribute positively to team-based projects	4.39	3.73	
15th	IP	3. Being able to develop and use networks of colleagues to help me solve key workplace problems	4.38	3.24	WA9

Lowest 15 Capability/Competence items for Universities on performance

In Table 10, items (in blue text) have an importance rating of more than 4.2/5 but a performance rating of less than 3/5. These identify potential areas for improvement action.

Items in this table that are not included in the overall data in Table 5 are Item 7 (Being able to see how apparently unconnected activities are linked and make up an overall picture) and Item 11 (An ability to help others learn in the workplace).

Table 10 Capability/competence items ranking lowest on performance

Rank	Domain	Item	Importance	Performance	Washington Accord
Lowest	KSK	5. An ability to communicate the range of services offered by the firm according (or tailored) to the needs of the client	3.56	2.10	
2nd lowest	KSK	3. Understanding how organisations like my current one operate	4.24	2.11	WA12
3rd lowest	IP	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	4.22	2.40	WA12
4th lowest	IP	7. Being able to motivate others to achieve great things	3.97	2.50	
5th lowest	KSK	4. Having an understanding of the current issues in my professional field	3.90	2.70	
6th lowest	IP	5. Being able to work with senior staff without feeling intimidated	4.40	2.74	WA9
7th lowest	PC	5. Having the ability to defer judgment and not to jump in too quickly to resolve a problem	4.20	2.76	
8th lowest	KSK	2. Understanding the role of risk management and litigation in current professional work	4.01	2.77	
9th lowest	Cog	10. Being able to understand internal or external client requirements and respond appropriately	4.56	2.79	WP6, WA9, WA10
10th lowest	KSK	8. An ability to chair and participate constructively in meetings	3.99	2.84	
11th lowest	IP	6. Being able to give constructive feedback to work colleagues and others without engaging in personal blame	4.20	2.85	
12th lowest	PC	9. Having an ability to make a hard decision	4.28	2.86	WA3, WA6, WA8
13th lowest	Cog	7. Being able to see how apparently unconnected activities are linked and make up an overall picture	4.13	2.88	
14th lowest	PC	3. Being confident to take calculated risks and take on new projects	4.20	2.94	WA11
15th lowest	KSK	11. An ability to help others learn in the workplace	3.91	2.98	WA12

Keeping Higher Education Learning Relevant at Universities

University graduates selected the same five items as in Table 6. However they ranked 2nd, Item 6 (Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my profession) and ranked 3rd Item 10 (Making assessment more real-world and problem-based and less focused on memorising factual material).

Institutes of Technology and Polytechnics

Judging your own effectiveness at work

When reviewing the top five rankings on importance in **Appendix 6**, Item 5 (Receiving positive feedback from my internal/external clients) was ranked 5th for ITP graduates compared with 6th in the overall rankings. Item 7 (Establishing a collegial working environment) was ranked at 6th for ITP graduates compared with 4th in the overall rankings. The other four items were ranked in the top five in both sets of data with small variations in their rankings.

A similar pattern is seen in the rankings on extent of focus in study. The same items were ranked in the top five in both sets of data, with only small variations in rankings. For example, item 6 (Achieving goals set for my professional development) was ranked 5th by ITP graduates and 3rd overall. Item 10 (Being invited to discuss my work with others) was ranked 3rd by ITP graduates and 5th overall.

Top 15 Capability/Competence items for ITPs on importance

Items in blue text in Table 11 require consideration for improvement action. They have an importance rating of more than 4.3/5 and a performance rating of less than 3.5/5.

- Hannah Klein

Table 11 Capability/competence items rated high on importance but low on focus during study

Rank	Domain	Item	Importance	Performance	Sydney/Dublin Accords
1st	KSK	12. Being able to organise my work and manage time effectively	4.77	3.93	
2nd=	Cog	10. Being able to understand internal or external client requirements and respond appropriately	4.69	2.81	SP6, SA10, DP6, DA10
2nd=	Cog	8. Being able to justify and set priorities	4.69	3.66	
4th	PC	1. Being willing to face and learn from my errors and listen openly to feedback	4.68	3.26	SA12, DA12
5th	Cog	3. The ability to use previous experience to figure out what is going on when a current situation takes an unexpected turn	4.59	3.23	SA2, SA4 DA2, DA4
6th	PC	4. Being able to remain calm under pressure or when things go wrong	4.56	2.97	SA9, DA9
7th=	IP	8. Being able to develop and contribute positively to team-based projects	4.55	3.82	
7th=	IP	3. Being able to develop and use networks of colleagues to help me solve key workplace problems	4.55	3.27	SA9, DA9
9th	IP	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	4.48	2.58	SA12, DA12
10th	PC	6. A willingness to persevere when things are not working out as anticipated	4.47	3.32	SA9, DA9
11th=	PC	7. Wanting to produce as good a job as possible	4.44	3.94	
11th=	PC	12. Having the courage and persistence to follow a course of action to its conclusion	4.44	3.38	SA8, DA8
13th	Cog	6. Being able to readjust a plan of action in light of what happens as it is implemented	4.41	2.97	SA6, DA6
14th=	KSK	3. Understanding how organisations like my current one operate	4.40	2.50	SA12, DA12
14th=	KSK	6. Being able to use ICT effectively to communicate and perform key work	4.40	3.73	SA5, DA5

The items in Table 11 ranked in the top 15 by ITP graduates on importance that did not appear in the overall results in Table 4 are:

- Item 4: Understanding how the different groups that make up my organisation operate and how much influence they have in different situations
- Item 12: Having the courage and persistence to follow a course of action to its conclusion
- Item 6: Being able to readjust a plan of action in light of what happens as it is implemented
- Item 3: Understanding how organisations like my current one operate.

Lowest 15 items for ITPs on performance

The items (in blue text) in Table 12 identified as warranting improvement attention have an importance rating of more than 4.2/5 but a performance rating of less than 3/5.
In Table 12, items included by ITP graduates that did not appear in the overall data in Table 5 are:

- Item 7: Being able to see how apparently unconnected activities are linked and make up an overall picture
- Item 6: Being able to readjust a plan of action in light of what happens as it is implemented
- Item 3: Understanding my personal strengths and limitations.

Table 12 Capability items rated low on performance and high on importance

Rank	Domain	Item	Importance	Performance	Sydney/Dublin Accords
Lowest	KSK	5. An ability to communicate the range of services offered by the firm according (or tailored) to the needs of the client	3.13	2.43	
2nd lowest	KSK	3. Understanding how organisations like my current one operate	4.40	2.50	SA12, DA12
3rd lowest	IP	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	4.48	2.58	SA12, DA12
4th lowest	IP	5. Being able to work with senior staff without feeling intimidated	4.39	2.61	SA9, DA9
5th lowest	KSK	8. An ability to chair and participate constructively in meetings	4.20	2.67	
6th lowest	KSK	4. Having an understanding of the current issues in my professional field	3.83	2.69	
7th lowest	IP	7. Being able to motivate others to achieve great things	4.09	2.73	
8th lowest	PC	11. Having a sense of humour and being able to keep work in perspective	4.18	2.74	
9th lowest	IP	6. Being able to give constructive feedback to work colleagues and others without engaging in personal blame	4.09	2.76	
10th lowest	Cog	10. Being able to understand internal or external client requirements and respond appropriately	4.69	2.81	SP6, SA10, DP6, DA10
11th lowest	PC	5. Having the ability to defer judgment and not to jump in too quickly to resolve a problem	4.09	2.82	
12th lowest	PC	9. Having an ability to make a hard decision	4.32	2.85	SA3, SA6, SA8, DA3, DA6, DA8
13th lowest	Cog	7. Being able to see how apparently unconnected activities are linked and make up an overall picture	4.13	2.94	
14th= lowest	Cog	6. Being able to readjust a plan of action in light of what happens as it is implemented	4.41	2.97	SA6, DA6
14th= lowest	PC	2. Understanding my personal strengths and limitations	4.32	2.97	SA12, DA12
14th= lowest	PC	4. Being able to remain calm under pressure or when things go wrong	4.56	2.97	SA9, DA9

Keeping Higher Education Relevant at ITPs

ITP graduates selected the top four of the five items in Table 6. Their 5th item was - Use successful graduates more consistently as a learning resource in polytechnic/university courses (e.g. as guest speakers.

Subset Findings – Graduates with 1-2 years of experience and graduates with 3+years

Full quantitative results are in **Appendix 7** (1-2 Year Graduates) and **Appendix 8** (3+ Year Graduates). Tables 13, 14, and 15 compare the rankings between the subsets to identify their different priorities due to their level of experience in work and study experiences.

Judging your own effectiveness at work

Table 13 Judging your own effectiveness – comparison of rankings

Importance for work		Judging Your own Effectiveness at Work	Extent of focus in study	
Rank 1-2 years	Rank 3+ years	Items	Rank 1-2 Years	Rank 3+ Years
3	3	1. Helping ensure my clients (internal and external) get the right support	11	11
2	2	2. Successfully finishing the jobs I have to do on time	2	1
8	8	3. Receiving positive feedback from my supervisor	7	8
5	6	4. Receiving positive feedback from my (internal/external) clients	8	10
9	9	5. Receiving positive feedback from colleagues	10	7
4	5	6. Achieving goals set for my professional development	3	5
6	4	7. Establishing a collegial working environment	6	3
1	1	8. Achieving successful outcomes	1	2
11	11	9. Winning awards for my work	9	9
10	10	10. Being invited to discuss my work with others	5	4
7	7	11. Successfully implementing new initiatives	4	6

In Table 13 both subsets of graduates rated the same six items as high on their importance with a similar pattern in terms of their performance ratings.

Top 15 Capability/Competence items on importance

For each subset, three different items were ranked high on importance in the top 15 capability/competence items in Table 14. The other 12 items were the same for each subset although they were ranked differently.

Table 14 Comparison of the top 15 capability/competence items ranked high on importance

Domain	Item	Rank 1-2 Years	Rank 3+ Years
KSK	12. Being able to organise my work and manage time effectively	2	1
Cog	10. Being able to understand internal or external client requirements and respond appropriately	5	3
Cog	8. Being able to justify and set priorities	3	5
PC	1. Being willing to face and learn from my errors and listen openly to feedback	1	2
Cog	3. The ability to use previous experience to figure out what is going on when a current situation takes an unexpected turn	9	6
PC	4. Being able to remain calm under pressure or when things go wrong	10=	4
IP	8. Being able to develop and contribute positively to team-based projects	4	13=
IP	3. Being able to develop and use networks of colleagues to help me solve key work-place problems	6=	13=
PC	6. A willingness to persevere when things are not working out as anticipated	10=	9
PC	7. Wanting to produce as good a job as possible	6=	11=
PC	12. Having the courage and persistence to follow a course of action to its conclusion	10=	22=
IP	1. The ability to empathise with and work productively with people from a wide range of backgrounds	13	19
IP	5. Being able to work with senior staff without feeling intimidated	8	16=
PC	8.Being willing to take responsibility for projects including how they turn out	14	7
IP	2.A willingness to listen to different points of view before coming to a decision	15	15
Cog	2. Being able to identify from a mass of detail the core issue in any situation	16	8
Cog	An ability to trace out and assess the consequences of alternate courses of action and, from this, pick the most suitable one	23	11=
KSK	Being able to use ICT effectively to communicate and perform key work	25	10

Lowest 15 items on performance

Two additional items were ranked low on performance by graduates with 1-2 years of experience that were not ranked within the 15 capability/competence items in Table 15 by graduates with 3 or more years of experience. The lowest four ranked items on performance were the same for both subsets.

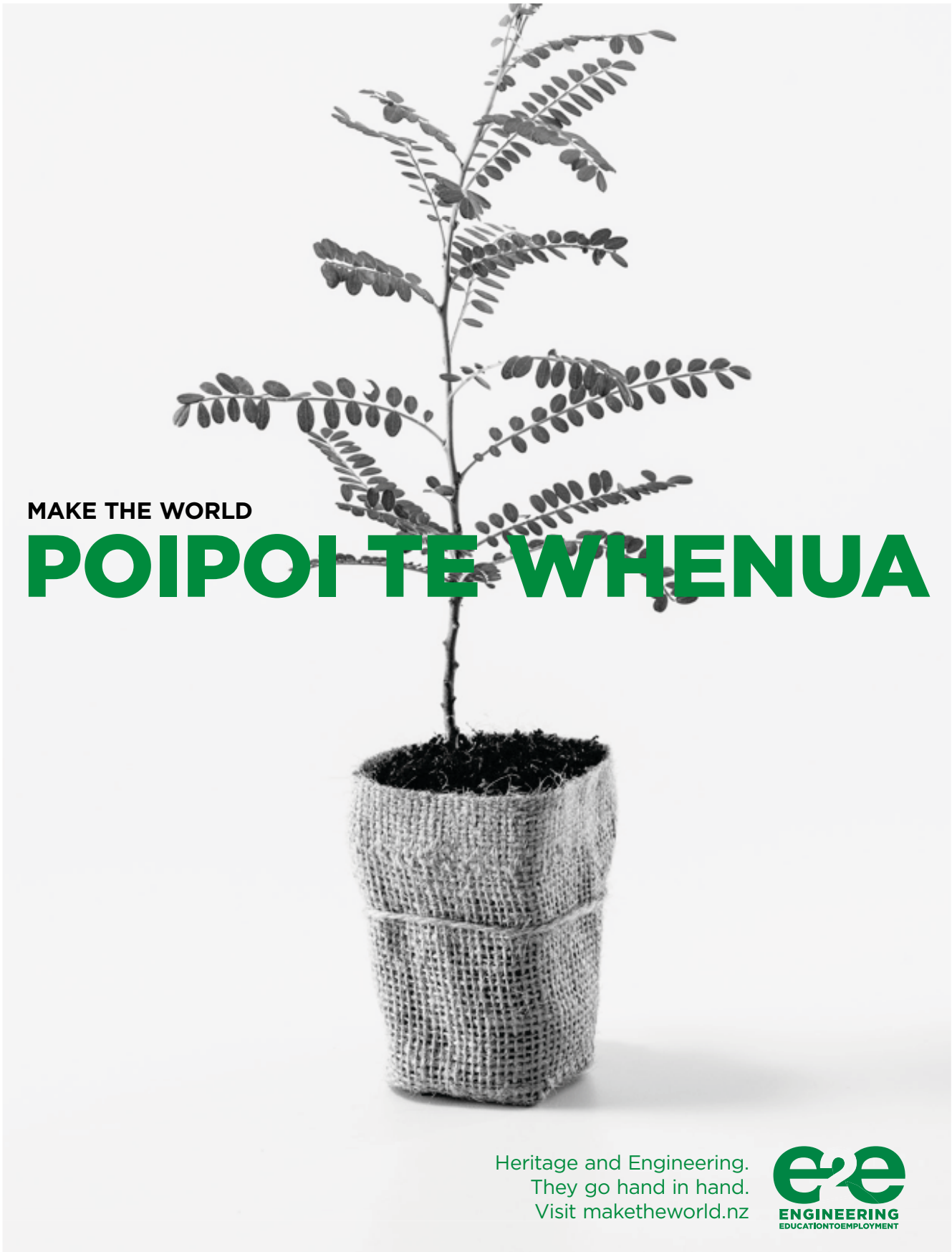

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Table 15 Comparison of the 15 capability/competence items ranked lowest on performance

Domain	Item	Rank 1-2 Years	Rank 3+ Years
KSK	5. An ability to communicate the range of services offered by the firm according (or tailored) to the needs of the client	Lowest 1=	Lowest 1
KSK	3. Understanding how organisations like my current one operate	1=	2
IP	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	3	3
IP	5. Being able to work with senior staff without feeling intimidated	8	5
KSK	8. An ability to chair and participate constructively in meetings	11=	8=
KSK	4. Having an understanding of the current issues in my professional field	6=	6=
IP	7. Being able to motivate others to achieve great things	4	4
PC	11. Having a sense of humour and being able to keep work in perspective	14	13=
IP	6. Being able to give constructive feedback to work colleagues and others without engaging in personal blame	5	13=
Cog	10. Being able to understand internal or external client requirements and respond appropriately	17	6=
PC	5. Having the ability to defer judgment and not to jump in too quickly to resolve a problem	9=	8=
PC	9. Having an ability to make a hard decision	9=	10
Cog	7. Being able to see how apparently unconnected activities are linked and make up an overall picture	11=	11
PC	2. Understanding my personal strengths and limitations	11=	-
PC	4. Being able to remain calm under pressure or when things go wrong	-	13=
KSK	11. An ability to help others learn in the workplace	6=	-
KSK	2. Understanding the role of risk management and litigation in current professional work	8	12

Keeping Higher Education Learning Relevant

In Table 16, the same items attracted the top five rankings on importance, with some variations in emphasis. For example, item (8) was ranked in the top five for graduates with 1-2 years of experience but was ranked 9th by graduates with three or more years of work experience. There were clear differences in the rankings of three other items (2, 9, and 10).

Table 16 Comparison of rankings on keeping higher education relevant

Importance for work		Keeping Higher Education Learning Relevant	Extent of focus in study	
Rank 1-2 years	Rank 3+ years		Rank 1-2 Years	Rank 3+ Years
5=	6	1. Focus more directly on the capabilities identified by successful engineers as being important in polytechnic/university courses and assessment	2	4
1	2	2. Use real-life workplace problems identified by successful graduates as a key resource for learning	9	5
5=	5	3. Make work-placements which test out the capabilities identified as most important in this study a key focus in each course	4	2
8=	8	4. Use successful graduates more consistently as a learning resource in polytechnic/university courses (e.g. as guest speakers)	10	10
11	11	5. Decrease the amount of formal classroom teaching of basic technical skills and use self-instructional guides and ICT to develop these	11	11
3	1	6. Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession	1	3
8=	7	7. When relevant, use ICT to make learning as convenient and interactive as possible	3	1
4	9	8. Ensure that all teaching staff model the key attributes identified as being important in this study	8	6
5=	4	9. Ensure that teaching staff have current workplace experience	5=	9
2	3	10. Make assessment more real-world and problem-based and less focused on memorising factual material	5=	7
10	10	11. Use performance on the capabilities identified as being most important in earlier parts of this survey as the focus for assessment and feedback on all learning tasks	7	8

Implications of Findings for Engineering Programme Reviews

When programme leaders and their teams review their engineering programme it is recommended that they:

- ensure they consider the capabilities ranked high on importance and low on university/ITP focus during study when seeking to validate program level outcomes (**Appendix 5** – Universities and **Appendix 6** ITPs). When they use the graduate attributes of the relevant Accord to validate the degree/diploma programme level outcomes, they could also validate the programme outcomes against the capabilities with the highest importance ratings

- use the top rating items in "Keeping Higher Education Relevant" on importance (**Appendix 5** – Universities and **Appendix 6** ITPs) such as the need for real-world learning and assessment to validate and enhanced learning designs and inform student feedback surveys

- look beyond the traditional classroom to the campus and community for opportunities where capabilities may be developed through real-world experience, simulations, case studies and learning and action research

- consider integrating dilemmas in professional practice into courses throughout engineering programmes. Students would consider the strategies and capabilities to use in dilemmas provided by successful early career graduates in studies like the present one and students could compare their approach with that taken by the graduate. In a final assessment they could respond to an unseen dilemma; review the approach taken by the graduate; and compare their strategies with those of the successful graduate using the top 12 capabilities (university or ITP) in this study for evaluation. Finally, they would show how they would approach the dilemma next time.

- work with employers to give more focus and direction to work experience by including an assessment of the top 12 capabilities during work experience. This could involve supervisors being made aware of these capabilities and choosing an event when the student is most challenged as the assessment task. The student would self-assess the effectiveness of his/her approach; compare their approach with the approach proposed by the supervisor using the top 12 capabilities for evaluation. To complete the task, students would state if they would use the same approach or a different one and why, next time they had a similar challenge.

- design courses that have digitally-enabled learning to develop key skills and competencies with "right" answers so that class time can be used for integrated, real-world, problem-based learning and assessment and to address specific areas requiring development such as "Learning how organisations work, client management, communicating with non-technical people".

- inform new students in their first year of study of the most important effectiveness items from "Judging your Effectiveness at Work" rated by successful graduates, along with the top 12 capabilities and how the program will be addressing them. It might also be advisable to consider the effectiveness items that rate high on importance but low on performance when reviewing programmes. This would include areas like "helping ensure my clients (internal and external) get the right support".

It is our view that the conclusion from the 2001 study is still valid:

"The study's findings about making learning more practice-based and responsive are not new. However, by using the capability framework confirmed in this study more explicitly, we have an opportunity to give greater focus to this highly valued aspect of university study, right from the outset. For example, students can be alerted at orientation to the findings of studies like the present one, a successful graduate who participated in the study can explain why the various dimensions of capability identified are all important and the way in which the course addresses these in a developmental way can be explained. As noted already, the university's industry placement programme can focus on using and testing the framework; and case studies which illustrate how it operates can be scrutinized more consistently. Such strategies are used in many university courses and meet the relevance tests for high-quality university learning identified in this and other studies…. The study has demonstrated that professional success requires far more than the possession of a high level of technical expertise, as important as this is. It demonstrates that it is the combination of emotional intelligence, a focused and contingent way of thinking, a specific set of generic skills as well as technical expertise that accounts for the successful delivery of engineering projects to specification and high levels of client and employer satisfaction.

Emotional intelligence—both social and personal—emerges as being a far more significant influence on successful early career performance than previously recognized; and there are indications from both our qualitative and quantitative data that, although such attributes may not necessarily be amenable to traditional, subject- based teaching, they are learnable. In this regard, it is very clear that we must look to the total university experience as a resource, not just to what happens in the traditional classroom."

(Scott & Yates, 2002: 374)

Conclusion

The results presented in this report constitute a “snapshot” of what successful early career engineering graduate capability in New Zealand looks like in practical terms and how it might best be developed and assessed. A substantial subset of data for each TEO is unavailable. TEOs have their own, additional systems for getting input to validate the focus and design of their Engineering programmes, including inviting graduates to provide feedback on the programme to accreditation panels and receiving feedback from employers on graduates’ performance from industry advisory groups. TEOs acknowledged that keeping in contact with their highly- mobile graduates to gather data over a long period of time is a real challenge.

This research can be viewed as a baseline and benchmark for further research to be conducted in five years’ time. In the interim, each TEO can compare the results of this project with their own graduate feedback and data from other sources to identify more specific changes required to their programmes.

The research identifies that the following personal capabilities, interpersonal capabilities, intellectual (cognitive) capabilities and generic skills and knowledge as warranting focus when developing an integrated curriculum design, experience and assessment system which ensures that engineering graduates are not only work ready for today but are also work-ready *plus* for the future

Personal capabilities

- Wanting to produce as good a job as possible, being able to remain calm under pressure or when things go wrong, being willing to learn from errors, being willing to take responsibility for projects, including how they turn out, a willingness to persevere when things are not working out as anticipated, having a sense of humour and being able to keep work in perspective

Interpersonal capabilities

- Being able to work with senior staff without being intimidated, being able to develop and contribute positively to team based projects, the ability to empathise and work productively with people from a wide range of backgrounds, being able to develop and use networks of colleagues to solve key workplace problems, a willingness to listen to different points of view before coming to a decision

Cognitive capabilities

- Being able to set and justify priorities, being able to identify from a mass of detail the core issue in any situation

Generic Skills and knowledge

- Being able to organise my work and manage time effectively

Recommendations

Tertiary Education Organisations

Recommendation 1

TEOs provide support processes and guidance to smaller engineering organisations prepared to offer internships and work experience to current students.

Recommendation 2

Within five years, TEOs replicate this research with sub-groups of their successful early-career graduates to identify the needs and priorities of graduates in each discipline and of priority groups such as women, Maori and Pasifika.

Recommendation 3

To support the introduction of the suggested improvements in assessment and learning delivery, Ako Aotearoa develops a programme to build staff capability in designing assessment tasks and delivering learning. There is a focus on programme level, integrated assessment tasks that test all of the key capabilities in combination using real-world dilemmas identified by successful early career engineers, real-world cases, practicums in which the lecturers look at how well the student applies the top 12 capabilities identified in this study when faced with situations when the unexpected happen.

Recommendation 4

TEOs use digitally-enabled learning and blended learning and delivery in the NZDE and BEngTech programmes to ensure that:

- assessments reflect feedback received about the focus on capabilities required in the engineering workforce
- learning provides the opportunity for the development of the capabilities to be assessed through strategies such as:
    - o multi-disciplinary project based learning
    - o real-world scenarios provided by graduates
    - o problem-based activities that develop and formatively assess the top 12 capabilities identified in the study.

Recommendation 5

TEOs include the personal capabilities, interpersonal capabilities, intellectual (cognitive) capabilities and generic skills and knowledge listed in the Conclusion in integrated curriculum design, experience and assessment to ensure graduates are work-ready for the future.

Universities

Recommendation 6

University engineering programmes enable students to practise and self-test key skills and knowledge where there are 'right' answers using digitally-enabled learning and other self-teaching and assessment modules out of class, thereby leaving room for integrated, real-world, case studies and problem-based activities to develop and formatively assess higher order capabilities.

Recommendation 7

Early career graduates are used as resources for the development of real-world scenarios and case studies and invited to speak to students about their experiences.

Institutes of Technology and Polytechnics

Recommendation 8

ITPs work closely with engineering organisations to enhance work experiences and part-time work to enable students to develop and be tested on the top 12 capabilities identified by ITP graduates in this study.

Employers

Recommendation 9

Employers collaborate more closely with TEOs to support the suggested improvements in assessment and learning delivery by:

- transferring good practice through lecturer engagement with industry experience
- taking on students for meaningful work experience and requiring students (and tutors) to tackle real work-related problems

- providing more final-year projects
- promoting engineering as an exciting career through site visits, guest presentations and contact with early career graduates in action.

The Tertiary Education Commission

Recommendation 10

A pilot is funded for closer TEO/industry collaboration on learning and delivery that builds on the secondary/tertiary pathways' projects; aligns with vocational pathways; and enables students to have exposure to a diverse range of engineering jobs and people in engineering industries.

Recommendation 11

Further research on successful early career engineering graduates is undertaken in five years (2021) using this research as a benchmark to determine if there are changes to the work-readiness of graduates.

A small commissioned set of interested Polytechnic and University engineering programme leaders and their teams undertake to work collaboratively in 2017-18 to test out the relevance and utility of the findings of the study for:

a. reviewing and enhancing the relevance of current programme level outcomes in the engineering qualification which they teach;
b. enhancing their current approaches to the use of integrating capstone assessment tasks and grading;
c. enhancing the design of their engineering program; and
d. aligning this work with the field tests of the proposed New Zealand Capability Development (currently called 'Assessment') framework for New Zealand TEOs.

The Productivity Commission

Recommendation 12

The Commission adopt a similar 'Successful Graduate' research process to field test the proposed New Zealand Capability Development Framework to identify the skills relevant to a changing job market and how these might be integrated into assessment processes.

The Ministry of Business, Innovation and Employment

Recommendation 13

MBIE note the potential of the 'Successful Graduate' research process to improve engagement between employers and academics, improve tertiary education providers' understanding of what employers need from new graduates and identify where changes can be made to the curriculum to make graduates more effective in the workplace.

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Appendix 1: Talking with Employers Workshop June 2015

The key capabilities and competencies of successful engineering graduates identified by participants were:

PERSONAL CAPABILITIES

- Self-awareness and regulation: humility; knows strengths and weaknesses; high levels of self-awareness and self-management; willing to learn from errors; leads a balanced life.
- Decisiveness: willing to go for sensible approximation; tolerates ambiguity; willing to take sensible risks.
- Commitment: energy, passion; commitment; takes responsibility for allocated jobs.

INTERPERSONAL CAPABILITIES

- Influencing: team player; able to work with diversity; good at influencing teams; community engaged.
- Empathising: a people person; empathises.

COGNITIVE CAPABILITIES

- Diagnosis: able to 'read' situations and 'match' the right combination of skills and knowledge to address this(multiple ticks); good at determining what is 'fit for purpose'; able to draw out the core issue from a mass of information; able to ask the right questions.
- Strategy: capable of lateral thinking; good at strategy and implementation.
- Flexibility and responsiveness: Able to learn from experience; adaptable.

KEY COMPETENCIES (skills & knowledge)

- A high level of technical skill and knowledge (including strong coding and calculus skills)
- The specific skills and knowledge to perform competently in the engineering area concerned
- Commercial astuteness, including the ability to manage risk and liability in a complex regulatory environment
- Knowledge of how to bring a competitive edge to an organisations) along with a range of basic, generic skills and knowledge (including strong written skills, computing skills and understanding, knowledge of how to project manage, work productively with clients from diverse backgrounds etc).

A high level of competence is necessary but not sufficient for effective professional performance.

Appendix 2: Quantitative results - All

Successful Graduate Capability Study – Engineering 2016 (N=124)
Five highest ranks within the first and last sections are highlighted in green
Twelve highest ranked abilities are highlighted in yellow

Importance for work		Items	Extent of focus in study	
Mean	Rank	Judging Your own Effectiveness at Work	Mean	Rank
4.35	3	1. Helping ensure my clients (internal and external) get the right support	2.47	11
4.53	2	2. Successfully finishing the jobs I have to do on time	3.95	1
3.75	8	3. Receiving positive feedback from my supervisor	2.83	7=
4.02	6	4. Receiving positive feedback from my (internal/external) clients	2.72	10
3.57	9	5. Receiving positive feedback from colleagues	2.83	7=
4.11	5	6. Achieving goals set for my professional development	3.21	3
4.15	4	7. Establishing a collegial working environment	3.15	4
4.64	1	8. Achieving successful outcomes	3.94	2
2.32	11	9. Winning awards for my work	2.74	9
3.16	10	10. Being invited to discuss my work with others	3.14	5
3.85	7	11. Successfully implementing new initiatives	3.00	6

Importance for work		Items	Extent of focus in study	
Mean	Rank	Personal Capabilities	Mean	Rank
4.69	2	1. Being willing to face and learn from my errors and listen openly to feedback	3.31	16=
4.31	20	2. Understanding my personal strengths & limitations	3.00	25
4.21	24=	3. Being confident to take calculated risks and take on new projects	2.96	28
4.56	5	4. Being able to remain calm under pressure or when things go wrong	2.99	26
4.17	27=	5. Having the ability to defer judgment and not to jump in too quickly to resolve a problem	2.78	36
4.43	8=	6. A willingness to persevere when things are not working out as anticipated	3.44	11=
4.44	7	7. Wanting to produce as good a job as possible	3.79	2
4.43	8=	8. Being willing to take responsibility for projects, including how they turn out	3.60	8
4.29	21=	9. Having an ability to make a hard decision	2.86	31
4.15	30	10. A willingness to pitch in and undertake menial tasks when needed	3.09	22
4.21	24=	11. Having a sense of humour and being able to keep work in perspective	2.92	29
4.32	19	12. Having the courage and persistence to follow a course of action to its conclusion	3.31	16=

Importance for work		Items	Extent of focus in study	
Mean	Rank	Interpersonal Capabilities	Mean	Rank
4.35	16=	1. The ability to empathise with and work productively with people from a wide range of backgrounds	3.44	11=
4.37	14	2. A willingness to listen to different points of view before coming to a decision	3.41	13
4.43	8=	3. Being able to develop and use networks of colleagues to help me solve key workplace problems	3.25	19
4.29	21=	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	2.45	40
4.39	13	5. Being able to work with senior staff without feeling intimidated	2.71	37
4.17	27=	6. Being able to give constructive feedback to work colleagues and others without engaging in personal blame	2.82	33
4.00	36	7. Being able to motivate others to achieve great things	2.56	39
4.43	8=	8. Being able to develop and contribute positively to team-based projects	3.75	5
2.32	11	9. Winning awards for my work	2.74	9
3.16	10	10. Being invited to discuss my work with others	3.14	5
3.85	7	11. Successfully implementing new initiatives	3.00	6

Importance for work		Items	Extent of focus in study	
Mean	Rank	Intellectual Capabilities	Mean	Rank
4.08	33	1. Knowing that there is never a fixed set of steps for solving workplace problems or carrying out a task	3.16	20
4.41	12	2. Being able to identify from a mass of detail the core issue in any situation	3.47	10
4.48	6	3. The ability to use previous experience to figure out what is going on when a current situation takes an unexpected turn	3.12	21
4.18	26	4. Being able to diagnose what is really causing a problem and then to test this out in action	3.30	18
4.35	16=	5. An ability to trace out and assess the consequences of alternate courses of action and, from this, pick the one most suitable	3.34	15
4.33	18	6. Being able to readjust a plan of action in light of what happens as it is implemented	3.02	24
4.13	31	7. Being able to see how apparently unconnected activities are linked and make up an overall picture	2.90	30
4.57	4	8. Being able to set and justify priorities	3.65	7
3.97	37	9. An ability to recognise patterns in a complex situation	3.39	14
4.59	3	10. Being able to understand internal or external client requirements and respond appropriately	2.79	34=

Importance for work		Items	Extent of focus in study	
Mean	Rank	Key Skills and Knowledge	Mean	Rank
3.74	41	1. Having a high level of current technical expertise relevant to my work area	3.76	3=
4.05	34	2. Understanding the role of risk management and litigation in current professional work	2.85	32
4.29	21=	3. Understanding how organisations like my current one operate	2.22	41
3.88	40	4. Having an understanding of the current issues in my professional field	2.70	38
3.45	42	5. An ability to communicate the range of services offered by the firm according (or tailored) to the needs of the client	2.19	42
4.36	15	6. Being able to use Information & Communications Technology (ICT) effectively to communicate and perform key work	3.76	3=
4.10	32	7. Being able to manage my own ongoing professional learning and development	3.52	9
4.04	35	8. An ability to chair and participate constructively in meetings	2.79	34=
3.92	39	9. Being able to make effective presentations to clients / colleagues	3.68	6
4.17	27=	10. Knowing how to manage projects into successful implementation	3.08	23
3.96	38	11. An ability to help others learn in the workplace	2.98	27
4.70	1	12. Being able to organise my work and manage time effectively	4.01	1

Importance for work		Items	Extent of focus in study	
Mean	Rank	Keeping Higher Education Learning Relevant	Mean	Rank
4.04	6	1. Focus more directly on the capabilities identified by successful engineers as being important in polytechnic/university courses and assessment	2.99	3
4.38	1	2. Use real-life workplace problems identified by successful graduates as a key resource for learning	2.77	5
4.15	5	3. Make work-placements which test out the capabilities identified as most important in this study a key focus in each course	2.98	4
3.91	9	4. Use successful graduates more consistently as a learning resource in polytechnic/university courses (e.g. as guest speakers)	2.64	10
2.98	11	5. Decrease the amount of formal classroom teaching of basic technical skills and use self-instructional guides and ICT to develop these	2.59	11
4.32	3	6. Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession	3.03	2
3.95	7=	7. When relevant, use ICT to make learning as convenient and interactive as possible	3.14	1
3.95	7=	8. Ensure that all teaching staff model the key attributes identified as being important in this study	2.75	7
4.16	4	9. Ensure that teaching staff have current workplace experience	2.71	9
4.34	2	10. Make assessment more real-world and problem-based and less focused on memorising factual material	2.76	6
3.75	10	11. Use performance on the capabilities identified as being most important in earlier parts of this survey as the focus for assessment and feedback on all learning tasks	2.72	8

Appendix 3: Profile of graduates

Location	Frequency	Percent
Metropolitan city - e.g. Auckland, Wellington or Christchurch	98	79
Provincial city - e.g. Hamilton, Napier, Nelson, Dunedin	17	13.7
Town - e.g. Thames, Oamaru, Fielding, Ashburton	5	4
Total	120	96.8
Missing	4	3.2
Total	124	100

Region	Frequency	Percent
Northland	1	0.8
Auckland	56	45.2
Waikato	2	1.6
Bay of Plenty	4	3.2
Hawkes Bay	3	2.4
Taranaki	2	1.6
Whanganui	1	0.8
Wellington	17	13.7
Canterbury	28	22.6
Otago	7	5.6
Other, please state (note none stated)	3	2.4
Total	124	100

Number of employees in organisation	Frequency	Percent
1 to 10	3	2.4
11 to 20	4	3.2
21 to 30	6	4.8
31 to 40	9	7.3
41 to 50	2	1.6
51 to 100	12	9.7
101 to 150	6	4.8
151 to 200	1	0.8
Over 200	81	65.3
Total	124	100

Type of Organisation	Frequency	Percent
Civil	67	54
Mechanical	27	21.8
Electrical	10	8.1
Civil and Mechanical	2	1.6
Mechanical and Electrical	7	5.7
Civil, Mechanical, Electrical	4	3.2
Other - Aviation, Industrial	7	5.7
Total	124	100

Job Title	Frequency	Percent
Civil Engineering		
Asset Engineer/Technician	2	1.6
Building Inspector	1	0.8
Civil Engineer/Technologist/Technician	15	12.1
Site Engineer	6	4.8
Structural Engineer	6	4.8
Structural Draftsman	1	0.8
Transportation engineer	3	2.4
Contract Manager	1	0.8
Engineering Technologist	1	0.8
Electrical/Electronics		
Electrical Engineer/Technician	4	3.2
Electronics Engineer	4	3.2
Engineer Lines	2	1.6
Mechanical		
Marine Engineer	2	1.6
Mechanical Engineer	8	6.5
Other		
Graduate Engineer	44	35.5
Project Engineer	9	7.3
Product Development Engineer	3	2.4
Civil & Mechanical Engineer	2	1.6
Analyst Lead	1	0.8
Application Development & Support Analyst	1	0.8
Engineering Lead	1	0.8
Naval Architect	1	0.8
Quality, Safety, and Risk Analyst	1	0.8
Services Engineer	1	0.8
Specialist Recruiting Officer (Engineers)	1	0.8
Systems Engineer 2	1	0.8
Automation Engineer	1	0.8
Biomedical Engineer	1	0.8
Total	124	100

Year joined organisation	Frequency	Percent
2016	23	18.5
2015	31	25
2014	27	21.8
2013	12	9.7
2012	15	12.1
2011	8	6.5
2010	1	0.8
2009	2	1.6
2008	1	0.8
2005	1	0.8
2003	2	1.6
1995	1	0.8
Total	124	100

Main activities in job

Design
Documentation – technical and reports
Client/Stakeholder management
Project management
Quality assurance

Institute of Technology and Polytechnic	Frequency	Percent
CPIT now Ara	4	3.2
MIT	2	1.6
Otago Polytechnic	6	4.8
Unitec	14	11.3
WelTec	8	6.5
Wintec	1	0.8
Total	35	28.2
University		
AUT	5	4.0
Massey University	4	3.2
University of Auckland	36	29
University of Canterbury	37	29.8
University of Waikato	3	2.4
Victoria University	1	0.8
Total	86	69.4
Other		
Loughborough University, UK	2	1.6
Australian Maritime College	1	0.8
Total	3	2.4
Grand Total	124	100

Main qualification and major				Frequency	Percent by major	Percent total
What was the main qualification (e.g. Diploma or Bachelors)	Diploma of Engineering	What was the major of your qualification?	Civil	3	38	2
			Mechanical	3	38	2
			Electrical	2	25	2
			Other	0	0	0
	Bachelor of Engineering Technology	What was the major of your qualification?	Civil	20	67	16
			Mechanical	5	17	4
			Electrical	4	13	3
			Other	1	3	1
	Bachelor of Engineering (Hons)	What was the major of your qualification?	Civil	39	49	31
			Mechanical	32	40	26
			Electrical	4	5	3
			Other	5	6	4
	Other, please specify below	What was the major of your qualification?	Civil	2	33	2
			Mechanical	0	0	0
			Electrical	0	0	0
			Other	4	67	3

Other

BEngTech Software (1)
BE (Hons)/BCom (1)
BE (Hons) Product Development (2)
BE (Hons) Naval Architecture (1)
BE (Hons) Chemical and Materials (1)
BE (Hons) Chemical and Process (1)
MEng Civil (3)
Bachelor Forestry Science (1)

Year qualification completed	Frequency	Percent
2016	3	2.4
2015	35	28.2
2014	31	25
2013	19	15.3
2012	15	12.1
2011	18	14.5
2010	2	1.6
2009	1	.8
Total	124	100

Gender	Frequency	Percent
Male	97	78.2
Female	27	21.8
Total	124	100

Ethnicity	Frequency	Percent
New Zealand Māori	7	5.6
New Zealand European/Pakeha	84	67.7
Pasifika	3	2.4
Asian	11	8.9
Other New Zealand	4	3.2
Other, please specify	15	12.1
Total	124	100

Other	Frequency	Other	Frequency
British	1	New Zealand Indian	1
EUROPEAN	1	New Zealander	2
Indian	5	NZ European/Asian	1
Kazakh	1	Scottish	1
Middle Eastern (Iraqi)	1	Turkish	1

Appendix 4: Six Key Challenging Situations

A selection of challenging situations from engineering graduates.

Situation 1

During a bridge pile pour the pile seal failed between the concrete pile and the void former which was supposed to remain empty to allow for movement in an earthquake. The void started filling with concrete as well but was not discovered until about 3 loads of concrete were emptied into the hole. The program was significantly behind and was holding up other crews on the job.
This would have been easy to hide as the engineering inspections were completed and the pile would be capped with a steel plate after the pour. I knew that the remedial for this would cost close to 100k vs a couple of extra trucks of concrete to cover it up. However I knew ethically this was not the right thing to do.

I made the call to stop the pour and bin 3 trucks of concrete that were waiting on site. I then decided to tell my manager and together we decided that the right thing to do would be to notify the design engineers to start planning the remedials. The main project (we were subbies) was not happy as the remedial as it took 3 months to implement although we bore the cost (approx $75,000) it was the right decision.

The most challenging part was understanding how bad the situation was in terms of contract delay and cost and having to be the person to stand up and do the right thig against what the main contractor wanted to do to save program. Understanding the professional consequences of omitting such a mistake aided in my decision making

Situation 2

I had a difficult client who refused to pay the company for any work undertaken and wanted to apportion blame for unforeseen circumstances that he was ultimately warned about. This required extensive time and resource.

I consulted with two mentors to seek experience from them.
I am very good at documenting time and tasks, so had a solid pool of evidence to back up any arguments I had to present. My work diary was invaluable.

Situation 3

Two years ago I was tasked with completing the compliance process for gaining approval to run a road-rail truck on the rail network in an Australian state. This involved completing a compliance plan which details how we plan to meet the requirements of the rail network regulations with the design of the vehicle, the construction of the vehicle and through performance testing of the vehicle.

This involved working with a rolling stock compliance engineer from the rail network to develop an approved plan, working with our Rail Chief Engineer to ensure the vehicle met the requirements of the compliance plan and working with vehicle manufacturers to ensure the construction of the vehicle met the requirements of the compliance plan.

The hardest part of the process was from the outset trying to learn how the process operated, as I had no previous experience of working to any form of standards during my time at university. This involved a lot of time working through the standards and example plans, as well as plenty of back and forth with the Rail network rolling stock engineer. The final plan required an exhaustive list of requirements for the vehicle to meet before it could be signed off for use. This then required a somewhat difficult task of ensuring all of the conditions were met before the vehicle was shipped to Australia, in particular with a boss that was more interested in just getting it on the rail then meeting the requirements of the standards.

Situation 4

My most challenging situation was the preparation of a large construction project, to issue the detailed design. This particular project was shelved half way through design due to money constraints, four years ago. It was my job (me alone) to bring the project up to scratch and get it finished and issued in VERY limited time. A lot of re-design was required. The most challenging parts were to take sense of various peoples work and bring it together to make it make sense to the bigger picture of the project. Client relations were also a challenge with me consulting the clients, without them realising this was my first project. I was definitely thrown in the deep end, but it was my interpersonal skills that ultimately got me through it. I found that simply by maintaining a high level of communication throughout, the clients and colleagues alike worked well, and were happy with my performance. This was because everybody could understand the situation everybody else was in, so could sympathise and empathise when required. It is surprising how much of an impact this has on a project's success.

Situation 5

We had been developing this new product for a few years now and it wasn't good enough in a particular area. We stopped what we were doing and for a few months just took a big step back and went back to first principles. We took photos and videos of the product being used and analysed frame by frame what was actually going on and how the product was functioning. Looking at it really closely trying to perform its function and forgetting all our assumptions and prior knowledge - looking at it with fresh eyes - gave us some amazing insights and completely flipped the knowledge we had been basing the design on. We stripped out some of the rubbish we assumed was working added some new features - transforming it into something almost ready to launch. The most challenging part was letting go of all this prior work and prior knowledge - taking my ego out of the situation and accepting that we needed to start from the basics again and that we didn't understand the root of the problem

Situation 6

On the first project in my career, I was looking after the drainage installation (2km of wastewater and 2.5km of stormwater). At the peak time there were 3 crews (1 our own crew + 2 subcontractors) doing the job which included excavating a trench, laying pipes (different types and sizes) and installing manholes, backfilling and compacting, cleaning and testing.
My job was to "read" the design, order materials, programme the construction, health & safety, quality assurance, measure an actual job is done on site, claim the payments from client and pay to the subcontractors, etc.

To the end of the drainage job one of the subcontractors came to me and would like to claim more than we suppose to pay. My first reaction was perplexity, because I knew that we paid the whole amount for the job his crew is done on site. So it was not the best thing for me (young and new) to deal with expe-

rienced man who knows his job very well (including all the tricks). However, my project manager advised me to start putting all my records together and prepare all the details (measurements, calculations, photos, as-built forms, etc.) for the meeting with the subcontractor.

I was so happy and thanked myself that I had very accurate records at the end (even I have spent a lot of time and energy on that during the construction period). It was my first lesson, ALWAYS have good records (diary, timesheets, photos, quality forms, etc.) and keep them up to date.

After preparing all backup documentations for the meeting with subcontractor I found that my project manager cannot participate to the meeting and I have to deal with that by myself. It was a little bit stressful for me but my attitude to that situation was that I need to find a positive side of it and carry on. So during the meeting both sides presented their views on that situation and their backup documents. A subcontractor really did not have a lot to show therefore he started to go through my records in details. After intensive discussion face to face and looking my records he could not argue much and agreed on what we have already paid to him.

The outcome for me was positive. I proved that I was correct and fair with him. Also, I have learnt a lot from that example, mainly how to manage critical situations using my personal and professional capabilities. At the end of the day I kept a good relationship with the subcontractor and we shake the hand and smile when we see each other.

Appendix 5: Quantitative results - Universities

Successful Graduate Capability Study – Engineering 2016 (N=89)
Five highest ranks within the first and last sections are highlighted in green
Twelve highest ranked abilities are highlighted in yellow

Importance for work		Items	Extent of focus in study	
Mean	Rank	Judging Your own Effectiveness at Work	Mean	Rank
4.42	3	1. Helping ensure my clients (internal and external) get the right support	2.48	11
4.53	2	2. Successfully finishing the jobs I have to do on time	3.97	1
3.76	8	3. Receiving positive feedback from my supervisor	2.81	8
4.03	6	4. Receiving positive feedback from my (internal/external) clients	2.67	10
3.60	9	5. Receiving positive feedback from colleagues	2.86	7
4.08	5	6. Achieving goals set for my professional development	3.25	3
4.25	4	7. Establishing a collegial working environment	3.14	4
4.65	1	8. Achieving successful outcomes	3.92	2
2.28	11	9. Winning awards for my work	2.73	9
3.10	10	10. Being invited to discuss my work with others	3.10	5
3.85	7	11. Successfully implementing new initiatives	2.99	6

Importance for work		Items	Extent of focus in study	
Mean	Rank	Personal Capabilities	Mean	Rank
4.69	1	1. Being willing to face and learn from my errors and listen openly to feedback	3.32	15
4.31	18	2. Understanding my personal strengths & limitations	3.01	25
4.20	25=	3. Being confident to take calculated risks and take on new projects	2.94	29
4.56	3=	4. Being able to remain calm under pressure or when things go wrong	3.00	26
4.20	25=	5. Having the ability to defer judgment and not to jump in too quickly to resolve a problem	2.76	36
4.41	11	6. A willingness to persevere when things are not working out as anticipated	3.48	10
4.44	7	7. Wanting to produce as good a job as possible	3.73	4=
4.46	6	8. Being willing to take responsibility for projects, including how they turn out	3.59	8=
4.28	20=	9. Having an ability to make a hard decision	2.86	31
4.11	31	10. A willingness to pitch in and undertake menial tasks when needed	3.12	21
4.22	23=	11. Having a sense of humour and being able to keep work in perspective	2.99	27
4.28	20=	12. Having the courage and persistence to follow a course of action to its conclusion	3.29	16

Importance for work		Items	Extent of focus in study	
Mean	Rank	Interpersonal Capabilities	Mean	Rank
4.36	16	1. The ability to empathise with and work productively with people from a wide range of backgrounds	3.45	11
4.40	12=	2. A willingness to listen to different points of view before coming to a decision	3.39	12
4.38	15	3. Being able to develop and use networks of colleagues to help me solve key workplace problems	3.24	18=
4.22	23=	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	2.40	40
4.40	12=	5. Being able to work with senior staff without feeling intimidated	2.74	37
4.20	25=	6. Being able to give constructive feedback to work colleagues and others without engaging in personal blame	2.85	32
3.97	36	7. Being able to motivate others to achieve great things	2.50	39
4.39	14	8. Being able to develop and contribute positively to team-based projects	3.73	4=
4.07	33	1. Knowing that there is never a fixed set of steps for solving workplace problems or carrying out a task	3.17	20
4.43	8=	2. Being able to identify from a mass of detail the core issue in any situation	3.38	13
4.43	8=	3. The ability to use previous experience to figure out what is going on when a current situation takes an unexpected turn	3.08	23
4.19	28	4. Being able to diagnose what is really causing a problem and then to test this out in action	3.24	18=
4.43	8=	5. An ability to trace out and assess the consequences of alternate courses of action and, from this, pick the one most suitable	3.27	17
4.30	19	6. Being able to readjust a plan of action in light of what happens as it is implemented	3.04	24
4.13	29	7. Being able to see how apparently unconnected activities are linked and make up an overall picture	2.88	30
4.52	5	8. Being able to set and justify priorities	3.64	7
3.94	37	9. An ability to recognise patterns in a complex situation	3.36	14
4.56	3=	10. Being able to understand internal or external client requirements and respond appropriately	2.79	34

Importance for work		Items	Extent of focus in study	
Mean	Rank	Key Skills and Knowledge	Mean	Rank
3.76	41	1. Having a high level of current technical expertise relevant to my work area	3.80	2
4.01	34	2. Understanding the role of risk management and litigation in current professional work	2.77	35
4.24	22	3. Understanding how organisations like my current one operate	2.11	41
3.90	39	4. Having an understanding of the current issues in my professional field	2.70	38
3.56	42	5. An ability to communicate the range of services offered by the firm according (or tailored) to the needs of the client	2.10	42
4.34	17	6. Being able to use Information & Communications Technology (ICT) effectively to communicate and perform key work	3.77	3
4.10	32	7. Being able to manage my own ongoing professional learning and development	3.59	8=
3.99	35	8. An ability to chair and participate constructively in meetings	2.84	33
3.85	40	9. Being able to make effective presentations to clients / colleagues	3.67	6
4.12	30	10. Knowing how to manage projects into successful implementation	3.09	22
3.91	38	11. An ability to help others learn in the workplace	2.98	28
4.68	2	12. Being able to organise my work and manage time effectively	4.04	1

Importance for work		Items	Extent of focus in study	
Mean	Rank	Keeping Higher Education Learning Relevant	Mean	Rank
4.03	6	1. Focus more directly on the capabilities identified by successful engineers as being important in polytechnic/university courses and assessment	2.97	4
4.36	1	2. Use real-life workplace problems identified by successful graduates as a key resource for learning	2.78	5=
4.10	5	3. Make work-placements which test out the capabilities identified as most important in this study a key focus in each course	3.08	2
3.82	9	4. Use successful graduates more consistently as a learning resource in polytechnic/university courses (e.g. as guest speakers)	2.65	9=
2.96	11	5. Decrease the amount of formal classroom teaching of basic technical skills and use self-instructional guides and ICT to develop these	2.57	11
4.31	2	6. Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession	2.99	3
3.88	8	7. When relevant, use ICT to make learning as convenient and interactive as possible	3.12	1
3.94	7	8. Ensure that all teaching staff model the key attributes identified as being important in this study	2.71	7
4.19	4	9. Ensure that teaching staff have current workplace experience	2.65	9=
4.29	3	10. Make assessment more real-world and problem-based and less focused on memorising factual material	2.78	5=
3.75	10	11. Use performance on the capabilities identified as being most important in earlier parts of this survey as the focus for assessment and feedback on all learning tasks	2.69	8

Appendix 6: Quantitative results – ITPs

Successful Graduate Capability Study – Engineering 2016 (N=35)
Five highest ranks within the first and last sections are highlighted in green
Twelve highest ranked abilities are highlighted in yellow

Importance for work		Items	Extent of focus in study	
Mean	Rank	Judging Your own Effectiveness at Work	Mean	Rank
4.18	4	1. Helping ensure my clients (internal and external) get the right support	2.44	11
4.53	2	2. Successfully finishing the jobs I have to do on time	3.91	2
3.71	8	3. Receiving positive feedback from my supervisor	2.88	7
3.97	5	4. Receiving positive feedback from my (internal/external) clients	2.85	8
3.50	9	5. Receiving positive feedback from colleagues	2.74	10
4.21	3	6. Achieving goals set for my professional development	3.12	5
3.88	6	7. Establishing a collegial working environment	3.19	4
4.62	1	8. Achieving successful outcomes	4.00	1
2.42	11	9. Winning awards for my work	2.76	9
3.29	10	10. Being invited to discuss my work with others	3.24	3
3.85	7	11. Successfully implementing new initiatives	3.03	6

Importance for work		Items	Extent of focus in study	
Mean	Rank	Personal Capabilities	Mean	Rank
4.68	4	1. Being willing to face and learn from my errors and listen openly to feedback	3.26	19
4.32	20=	2. Understanding my personal strengths & limitations	2.97	27=
4.26	24	3. Being confident to take calculated risks and take on new projects	3.00	25=
4.56	6	4. Being able to remain calm under pressure or when things go wrong	2.97	27=
4.09	36=	5. Having the ability to defer judgment and not to jump in too quickly to resolve a problem	2.82	32
4.47	10	6. A willingness to persevere when things are not working out as anticipated	3.32	17
4.44	11=	7. Wanting to produce as good a job as possible	3.94	1
4.35	18	8. Being willing to take responsibility for projects, including how they turn out	3.62	9
4.32	20=	9. Having an ability to make a hard decision	2.85	31
4.24	25	10. A willingness to pitch in and undertake menial tasks when needed	3.03	24
4.18	27	11. Having a sense of humour and being able to keep work in perspective	2.74	35
4.44	11=	12. Having the courage and persistence to follow a course of action to its conclusion	3.38	15

Importance for work		Items	Extent of focus in study	
Mean	Rank	Interpersonal Capabilities	Mean	Rank
4.33	19	1. The ability to empathise with and work productively with people from a wide range of backgrounds	3.39	14
4.30	22=	2. A willingness to listen to different points of view before coming to a decision	3.45	12=
4.55	7=	3. Being able to develop and use networks of colleagues to help me solve key workplace problems	3.27	18
4.48	9	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	2.58	40
4.39	16	5. Being able to work with senior staff without feeling intimidated	2.61	39
4.09	36=	6. Being able to give constructive feedback to work colleagues and others without engaging in personal blame	2.76	34
4.09	36=	7. Being able to motivate others to achieve great things	2.73	36
4.55	7=	8. Being able to develop and contribute positively to team-based projects	3.82	3

Importance for work		Items	Extent of focus in study	
Mean	Rank	Key Skills and Knowledge	Mean	Rank
3.70	41	1. Having a high level of current technical expertise relevant to my work area	3.63	8
4.17	28	2. Understanding the role of risk management and litigation in current professional work	3.10	22
4.40	14=	3. Understanding how organisations like my current one operate	2.50	41
3.83	40	4. Having an understanding of the current issues in my professional field	2.69	37
3.13	42	5. An ability to communicate the range of services offered by the firm according (or tailored) to the needs of the client	2.43	42
4.40	14=	6. Being able to use Information & Communications Technology (ICT) effectively to communicate and perform key work	3.73	4
4.10	32=	7. Being able to manage my own ongoing professional learning and development	3.33	16
4.20	26	8. An ability to chair and participate constructively in meetings	2.67	38
4.10	32=	9. Being able to make effective presentations to clients / colleagues	3.70	6
4.30	22=	10. Knowing how to manage projects into successful implementation	3.07	23
4.10	32=	11. An ability to help others learn in the workplace	3.00	25=
4.77	1	12. Being able to organise my work and manage time effectively	3.93	2

Importance for work		Items	Extent of focus in study	
Mean	Rank	Keeping Higher Education Learning Relevant	Mean	Rank
4.07	7=	1. Focus more directly on the capabilities identified by successful engineers as being important in polytechnic/university courses and assessment	3.04	3
4.44	2	2. Use real-life workplace problems identified by successful graduates as a key resource for learning	2.74	7
4.30	4	3. Make work-placements which test out the capabilities identified as most important in this study a key focus in each course	2.70	8
4.19	5	4. Use successful graduates more consistently as a learning resource in polytechnic/university courses (e.g. as guest speakers)	2.62	11
3.04	11	5. Decrease the amount of formal classroom teaching of basic technical skills and use self-instructional guides and ICT to develop these	2.63	10
4.33	3	6. Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession	3.15	2
4.15	6	7. When relevant, use ICT to make learning as convenient and interactive as possible	3.19	1
4.00	9	8. Ensure that all teaching staff model the key attributes identified as being important in this study	2.85	5
4.07	7=	9. Ensure that teaching staff have current workplace experience	2.88	4
4.48	1	10. Make assessment more real-world and problem-based and less focused on memorising factual material	2.69	9
3.74	10	11. Use performance on the capabilities identified as being most important in earlier parts of this survey as the focus for assessment and feedback on all learning tasks	2.81	6

Appendix 7: Quantitative results – 1-2 Year Graduates

Successful Graduate Capability Study – Engineering 2016 (N=38)

Five highest ranks within the first and last sections are highlighted in green
Twelve highest ranked abilities are highlighted in yellow

Importance for work		Items	Extent of focus in study	
Mean	Rank	Judging Your own Effectiveness at Work	Mean	Rank
4.33	3	1. Helping ensure my clients (internal and external) get the right support	2.74	11
4.54	2	2. Successfully finishing the jobs I have to do on time	4.08	2
3.95	8	3. Receiving positive feedback from my supervisor	3.08	7
4.23	5	4. Receiving positive feedback from my (internal/external) clients	3.03	8
3.69	9	5. Receiving positive feedback from colleagues	2.97	10
4.31	4	6. Achieving goals set for my professional development	3.61	3
4.21	6	7. Establishing a collegial working environment	3.26	6
4.67	1	8. Achieving successful outcomes	4.15	1
2.47	11	9. Winning awards for my work	3.00	9
3.23	10	10. Being invited to discuss my work with others	3.33	5
4.00	7	11. Successfully implementing new initiatives	3.47	4

Importance for work		Items	Extent of focus in study	
Mean	Rank	Personal Capabilities	Mean	Rank
4.66	1	1. Being willing to face and learn from my errors and listen openly to feedback	3.42	15=
4.29	26	2. Understanding my personal strengths & limitations	3.03	29=
4.18	31	3. Being confident to take calculated risks and take on new projects	3.11	27
4.50	10=	4. Being able to remain calm under pressure or when things go wrong	3.29	22=
4.26	28	5. Having the ability to defer judgment and not to jump in too quickly to resolve a problem	2.95	32=
4.50	10=	6. A willingness to persevere when things are not working out as anticipated	3.58	10=
4.58	6=	7. Wanting to produce as good a job as possible	3.92	3
4.45	14	8. Being willing to take responsibility for projects, including how they turn out	3.71	7
4.37	21	9. Having an ability to make a hard decision	2.95	32=
4.39	17=	10. A willingness to pitch in and undertake menial tasks when needed	3.26	24
4.39	17=	11. Having a sense of humour and being able to keep work in perspective	3.05	28
4.50	10=	12. Having the courage and persistence to follow a course of action to its conclusion	3.37	18

Importance for work		Items	Extent of focus in study	
Mean	Rank	Interpersonal Capabilities	Mean	Rank
4.47	13	1. The ability to empathise with and work productively with people from a wide range of backgrounds	3.56	12
4.42	15	2. A willingness to listen to different points of view before coming to a decision	3.31	21
4.58	6=	3. Being able to develop and use networks of colleagues to help me solve key workplace problems	3.42	15=
4.33	22	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	2.50	40
4.56	8	5. Being able to work with senior staff without feeling intimidated	2.86	35
4.31	24	6. Being able to give constructive feedback to work colleagues and others without engaging in personal blame	2.75	38
4.06	36=	7. Being able to motivate others to achieve great things	2.69	39
4.60	4	8. Being able to develop and contribute positively to team-based projects	3.83	4

Importance for work		Items	Extent of focus in study	
Mean	Rank	Intellectual Capabilities	Mean	Rank
4.27	27	1. Knowing that there is never a fixed set of steps for solving workplace problems or carrying out a task	3.21	25
4.41	16	2. Being able to identify from a mass of detail the core issue in any situation	3.64	9
4.53	9	3. The ability to use previous experience to figure out what is going on when a current situation takes an unexpected turn	3.39	17
4.21	29=	4. Being able to diagnose what is really causing a problem and then to test this out in action	3.44	13=
4.32	23	5. An ability to trace out and assess the consequences of alternate courses of action and, from this, pick the one most suitable	3.44	13=
4.38	20	6. Being able to readjust a plan of action in light of what happens as it is implemented	3.35	19
4.09	33=	7. Being able to see how apparently unconnected activities are linked and make up an overall picture	3.03	29=
4.62	3	8. Being able to set and justify priorities	3.94	2
4.06	36=	9. An ability to recognise patterns in a complex situation	3.29	22=
4.59	5	10. Being able to understand internal or external client requirements and respond appropriately	3.12	26

Importance for work		Items	Extent of focus in study	
Mean	Rank	Key Skills and Knowledge	Mean	Rank
3.48	41	1. Having a high level of current technical expertise relevant to my work area	3.78	6
4.09	33=	2. Understanding the role of risk management and litigation in current professional work	2.88	34
4.39	17=	3. Understanding how organisations like my current one operate	2.44	41=
3.91	40	4. Having an understanding of the current issues in my professional field	2.81	36=
3.42	42	5. An ability to communicate the range of services offered by the firm according (or tailored) to the needs of the client	2.44	41=
4.30	25	6. Being able to use Information & Communications Technology (ICT) effectively to communicate and perform key work	3.67	8
4.21	29=	7. Being able to manage my own ongoing professional learning and development	3.58	10=
4.03	38	8. An ability to chair and participate constructively in meetings	3.03	29=
3.97	39	9. Being able to make effective presentations to clients / colleagues	3.79	5
4.15	32	10. Knowing how to manage projects into successful implementation	3.33	20
4.09	33=	11. An ability to help others learn in the workplace	2.81	36=
4.64	2	12. Being able to organise my work and manage time effectively	4.12	1

Importance for work		Items	Extent of focus in study	
Mean	Rank	Keeping Higher Education Learning Relevant	Mean	Rank
4.19	5=	1. Focus more directly on the capabilities identified by successful engineers as being important in polytechnic/university courses and assessment	3.19	2
4.58	1	2. Use real-life workplace problems identified by successful graduates as a key resource for learning	2.74	9
4.19	5=	3. Make work-placements which test out the capabilities identified as most important in this study a key focus in each course	3.03	4
4.00	8=	4. Use successful graduates more consistently as a learning resource in polytechnic/university courses (e.g. as guest speakers)	2.65	10
3.06	11	5. Decrease the amount of formal classroom teaching of basic technical skills and use self-instructional guides and ICT to develop these	2.58	11
4.26	3	6. Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession	3.26	1
4.00	8=	7. When relevant, use ICT to make learning as convenient and interactive as possible	3.10	3
4.23	4	8. Ensure that all teaching staff model the key attributes identified as being important in this study	2.74	8
4.19	5=	9. Ensure that teaching staff have current workplace experience	2.84	5=
4.48	2	10. Make assessment more real-world and problem-based and less focused on memorising factual material	2.84	5=
3.87	10	11. Use performance on the capabilities identified as being most important in earlier parts of this survey as the focus for assessment and feedback on all learning tasks	2.81	7

Appendix 8: Quantitative results – 3+ Year Graduates

Successful Graduate Capability Study – Engineering 2016 (N=86)
Five highest ranks within the first and last sections are highlighted in green
Twelve highest ranked abilities are highlighted in yellow

Importance for work		Items	Extent of focus in study	
Mean	Rank	Judging Your own Effectiveness at Work	Mean	Rank
4.36	3	1. Helping ensure my clients (internal and external) get the right support	2.34	11
4.52	2	2. Successfully finishing the jobs I have to do on time	3.89	1
3.65	8	3. Receiving positive feedback from my supervisor	2.71	8
3.92	6	4. Receiving positive feedback from my (internal/external) clients	2.58	10
3.51	9	5. Receiving positive feedback from colleagues	2.76	7
4.02	5	6. Achieving goals set for my professional development	3.04	5
4.12	4	7. Establishing a collegial working environment	3.10	3
4.63	1	8. Achieving successful outcomes	3.84	2
2.25	11	9. Winning awards for my work	2.61	9
3.12	10	10. Being invited to discuss my work with others	3.05	4
3.78	7	11. Successfully implementing new initiatives	2.78	6

Importance for work		Items	Extent of focus in study	
Mean	Rank	Personal Capabilities	Mean	Rank
4.70	2	1. Being willing to face and learn from my errors and listen openly to feedback	3.25	17
4.33	16=	2. Understanding my personal strengths & limitations	2.99	24
4.23	24	3. Being confident to take calculated risks and take on new projects	2.89	26
4.59	4	4. Being able to remain calm under pressure or when things go wrong	2.86	28=
4.12	28=	5. Having the ability to defer judgment and not to jump in too quickly to resolve a problem	2.70	34=
4.40	9	6. A willingness to persevere when things are not working out as anticipated	3.37	14
4.37	11=	7. Wanting to produce as good a job as possible	3.73	4
4.42	7	8. Being willing to take responsibility for projects, including how they turn out	3.54	7
4.25	21	9. Having an ability to make a hard decision	2.81	33
4.04	33=	10. A willingness to pitch in and undertake menial tasks when needed	3.01	22=
4.12	28=	11. Having a sense of humour and being able to keep work in perspective	2.86	28=
4.24	22=	12. Having the courage and persistence to follow a course of action to its conclusion	3.29	15=

Importance for work		Items	Extent of focus in study	
Mean	Rank	Interpersonal Capabilities	Mean	Rank
4.30	19	1. The ability to empathise with and work productively with people from a wide range of backgrounds	3.39	13
4.35	15	2. A willingness to listen to different points of view before coming to a decision	3.45	10
4.36	13=	3. Being able to develop and use networks of colleagues to help me solve key workplace problems	3.18	19
4.28	20	4. Understanding how the different groups that make up my organisation operate and how much influence they have in different situations	2.42	40
4.33	16=	5. Being able to work with senior staff without feeling intimidated	2.64	38
4.11	30	6. Being able to give constructive feedback to work colleagues and others without engaging in personal blame	2.86	28=
3.98	36	7. Being able to motivate others to achieve great things	2.51	39
4.36	13=	8. Being able to develop and contribute positively to team-based projects	3.72	5

Importance for work		Items	Extent of focus in study	
Mean	Rank	Intellectual Capabilities	Mean	Rank
4.00	35	1. Knowing that there is never a fixed set of steps for solving workplace problems or carrying out a task	3.15	20
4.41	8	2. Being able to identify from a mass of detail the core issue in any situation	3.40	12
4.46	6	3. The ability to use previous experience to figure out what is going on when a current situation takes an unexpected turn	3.01	22=
4.17	26	4. Being able to diagnose what is really causing a problem and then to test this out in action	3.24	18
4.37	11=	5. An ability to trace out and assess the consequences of alternate courses of action and, from this, pick the one most suitable	3.29	15=
4.31	18	6. Being able to readjust a plan of action in light of what happens as it is implemented	2.88	27
4.15	27	7. Being able to see how apparently unconnected activities are linked and make up an overall picture	2.84	32
4.55	5	8. Being able to set and justify priorities	3.52	8
3.93	37	9. An ability to recognise patterns in a complex situation	3.43	11
4.60	3	10. Being able to understand internal or external client requirements and respond appropriately	2.66	36=

Importance for work		Items	Extent of focus in study	
Mean	Rank	Key Skills and Knowledge	Mean	Rank
3.85	41	1. Having a high level of current technical expertise relevant to my work area	3.75	3
4.04	33=	2. Understanding the role of risk management and litigation in current professional work	2.85	31
4.24	22=	3. Understanding how organisations like my current one operate	2.13	41
3.87	40	4. Having an understanding of the current issues in my professional field	2.66	36=
3.46	42	5. An ability to communicate the range of services offered by the firm according (or tailored) to the needs of the client	2.09	42
4.38	10	6. Being able to use Information & Communications Technology (ICT) effectively to communicate and perform key work	3.80	2
4.05	31=	7. Being able to manage my own ongoing professional learning and development	3.49	9
4.05	31=	8. An ability to chair and participate constructively in meetings	2.70	34=
3.90	39	9. Being able to make effective presentations to clients / colleagues	3.63	6
4.18	25	10. Knowing how to manage projects into successful implementation	2.97	25
3.91	38	11. An ability to help others learn in the workplace	3.05	21
4.73	1	12. Being able to organise my work and manage time effectively	3.96	1

Importance for work		Items	Extent of focus in study	
Mean	Rank	Keeping Higher Education Learning Relevant	Mean	Rank
3.97	6	1. Focus more directly on the capabilities identified by successful engineers as being important in polytechnic/university courses and assessment	2.90	4
4.30	2	2. Use real-life workplace problems identified by successful graduates as a key resource for learning	2.78	5
4.14	5	3. Make work-placements which test out the capabilities identified as most important in this study a key focus in each course	2.96	2
3.88	8	4. Use successful graduates more consistently as a learning resource in polytechnic/university courses (e.g. as guest speakers)	2.64	10
2.95	11	5. Decrease the amount of formal classroom teaching of basic technical skills and use self-instructional guides and ICT to develop these	2.59	11
4.34	1	6. Include learning experiences based on real-life case studies that specifically develop the interpersonal and personal skills needed in my particular profession	2.93	3
3.93	7	7. When relevant, use ICT to make learning as convenient and interactive as possible	3.15	1
3.83	9	8. Ensure that all teaching staff model the key attributes identified as being important in this study	2.75	6
4.15	4	9. Ensure that teaching staff have current workplace experience	2.65	9
4.27	3	10. Make assessment more real-world and problem-based and less focused on memorising factual material	2.72	7
3.69	10	11. Use performance on the capabilities identified as being most important in earlier parts of this survey as the focus for assessment and feedback on all learning tasks	2.68	8

Appendix 9: Standard for Accreditation/Recognition of Engineering Education Programmes (Excerpt)

(IPENZ, 2014)

Knowledge Profiles (K)

A Washington Accord programme (BE(Hons)) provides:	A Sydney Accord programme (BEngTech) provides:	A Dublin Accord programme (NZDE) provides:
WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline	**SK1:** A systematic, theory-based understanding of the natural sciences applicable to the sub-discipline	**DK1:** A descriptive, formula-based understanding of the natural sciences applicable in a sub-discipline
WK2: Conceptually-based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline	**SK2:** Conceptually-based mathematics, numerical analysis, statistics and aspects of computer and information science to support analysis and use of models applicable to the sub-discipline	**DK2**: Procedural mathematics, numerical analysis, statistics applicable in a sub-discipline
WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline	**SK3:** A systematic, theory-based formulation of engineering fundamentals required in an accepted sub-discipline	**DK3:** A coherent procedural formulation of engineering fundamentals required in an accepted sub-discipline
WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline	**SK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for an accepted sub-discipline	**DK4:** Engineering specialist knowledge that provides the body of knowledge for an accepted sub-discipline
WK5: Knowledge that supports engineering design in a practice area	**SK5:** Knowledge that supports engineering design using the technologies of a practice area	**DK5:** Knowledge that supports engineering design based on the techniques and procedures of a practice area
WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline	**SK6:** Knowledge of engineering technologies applicable in the sub-discipline	**DK6:** Codified practical engineering knowledge in recognised practice area
WK7: Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability	**SK7:** Comprehension of the role of technology in society and identified issues in applying engineering technology: ethics and impacts: economic, social, environmental and sustainability	**DK7:** Knowledge of issues and approaches in engineering technician practice: ethics, financial, cultural, environmental and sustainability impacts
WK8: Engagement with selected knowledge in the research literature of the discipline	**SK8:** Engagement with the technological literature of the discipline	

Range of Problem-Solving (P)

Attribute	Complex Engineering Problems have characteristic WP1 and some or all of WP2 to WP7:	Broadly-defined Engineering Problems have characteristic SP1 and some or all of SP2 to SP7:	Well-defined Engineering Problems have characteristic DP1 and some or all of DP2 to DP7:
Depth of Knowledge Required	**WP1:** Cannot be resolved without in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 which allows a fundamentals-based, first principles analytical approach	**SP1:** Cannot be resolved without engineering knowledge at the level of one or more of SK 4, SK5, and SK6 supported by SK3 with a strong emphasis on the application of developed technology	**DP1:** Cannot be resolved without extensive practical knowledge as reflected in DK5 and DK6 supported by theoretical knowledge defined in DK3 and DK4
Range of conflicting requirements	**WP2:** Involve wide-ranging or conflicting technical, engineering and other issues	**SP2:** Involve a variety of factors which may impose conflicting constraints	**DP2:** Involve several issues, but with few of these exerting conflicting constraints
Depth of analysis required	**WP3:** Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models	**SP3:** Can be solved by application of well-proven analysis techniques	**DP3:** Can be solved in standardised ways
Familiarity of issues	**WP4:** Involve infrequently encountered issues	**SP4:** Belong to families of familiar problems which are solved in well-accepted ways	**DP4:** Are frequently encountered and thus familiar to most practitioners in the practice area
Extent of applicable codes	**WP5:** Are outside problems encompassed by standards and codes of practice for professional engineering	**SP5:** May be partially outside those encompassed by standards or codes of practice	**DP5:** Are encompassed by standards and/or documented codes of practice
Extent of stakeholder involvement and conflicting requirements	**WP6:** Involve diverse groups of stakeholders with widely varying needs	**SP6:** Involve several groups of stakeholders with differing and occasionally conflicting needs	**DP6:** Involve a limited range of stakeholders with differing needs
Interdependence	**WP 7:** Are high level problems including many component parts or sub-problems	**SP7:** Are parts of, or systems within complex engineering problems	**DP7:** Are discrete components of engineering systems

Graduate Attributes, Programme Design and Student Achievement (A)

- A set of Programme Graduate Outcomes are defined for the programme.
- Programme Graduate Outcomes are substantially equivalent to the exemplar Graduate Attributes of the relevant Accord, but may also be customised to meet the advice of likely employers and target industries.
- The TEO must demonstrate that the programme provides for the progressive development and assessment of the relevant set of Graduate Attributes. The Graduate Attributes for each international accord are set out below, along with indicators of attainment to guide interpretation.

	Washington Accord	Sydney Accord	Dublin Accord
1.Engineering knowledge	**WA1: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to the solution of complex engineering problems.**	**SA1: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in SK1 to SK4 respectively to defined and applied engineering procedures, processes, systems or methodologies.**	**DA1: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in DK1 to DK4 respectively to wide practical procedures and practices.**
2.Problem analysis Complexity of analysis	**WA2: Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (WK1 to WK4)** **Indicators of attainment** • Identifies all relevant constraints and requirements and formulates an accurate description of the problem • Gathers engineering knowledge from the open literature and discerns the most relevant • Develops from the qualitative description of the problem mathematical, physical or computational models/solutions based on fundamental principles and justifiable assumptions • Selects appropriate analysis tools and applies those proficiently to implement the model/solution • Evaluates the analysis for accuracy and validity of assumptions made	**SA2: Identify, formulate, research literature and analyse broadly-defined engineering problems reaching substantiated conclusions using analytical tools appropriate to the discipline or area of specialisation (SK1 to SK4).** **Indicators of attainment** • Identifies relevant constraints and requirements and develops an accurate description of the problem • Gathers engineering knowledge from sources such as textbooks, reviews, codes of practice and standards and identifies the most relevant • Selects from the qualitative description of the problem a suitable form of mathematical, physical or computation model and justifies that choice • Selects appropriate analysis tools, which may include relevant standards and codes of practice, and applies those proficiently to implement the model • Systematically checks the analysis for accuracy and validity of assumptions made	**DA2: Identify and analyse well-defined engineering problems reaching substantiated conclusions using codified methods of analysis specific to their field of activity (DK1 to DK4).** **Indicators of attainment** • Identifies relevant constraints and requirements and sets out an accurate description of the problem • Gathers engineering knowledge from sources such as standards and codes of practice and identifies the most relevant • Applies established diagnostic processes and codified methods to define problems • Systematically checks the analysis for accuracy and validity of assumptions made
3.Design/ development of solutions Breadth and uniqueness of engineering problems i.e. the extent to which problems are original and to which solutions have previously been identified or codified	**WA3: Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations (WK5).** **Indicators of attainment** • Identifies all relevant constraints and requirements • Identifies information requirements and selects what is relevant from the open literature • Demonstrates creativity when proposing possible solutions • Screens alternative solutions systematically • Applies modern design theories and methodologies to develop/design possible solutions • Evaluates the feasibility of several possible solutions in all relevant contexts which, as appropriate to the problem, may include: technical, suitability for implementation, economic, aesthetic, ethical, health and safety, societal, environmental and cultural • Undertakes analysis to confirm the robustness of the proposed solution in the light of uncertain information and data • Describes the preferred solution and presents the findings in a coherent written form and defends those findings orally	**SA3: Design solutions for broadly- defined engineering technology problems and contribute to the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations (SK5).** **Indicators of attainment** • Identifies all relevant constraints and requirements • Identifies information requirements and obtains information from the relevant industry literature • Demonstrates creativity to propose possible solutions • Screens alternative solutions systematically • Develops/designs at least two possible solutions • Evaluates the feasibility of possible solutions in the most relevant contexts which, as appropriate to the problem, include some of technical, suitability for implementation, economic, aesthetic, ethical, health and safety, societal, environmental and cultural • Makes informed choices between alternatives based on sound analysis • Evaluates the robustness of the proposed solution in the light of uncertain information and data • Documents a preferred solution and presents the findings in a coherent written form	**DA3: Design solutions for well-defined technical problems and assist with the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations (DK5).** **Indicators of attainment** • Identifies relevant practical constraints and requirements • Identifies information requirements and obtains information from the relevant industry literature • Demonstrates creativity to propose possible solutions • Screens alternative solutions systematically • Develops/designs at least one possible solution • Considers contextual factors and in particular ensures that health, safety and sustainability imperatives are addressed as an integral part of the design process • Makes informed choices between alternatives and justifies approach. • Verifies the robustness of the proposed solution against clearly specified user requirements • Documents a preferred solution and presents the findings in a coherent written form

	Washington Accord	Sydney Accord	Dublin Accord
4.Investigation Breadth and depth of investigation and experimentation	**WA4: Conduct investigations of complex problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.** **Indicators of attainment** • Reviews the open research literature • Identifies the needs for research or investigation • Identifies appropriate research or investigation methodologies • Designs and executes valid forms of research, experimentation or measurement • Calibrates/validates the data collection methods and equipment • Analyses the data including considering sources of error • Draws valid conclusions and justifies those conclusions	**SA4: Conduct investigations of broadly-defined problems; locate, search and select relevant data from codes, data bases and literature (SK8), design and conduct experiments to provide valid conclusions.** **Indicators of attainment** • Reviews relevant textbooks, databases and guidance documents • Identifies the needs for investigation • Identifies an appropriate investigation methodology • Designs and executes valid forms of experimentation or measurement • Calibrates/validates the data collection methodology and equipment • Analyses the data including considering sources of error • Draws valid conclusions	**DA4: Conduct investigations of well-defined problems; locate and search relevant codes and catalogues, conduct standard tests and measurements.** **Indicators of attainment** • Reviews relevant textbooks, databases and guidance documents • Identifies the needs for data collection and/or testing • Identifies an appropriate data collection or testing methodology • Selects and applies established methods of data collection and measurement • Safely implements laboratory test and measurement procedures • Calibrates/validates the data collection methods and equipment • Analyses the data including considering sources of error • Draws valid conclusions
5.Modern tool usage Level of understanding of the appropriateness of the tool	**WA5: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations (WK6).** **Indicators of attainment** • Identifies the range of current tools available, selects one or more suitable tools and justifies the selection including considerations of the limitations of the tools available • Applies such tools, checks the results for validity, evaluates conclusions and the limitations on those conclusions	**SA5: Select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to broadly-defined engineering problems, with an understanding of the limitations (SK6).** **Indicators of attainment** • Understands the range of tools available, selects a suitable tool and justifies the selection including consideration of the limitation of the tools available • Applies such tools, checks results for validity, draws and explains conclusions and limitations on those conclusions	**DA5: Apply appropriate techniques, resources, and modern engineering and IT tools to well-defined engineering problems, with an awareness of the limitations (DK6).** **Indicators of attainment** • Understands the range of tools available, selects a suitable tool and explains the selection including consideration of the limitation of the tools available • Applies such tools, check the results for validity, identifies and draws conclusions and limitations on those conclusions
6.The engineer and society Level of knowledge and responsibility	**WA6: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems (WK7).** **Indicators of attainment** • Identifies the responsibilities of a professional engineer generally, and demonstrates an awareness of the issues associated with international engineering practice and global operating contexts • Evaluates the impacts of any relevant legislation or regulations and justifies relevant steps to be taken to ensure compliance • Identifies risks, develops and evaluates risk management strategies to minimise the likelihood of significant consequences (such as injury or loss of life, major environmental damage, or significant economic loss) occurring in the event of failure, unusual or unexpected circumstances • Identifies the relevant steps to be undertaken to address cultural (including Treaty of Waitangi) or community concerns • Identifies hazards and justifies relevant strategies and systems to reasonably assure public health and safety (including as appropriate to the discipline, safety in construction/fabrication, operation, maintenance, deconstruction/disposal, failing-safe and occupational health and safety)	**SA6: Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technology practice and solutions to broadly defined engineering problems (SK7).** **Indicators of attainment** • Identifies the responsibilities of an engineering technologist generally • Identifies the impacts of any relevant legislation or regulation and sets out relevant steps to be taken to ensure compliance • Identifies risks and develops risk management strategies to minimise the likelihood of significant consequences (such as injury or loss of life, major environmental damage, or significant economic loss) occurring in the event of failure, unusual or unexpected circumstances • Identifies the relevant steps to be undertaken to address cultural (including Treaty of Waitangi) or community concerns • Identifies hazards and explains relevant steps to be taken to reasonably assure public health and safety (including as appropriate to the discipline, safety in construction/fabrication, operation, maintenance, deconstruction/disposal, failing-safe and occupational health and safety)	**DA6: Demonstrate knowledge of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technician practice and solutions to well defined engineering problems (DK7).** **Indicators of attainment** • Demonstrates knowledge of the responsibilities of an engineering technician generally • Demonstrates knowledge of the impacts of any relevant legislation or regulation and identifies relevant steps to be taken to ensure compliance • Applies established risk management strategies to minimise the likelihood of significant consequences (such as injury or loss of life, major environmental damage, or significant economic loss) occurring in the event of failure • Identifies the relevant steps to be undertaken to address cultural (including Treaty of Waitangi) or community concerns • Identifies operational hazards and sets out relevant steps to be taken to lower the risk to public health and safety (including as appropriate to the discipline, safety in construction/fabrication, operation, maintenance, deconstruction/disposal, failing-safe and occupational health and safety)
7.Environment and sustainability Type of solutions.	**WA7: Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts (WK7).** **Indicators of attainment** • Identifies both direct and indirect and short and long term impacts (including through Treaty of Waitangi obligations) on people and the environment • Identifies and justifies specific actions required for environmental protection in the event of failure • Undertakes life-cycle analysis to determine the sustainability of any proposed outcomes	**SA7: Understand and evaluate the sustainability and impact of engineering technology work in the solution of broadly defined engineering problems in societal and environmental contexts (SK7).** **Indicators of attainment** • Identifies both direct and indirect impacts on people (including through Treaty of Waitangi obligations) and the environment • Identifies and explains means for ensuring environmental protection in the event of failure • Identifies and evaluates the major factors that have impact on the sustainability of any proposed outcomes	**DA7: Understand and evaluate the sustainability and impact of engineering technician work in the solution of well defined engineering problems in societal and environmental contexts (DK7).** **Indicators of attainment** • Identifies practical impacts on people (including through Treaty of Waitangi obligations) and the environment • Applies established methods for ensuring environmental protection in the event of failure • Identifies the major factors that have impacts on the sustainability of practical and technical project work

	Washington Accord	Sydney Accord	Dublin Accord
8.Ethics Understanding and level of practice	**WA8: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice (WK7).** **Indicators of attainment** • Demonstrates an understanding of the moral responsibilities of a professional engineer including: the need to self-manage in an orderly and ethical manner, to balance the wider public interest with the interests of employers and clients, and to uphold standards in the engineering profession • Identifies and justifies ethical courses of action when confronted with complex situations that might arise in the work of a professional engineer	**SA8: Understand and commit to professional ethics and responsibilities and norms of engineering technology practice (SK7).** **Indicators of attainment** • Demonstrates an understanding of the moral responsibilities of an engineering technologist including: the need to self-manage in an orderly and ethical manner, to balance the wider public interest with the interests of employers and clients, and to uphold standards in the engineering profession • Identifies ethical courses of action when confronted with situations that might arise in the work of an engineering technologist	**DA8: Understand and commit to professional ethics and responsibilities and norms of technician practice (DK7).** **Indicators of attainment** • Demonstrates an understanding of the moral responsibilities of an engineering technician including: the need to self-manage in an orderly and ethical manner, to balance the wider public interest with the interests of employers and clients, and to uphold standards in the engineering profession • Identifies relevant clauses in the IPENZ code of ethics when confronted with situations that might arise in the work of an engineering technician
9.Individual and team work Role in and diversity of team	**WA9: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.** **Indicators of attainment** • Manages own activities with honesty and integrity and in an orderly manner to meet deadlines • Contributes constructively to team decision making, earns the trust and confidence of other team members • Provides leadership in a team environment by making informed decisions, keeping the team motivated and accepting and delegating responsibility	**SA9: Function effectively as an individual, and as a member or leader in diverse teams.** **Indicators of attainment** • Manages own activities with honesty and integrity and in an orderly manner to meet deadlines • Contributes constructively to team decision making, earns the trust and confidence of other team members • Provides leadership in a team environment by making informed decisions, keeping the team motivated and accepting and delegating responsibility	**DA9: Function effectively as an individual, and as a member in diverse technical teams.** **Indicators of attainment** • Manages own activities with honesty and integrity and in an orderly manner to meet deadlines • Contributes constructively to team decision making, earns the trust and confidence of other team members
10.Communication Level of communication according to type of activities performed	**WA10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.** **Indicators of attainment** • Presents a range of written reports and other documentation relevant to the engineering discipline that convey information effectively to both technical and non-technical audiences. • Presents work verbally in a clear and articulate manner, using visual aids appropriately in a range of contexts • Comprehends and responds appropriately to written and verbal instructions and appropriately instructs or briefs others in group exercises • Produces engineering specifications or design documentation that satisfy the requirements of the design brief	**SA10: Communicate effectively on broadly-defined engineering activities with the engineering community and with society at large, by being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.** **Indicators of attainment** • Presents clearly written reports for both technical and lay audiences, as is appropriate • Presents work verbally in a clear and articulate manner, using visual aids appropriately • Comprehends and responds appropriately to written and verbal instructions and appropriately instructs or briefs others in group exercises • Produces engineering specifications or design documentation that satisfy the requirements of the design brief	**DA10: Communicate effectively on well-defined engineering activities with the engineering community and with society at large, by being able to comprehend the work of others, document their own work, and give and receive clear instructions.** **Indicators of attainment** • Presents clearly written reports for both technical and lay audiences, as is appropriate • Presents work verbally in a clear and articulate manner, using visual aids appropriately • Comprehends and responds appropriately to written and verbal instructions and appropriately instructs or briefs others in group exercises • Prepares engineering documents including sketches, charts, plans, drawings and technical instructions
11.Project management and finance Level of management required for differing types of activity	**WA11: Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member or leader in a team, to manage projects and in multidisciplinary environments.** **Indicators of attainment** • Comprehends how legislative, regulatory, contract law, other common law and professional obligations apply and manages own activities to comply • Selects and applies relevant project management techniques to the planning and execution of future work • Selects and justifies appropriate forms of contract for delivery of work by consultants or contractors • Selects and applies relevant systems or techniques for managing quality, reliability and risk in the context of engineering projects • Estimates the capital and on-going costs of engineering work	**SA11: Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a team and to manage projects in multidisciplinary environments.** **Indicators of attainment** • Comprehends how legislative, regulatory, contract law, other common law and professional obligations apply and manages own activities to comply • Selects and applies relevant project management techniques to the planning and execution of future work • Selects appropriate forms of contract for delivery of work by consultants or contractors • Selects relevant techniques for managing quality, reliability and engineering risk • Estimates the capital and on-going costs of engineering work	**DA11: Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a technical team and to manage projects in multidisciplinary environments.** **Indicators of attainment** • Comprehends how legislative, regulatory, contract law, other common law and professional obligations apply and manages own activities to comply • Selects and applies basic project management tools to the planning and execution of practical project work • Identifies an appropriate form of contract for delivery of work by contractors • Identifies relevant practical methods for managing quality, reliability and engineering risk • Applies established methods for costing engineering work
12.Lifelong learning Preparation for and depth of continuing learning.	**WA12: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.** **Indicators of attainment** • Applies independent learning practices • Demonstrates self-awareness of own level of competence and identifies opportunities to extend own competence in a timely manner • Comprehends the importance of engaging with a professional and intellectual community, learning from its knowledge and standards, and contributing to their maintenance and advancement	**SA12: Recognize the need for, and have the ability to engage in independent and life-long learning in specialist technologies.** **Indicators of attainment** • Applies independent learning practices • Demonstrates self-awareness of own level of competence and identifies opportunities to extend own competence in a timely manner • Comprehends the importance of engaging with a professional community, learning from its knowledge and standards	**DA12: Recognize the need for, and have the ability to engage in independent updating in the context of specialized technical knowledge.** **Indicators of attainment** • Applies independent learning practices • Demonstrates self-awareness of own level of competence and identifies opportunities to extend own competence in a timely manner • Comprehends the importance of engaging with a professional community, learning from its knowledge and standards

Appendix 10: Professional and Graduate Capability Framework

Emeritus Professor Geoff Scott
OLT Senior National Teaching Fellow 2014-6

Source

Scott, G (2016): *Transforming graduate capabilities & achievement standards for a sustainable future: Key insights from a 2014-16 Office for Learning & Teaching National Senior Teaching Fellowship,* Office for Learning & Teaching, Canberra, *pgs* 40ff

One of the challenges faced when seeking to ensure that higher education programs focus on the capabilities that count (the Impact dimension in the Quality and Standards Framework outlined in Diagram 2) is the absence of a validated, proven capability framework to ensure that input and feedback from successful practitioners, employers and other key stakeholders is comprehensive.

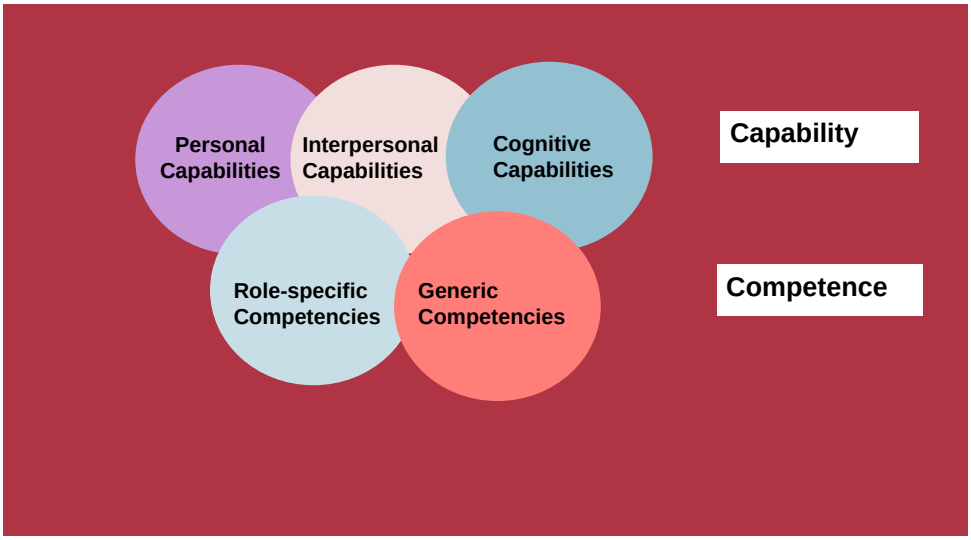
Below is a professional capability framework validated in studies of successful graduates in nine professions along with studies of educational leaders in schools, VET and Higher Education. It distinguishes between capabilities and competencies.

It can be used when seeking to identify, validate and cluster the program-level learning outcomes deemed relevant in each degree or diploma, using peer review and taking into account the input from a wide range of university and external reference points.

In the tables which follow the diagram the specific capabilities validated in all these studies are presented as a series of factor analysed sub-scales. Every study undertaken to date identifies generic and role-specific competencies (skills and knowledge) as being necessary but not sufficient for effective early career performance.

WESTERN SYDNEY UNIVERSITY

Professional capability framework



Personal capabilities

Table 1 presents the scales and items developed to provide measurement of the domain of personal capability. This aspect of the practitioner's capability is made up of three interlocked components: Self-awareness, Decisiveness and Commitment.

Table 1: Personal capability scales and items

Scale	Item
Self Awareness & Regulation	Deferring judgment and not jumping in too quickly to resolve a problem
	Understanding my personal strengths and limitations
	Being willing to face and learn from my errors
	Bouncing back from adversity
	Maintaining a good work/life balance and keeping things in perspective
	Remaining calm under pressure or when things take an unexpected turn
Decisiveness	Being willing to take a hard decision
	Being confident to take calculated risks
	Tolerating ambiguity and uncertainty
	Being true to one's personal values and ethics
Commitment	Having energy, passion and enthusiasm for my profession and role
	Wanting to produce as good a job as possible
	Being willing to take responsibility for projects and how they turn out
	PA willingness to persevere when things are not working out as anticipated
	Pitching in and undertaking menial tasks when needed

Interpersonal capabilities

Table 2 presents the scales and items developed to provide measurement of the practitioner's interpersonal capabilities. This has been distinguished into two subscales: Influencing and Empathising with others.

Table 2: Interpersonal capability scales and items

Scale	Item
Influencing	Influencing people's behaviour and decisions in effective ways
	Understanding how the different groups that make up my university operate and influence different situations
	Being able to work with senior staff within and beyond my organisation without being intimidated
	Motivating others to achieve positive outcomes
	Working constructively with people who are 'resistors' or are over-enthusiastic
	Being able to develop and use networks of colleagues to solve key workplace problems
	Giving and receiving constructive feedback to/from work colleagues and others
Empathising	Empathising and working productively with people from a wide range of backgrounds
	Listening to different points of view before coming to a decision
	The ability to empathise and work productively with people from a wide range of backgrounds
	Being able to develop and contribute positively to team-based programs
	Being transparent and honest in dealings with others
	PA willingness to persevere when things are not working out as anticipated
	Pitching in and undertaking menial tasks when needed

Cognitive capabilities

Table 3 presents the scales and items developed to provide measurement of the domain of cognitive capability. This aspect of the practitioner's capability is made up of attributes that fit into three interlocked subscales: Diagnosis, Strategy and Flexibility & Responsiveness.

Table 3: Cognitive capability scales and items

Scale	Item
Diagnosis	Diagnosing the underlying causes of a problem and taking appropriate action to address it
	Recognising how seemingly unconnected activities are linked
	Recognising patterns in a complex situation
	Being able to identify the core issue from a mass of detail in any situation
Strategy	Seeing and then acting on an opportunity for a new direction
	Tracing out and assessing the likely consequences of alternative courses of action
	Using previous experience to figure out what's going on when a current situation takes an unexpected turn
	Thinking creatively and laterally
	Having a clear, justified and achievable direction in my area of responsibility
	Seeing the best way to respond to a perplexing situation
	Setting and justifying priorities for my daily work
Flexibility & Responsiveness	Adjusting a plan of action in response to problems that are identified during its implementation
	Making sense of and learning from experience
	Knowing that there is never a fixed set of steps for solving workplace problems

Aggregated results of studies of successful early career graduates in nine professions

Table 4 presents (in rank order) the 12 items attracting the highest importance ratings in the successful graduates' research out of the full list of capabilities identified in tables 1-3 (source: Vescio, J.
What is noteworthy is that only one of the top 12 ranked items concerns generic or role specific competencies. The other 11 are made up of 5 specific capabilities from the personal domain; 4 from the Interpersonal domain and 2 from the cognitive domain. Our research has demonstrated that each of these is both assessable and learnable, especially if directly given focus in work-based placements, simulations and in dilemma based tasks.

Table 4: Top ranking capabilities from studies of successful graduates in 9 professions (top 12/38 in rank order)

1.	Being able to organise work and manage time effectively (GSK)
2.	Wanting to produce as good a job as possible (P-C)
3.	Setting and justifying priorities for my daily work (C-S)
4.	Being able to remain calm under pressure or when things take an unexpected turn (P-SA)
5.	Being willing to face and learn from errors and listen openly to feedback (P-SA)
6.	Being able to identify the core issue from a mass of detail in any situation (C-D)
7.	Being able to work with senior staff without being intimidated (IP-I)
8.	Being willing to take responsibility for projects & how they turn out (P-C)
9.	Being able to develop and contribute positively to team-based projects (IP-E)
10.	A willingness to persevere when things are not working out as anticipated (P-C)
11.	The ability to empathise and work productively with people from a wide rang of backgrounds (IP-E)
12.	Being able to develop and use networks of colleagues to help solve key workplace problems (IP-I)
	P-SA: personal–self awareness; P-D: personal-decisiveness; P-C: personal-commitment IP-I: interpersonal-influencing; IP-E: interpersonal-emphathising; C-D: cognitive-diagnosis; C-S: cognitive-strategy; C-F/R: cognitive-flexibility & responsiveness

These align closely with the results when the specific dimensions, subscales and items in the graduate and professional capability framework have been used to get feedback from employers (Table 5).

Table 5: Capabilities rated greater than 4/5 on importance by 147 Western Sydney employers

Personal capabilities
Willing to learn from errors; calm under pressure; perseveres; responsible; wants to do a good job; ethical practitioner; sustainability literate; adaptable; knows own strengths/ weaknesses; can defer judgement; pitches in; has sense of humour & perspective

Interpersonal capabilities=
Empathy – can work with diversity; listens; networks well; team-player; communicates effectively; understands organisations; not intimidated

Cognitive capabilities
Can set priorities; sees key point; diagnostic not fixed approach; can adjust plans in practice; independent thinker; creative & enterprising

Generic skills & knowledge
Can organise and manage workload; effective user of IT; effective at self-managed learning and professional development; sustainability literate

What is particularly noteworthy is how closely these top ranked capabilities align with those allocated most importance by university learning leaders in our 2008 Learning leaders in times of change study. The top ranking items for these HE leaders are given in Table 6.

Table 6: Top 12 highest ranked capabilities for HE Learning Leaders (rank order in brackets)

EI (Personal)
- Being true to one's personal values & ethics (2)
- Remaining calm under pressure or when things take an unexpected turn (3)
- Understanding my personal strengths & limitations (5)
- Energy & passion for L&T (7)
- Admitting to & learning from my errors (10)

EI (Interpersonal)
- Being transparent & honest in dealings with others (1)
- Empathising and working productively with staff and other key players from a wide range of backgrounds (4)

Intellectual
- Identifying from a mass of information the core issue or opportunity in any situation (8)
- Making sense of and learning from experience (9)
- Thinking creatively & laterally (11)
- Diagnosing the underlying causes of a problem & taking appropriate action to address it (12)

Skills & Knowledge
- Being able to organise my work & manage time effectively (6)

Distinguishing between 'capability' and 'competence'

A brief distinction between capability and competence (which aligns with the 'five circle' framework and the scales above) is given in my article in the South African Journal of Higher Education, Vol 27, no 2, 2013: 283-4

'It is important to distinguish between the terms 'capability' and 'competence', as they are often used interchangeably but incorrectly:

Whereas being competent is about delivery of specific tasks in relatively predictable circumstances, capability is more about responsiveness, creativity, contingent thinking and growth in relatively uncertain ones. What distinguishes the most effective (performers) ... is their capability -- in particular their emotional intelligence ... and a distinctive, contingent capacity to work with and figure out what is going on in troubling situations, to determine which of the hundreds of problems and unexpected situations they encounter each week are worth attending to and which are not, and then the ability to identify and trace out the consequences of potentially

relevant ways of responding to the ones they decide need to be addressed ... While competencies are often fragmented into discrete parcels or lists, capability is a much more holistic, integrating, creative, multidimensional and fluid phenomenon. Whereas most conceptions of competence concentrate on assessing demonstrated behaviours and performance, capability is more about what is going on inside the person's head' (Scott, Coates and Anderson 2008, 12).

And, as Stephenson (1992, 2-3) concluded some 20 years ago, capability depends '... much more on our confidence that we can effectively use and develop our skills in complex and changing circumstances than on our mere possession of these skills... Capability is not just about skills and knowledge. Taking effective and appropriate action within unfamiliar and changing circumstances involves judgments, values, the self-confidence to take risks and a commitment to learn from the experience'.

Lester (2014) in his draft article 'Professional standards, competence and capability" provides a comprehensive and detailed analysis of the area. He reports on a study by 'Lester and Chapman (2000) who comment that while competence "is typically concerned with fitness for purpose (or getting the job right), capability infers concern also with fitness of purpose (or making judgements about the right job to do)" (p2), again suggesting a conceptually higher level of operation than that typically captured in most notions of competence. Nevertheless, in all these accounts the capable practitioner is also expected to be functionally competent, while also being aware of the limits of his or her competence – and potentially how to overcome them – in any given situation' (Lester, 2014: pgs 7-8).

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