Shelf-life of postgraduate engineering and IT education – relevance and currency in an age of dynamic industry expectations

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Structured abstract

BACKGROUND

In response to the changing environment, industry requirements and the underpinning AQF specifications for higher education awards, UTS Faculty of Engineering and Information Technology (FEIT) has embarked on a research project to review their Masters programs to ensure that the commitment to practice-based fields in both Engineering and Information Technology (EIT) education remains relevant. Both fields share synergies for teaching and research, and both professions are constantly evolving in a dynamic environment. For context, postgraduate courses in this study are the Masters of Enginering (ME), Engineering Studies (MES), Engineering Management (MEM), Internetworking (MSc.I) and Information Technology (MIT).

This paper draws on research insights that form part of a larger project that entails stakeholder consultations (students/graduates, industry and academics) as part of the 3 yearly Faculty Masters review and renewal process. The research completed to date includes quantitative and qualitative perspectives of current students and recent graduates regarding their learning and professional expectations and actual experiences, including relevance and currency in industry.

PURPOSE

The key purpose of this paper is to present the insights based on research conducted with stakeholder perspectives centred on their needs, expectations and actual experience. Consequently the purpose is to evaluate the currency, relevance and value of current postgraduate program contributions to industry and the Engineering and IT profession; and more importantly in addressing future industry needs to ensure that Engineering and IT education programs remains robust, relevant and sustainable in dynamic industry environments where rapid change is the norm.

DESIGN/METHOD

The study utilised a mixed-methodology with quantitative and qualitative perspectives. 308 students and graduates were surveyed online to gauge their attitudes with regards to the relevance and contribution of the respective Masters programs undertaken in enhancing career and employment opportunities. Another 13 students and graduates were involved in semi-structured qualitative interviews to explore what drove student choices in undertaking the programs, key contributions to learning and to their current professions, areas to improve on and what an ideal Masters program might look like.

RESULTS AND CONCLUSIONS

Students indicate that they expect a program to be industry relevant; to be up to date with market needs; to foster linkages across research, academia, their cohorts and industry; to provide extensive practical opportunities and include a balance of technical application and managerial development. Programs also need to provide sufficient choice and flexibility to meet student goals and future career aspirations. Age and personal goals; as well as employer support, educator industry experience and the economic environment play a key role in professional sentiments towards program relevance in meeting industry needs and thus enhancing career opportunities. To extend the shelf-life of a postgraduate qualification in a dynamic environment faced by professionals today, universities need to work in close collaboration with industry partners to ensure that industry-relevant issues are authentically addressed in the students' learning experiences. Therefore a postgraduate educational framework that encompasses a balance of core and elective subjects; provides authentic industry viewpoints; builds network relationships; fosters knowledge transfer across research, students, alumni, academia and industry; facilitates industry-relevant or industry-involved project work and internships in a blended-learning environment could further enhance expert-level graduate capabilities in a multi-dimensional and dynamic environment to ensure industry relevance and currency.

KEYWORDS
Industry relevance, currency, engineering and IT education

Background and introduction

Australia's engineering and information technology (EIT) education systems reflect on its practice and performance in order to anticipate, adapt and respond to the changing environment and consequently endeavours to develop graduates that are industry-ready (Daniele & Mistilis, 1999; King, 2008). At UTS, the faculty structure combines both engineering and IT fields. Synergies and overlaps are identified. Both have common ALTC Threshold Learning Outcomes (TLOs) (Wright, Hadgraft & Cameron, 2010). There is an overlap of disciplinary knowledge and possibilities of cross-disciplinary study or knowledge. Both professions face dynamic changes in their respective fields. Driven by the desire to produce Masters graduates that meet the requirements of a dynamic industry, it is imperative to evaluate if the actual outcomes of the programs are relevant to industry needs. Therefore, in response to the changing demands, industry requirements and the underpinning AQF specifications (AQF, 2013), UTS Faculty of Engineering and Information Technology (FEIT) has undertaken a review of its Masters programs to ensure that the commitment to practice-based EIT education remains relevant. What is known is that industry relevance and currency are critical elements in EIT education and that these elements are likely to influence the shelf-life of a postgraduate qualification.

This paper draws on the quantitative and qualitative research insights that form part of a larger project comprising stakeholder consultations (students/graduates, industry and academics). The purpose of this paper is to present relevance and currency from the viewpoints of EIT postgraduate students and graduates. It identifies student segments that are more inclined to appreciate the connection between their studies with industry relevance and professional contribution. It examines their drivers and experiences of learning in light of industry relevance and contribution to their professional careers. It highlights opportunities and recommends strategies within EIT that ensure industry relevance and currency. The outcomes ultimately serve to inform and inspire educators to consider alternative ways in EIT education to ensure that programs remains robust, relevant and sustainable in dynamic industry environments.

Literature Review: Engineering and IT education today

Shift in engineering and IT education paradigms

Engineering and IT are increasingly complex and multidisciplinary fields, and is practised diversely, in business, government and educational enterprises (King, 2008). Universities are constantly aiming to provide education pathways and awards that meet student's goals, industry and regulatory demands. A new Higher Education Quality and Regulatory Framework emphasises the need for assuring Threshold learning outcomes (TLOs). These are defined as *"minimum discipline knowledge, discipline-specific skills and professional capabilities including attitudes and professional values that are expected of a graduate from a specified level of program in a specified discipline area"* (ALTC 2010, p3). Response to these requirements means having a shift in EIT education paradigms - from being solely content driven to being industry relevant and practice-driven. To do so, universities need to work closely with stakeholders including employers, students, accreditation bodies and industry members to ensure that EIT programs remain relevant in professional practice (Clayton, Jonas, Harding, Harris, & Toze, 2013). One philosophical view of the nature of relevance is that it is dynamic and multi-dimensional (Hjørland, 2010) and thus industry relevance is closely related to the individual's interaction with the EIT knowledge ecology. Additionally, 'industry relevance' implies that the education will prepare students so that they are ready to cope with industry demands (Wohlin & Regnell, 1999). EIT education links industry relevance to being aware of and having broadened perspectives of the challenges and proven techniques applied in industry (Markes, 2006; Webster, 2000). To enhance employment opportunities for graduates, educators need to take a holistic approach that integrates the development of knowledge, work experience, and technical and interactive skills, whilst reflecting on how these may address the current and emerging demands of employers in a dynamic environment. The expectation of EIT practitioners is no longer limited to technical competence. Practitioners are increasingly expected to understand complex and changing industrial, social, global, legal, regulatory and economic contexts (Daniele & Mistilis, 1999; King, 2008; Mills & Treagust, 2003). We therefore suggest that industry relevance needs to be viewed from multiple perspectives in order to inform curricula strategies and structure. The following section briefly explains the philosophical framework of this study, which informs its design and methodology.

Research approach and analysis

This study is distinct from many others in the EIT education literature reviewed, in that it entails a mixed-methods design comprising quantitative online surveys and qualitative semi-structured interviews. The quantitative method provides a 'positivist' worldview which is oriented towards '*absolute truths'* and accepts that there is one objective reality (Creswell, 1998; Mertens, 1998). There are strengths in being precise in analysing statistical correlations and trends. On the other hand, the qualitative approach is well suited to the 'interpretivist' worldview that enables the exploration of the 'how' and 'why'. The semi-structured qualitative framework enables participants to express their views openly whilst maintaining focus within a general pre-set framework of inquiry (Hyland 2010; Travers 2006). Mixed-methods provides a triangulation process that improves accuracy, complements and balances the strengths and weaknesses of each method of research and builds a more complete picture (Creswell, 1998; Denscombe, 2003; Lincoln & Guba, 1985; Martin, Maytham, Case, & Fraser, 2005). This allows for the identification of issues that are scantly mentioned in the current academic studies linking postgraduate EIT programs with industry relevance (Martin et al., 2005).

An initial online survey (n=308) was conducted amongst Masters graduates (n=84) and students (n=224). The graduate sample was drawn from the UTS Alumni database. Student samples were drawn from the UTS Enrolment database. The survey was designed to gauge student and graduate attitudes regarding relevance and contribution of the respective EIT programs in enhancing career and employment opportunities. The quantitative data was analysed using SPSS and includes correlations, means comparisons and analysis of variance (ANOVA). Only statistically significant results are presented in this paper. For the qualitative research, a sample of thirteen students and graduates of select postgraduate EIT programs were recruited. Participants were drawn from the Masters of Engineering (ME), Engineering Studies (MES), Engineering Management (MEM), Internetworking (MSc.I) and Information Technology (MIT). The sample varied with respect to employment status and whether they were full- or part-time students. This was to ensure that we achieved a good diversity of responses, a term referred to as purposive sampling (Lincoln & Guba, 1985). The qualitative stage explored student motivations in undertaking the programs, key contributions to learning and to their current professions, including suggested areas for improvement. Analysis of the qualitative data includes coded themes and text correlations. The next section presents the triangulated findings from the research.

Findings

Four key attitudinal statements about the Masters programs were measured in the quantitative survey based on a five-point Likert scale: i) Improved my employment and career opportunities; ii) Relevant to my current field of practice and work; iii) My contribution in my workplace has been/will be enhanced; iv) I would recommend the Masters program at UTS to others.

A one-way ANOVA reveals that those who have more positive inclinations towards the statements are more likely to be: supported by their employers in their studies (Table 1) and, working full time or are self-employed (Table 2). This is supported by qualitative comments by a recent graduate in MSc. Internetworking whereby *"My (previous) employer recommended (and supported) the program as it was in line with my work objectives then. It would have been a large* *technical aspect of my job. This is quite a key benefit and it is directly related to my job, both initially and in my new job now."*

Table 1: ANOVA of attitudes regarding Masters programs - those supported by employer or self

	Support by Employer/self			ANOVA	
Mean scores based on Likert scale where 5=Strongly Agree, and 1=Strongly Disagree	**Emplyr n=70**	**Self n=159**	**Total N=229**	***F***	***p*, Sig. (<0.05)**
Improves employment & career opportunities.	4.2	3.8	3.9	5.9	.02
Relevant to my current field of practice & work.	4.3	3.8	4.0	7.6	.01
Enhances my contributions in my workplace	4.3	3.8	3.9	9.2	.00
I would recommend the program to others.	4.2	4.0	4.1	1.7	.20

Table 2: ANOVA of attitudes regarding Masters programs – by employment status

	FT=Full time, PT=Part time, UE=Unemployed, SE=Self						ANOVA	
Mean scores based on Likert scale where 5=Strongly Agree, and 1=Strongly Disagree	**FT n=166**	**PT n=46**	**Self n=17**	**UE n=66**	**Othr n=6**	**Total N=301**	***F***	***p*, Sig. (<0.05)**
Improves employment & career opportunities.	4.0	3.4	4.4	3.7	4.3	3.9	3.6	.01
Relevant to my current field of practice & work.	4.3	2.7	4.4	3.6	3.7	3.9	18.2	.00
Enhances my contributions in my workplace	4.1	3.0	4.4	3.5	3.3	3.8	11.0	.00
I would recommend the program to others.	4.1	3.9	4.4	3.7	4.0	4.0	2.2	.07

Figure 1 illustrates significant variation in employment attitudes among the years when students graduated. Earlier graduates from 2010 are more positive in their views relating studies to work relevance and career opportunities. Recent unemployment trends (ABS, 2013) may provide a plausible explanation of the shift in graduate sentiments. As unemployment rates rise from 2011-2012, these sentiments tend to become less positive as the may be more likely to face employment challenges and decreasing work opportunities.

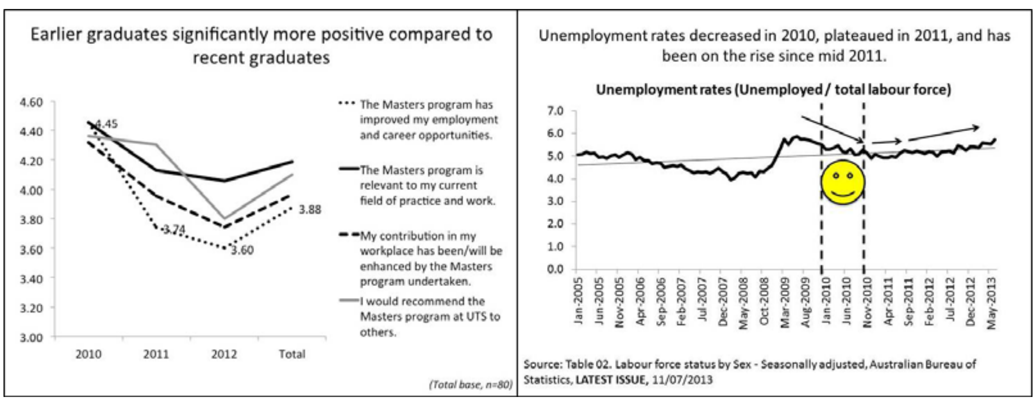

Figure 1: Attitudes of graduates 2010-2012 (left) compared with Unemployment rates (right)

Figure 2 indicates that progressively older groups are more likely to state that the programs have more relevance to their work, improve their employment opportunities and enhance their workplace contributions. This is possibly to be due to older professionals having more work experience and industry-based knowledge. Potentially, they have a greater appreciation of the relevance of their studies to industry and workplace issues.

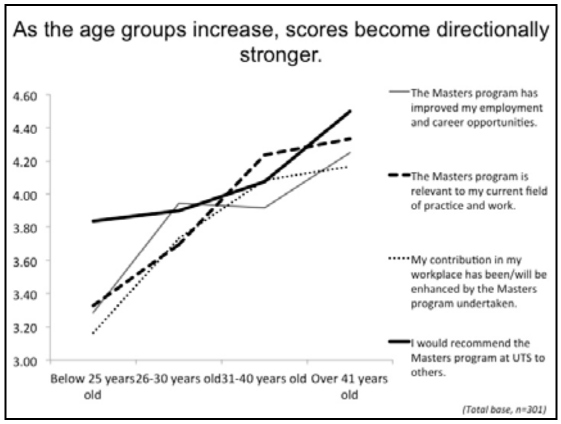

Figure 2: Attitudes by age groups

In the next section, three qualitative themes linked to accomplishing industry relevance are presented. These relate to industry linkages, educator industry experience, and program design and learning experiences.

Theme 1: Relevance through fostering industry linkages

Industry relevance is viewed as being up to date with market needs. To achieve this, participants identify the need for universities to facilitate and leverage on industry linkages across research, academia, student cohorts and industry. A part-time MES student suggests *"Have a congress of engineers. Gather professionals and academia, for example Alumni and Engineers Australia to bring value from industry. Could have students coming in to see industry talks, have closer industry links".* This includes increasing student access to and networking with industry within the program. In doing so, there is the need to engage industry experts and leaders in knowledge sharing and networking.

Theme 2: Relevance through educators with industry experience

Educators with industry relevance are perceived as those participating in industry, and possess practical, applied experience in their fields of specialisation. Comments from ME students include: *"Staff here, they participate in industry, research and academia, it's a good bridge and beautifully matched".* Teaching staff and guest lecturers that are connected with industry are stated as important in maintaining relevance and currency, *"The guest lecturers coming in with the experience, it is really cool."*

> *"Keep the expertise, since we have the best in the industry teaching us. I like the way things are explained, clear and related to reality rather than theoretical and not applied to the workplace" (MSC Internetworking)*

Theme 3: Relevance through program design and learning experiences

To ensure relevance, it is often expected that program design needs to be closely linked to industry demands and current practices. In the following paragraphs, five facets within program design are presented. They are: interactive and collaborative learning; learning beyond the classroom; project-oriented learning; practical industry portfolio development and ensuring that the subjects on offer match study and professional goals.

Learning experiences that are interactive and collaborative: Students desire the opportunity to connect and engage with their cohort and professional industry to build networks that are useful in the present and in the future. Moreover, cross-disciplinary experiences provide different perspectives and add to the students' learning outcomes. This does not always mean being involved in group projects, but teaching and learning experiences that encourage interaction and engagement amongst students. Any learning activities that are project- and group-based were mentioned as useful although these need to be managed and executed well. Case studies on current relevant issues to discuss and share thinking was also cited by participants as a way to stay in touch with industry.

Learning beyond the classroom: Students appreciate the opportunity to participate in real-world opportunities that are linked with industry. A graduate comments *"Students need skills related to the real world"* (M.Sc. Internetworking) whilst another remarks that *"Learning outside the classroom expands knowledge"* (MEM graduate). These opportunities include joint or cooperative projects with industry or internships. Those who value work experience appreciate the time spent in the local industry. Some view extended time-frames in a program due to internships or projects as a positive point, as this meant increasing the students' knowledge and practical experiences in the 'real world'.

> *"Most students want local experience, even real practical experience and projects. In China, in Chinese universities, there are many real projects that we are involved in. Almost spend half our time and effort on real projects. Students from post graduate course, when they graduate from China universities, they already have lots of real working experience." (MIT, graduate).*

> *"We can mingle with different people, and get advice from 'real people' in the corporation and talk to others about our career futures …."* (MEM graduate).

Project-oriented learning: Projects could add value if it adds to new experiences or work-related experiences.

> *"The project pushes us, it pressures us.. in a good way, this is how it is in reality. We have a project presentation to the industry panel, to companies, start-ups and co-working spaces."* (MIT graduate).

> *"It is practical, it is fun and interesting. We get an idea, we have a mission, goal and problem… we start from scratch till the end. It's a mixed, cross-faculty group, we all have different perspectives, but have good communication."* (MIT graduate).

Additionally, projects that integrate subject knowledge or produce tangible results are well supported by participants, as commented by an MEM student *"Gaining relevant work experience and applying skills to add value to what is learnt through projects and internships. It gets you out there. It bridges the gap between education and the workplace, it's a closer interface with industry needs and knowledge".* Projects need to be relevant to the students' interests and longer term plans. This indicates that projects could be designed and executed independently by each student to tailor to their own specific needs, as one participant comments: *"It depends on students and what they want to do, for example whether they want to be in leadership or technical areas"* (MEM/MES graduate).

Practical industry portfolio development*:* Subjects that facilitate applied and tangible learning outcomes, such as prototypes, games or models are appreciated as it offers opportunities to showcase one's knowledge and skills to potential employers. Two IT students remark, *"We're actually making it [the game]! At the end there is some product on hand, we have a game and I am proud to show it off to others, even future employers…."* and *"…. Many industries are looking for it, for programming. I want to learn it for my employment. Also, I want to be able to build my own apps, even for our own sales."*

Subject availability matched with goals: Relevance is also impacted by subject availability. For example, if the subjects of choice become inaccessible, it disrupts the students' goals, career direction or work plans, and loses relevance, as is observed by two students, *"It depends on students and what they want to do, for example whether they want to be in leadership or technical areas. The program needs to be designed for seasoned professionals, not just fresh graduates"* (MEM), and *"I want to learn more on the technical side. Many subjects are centred around managerial and analysis, we need more technical subjects."* (MIT).

Additionally, subject content needs to keep up with market requirements in order to maintain currency and longevity with the changing technological trends and demands in the industry.

> *"By the time I finished my studies, some of the technology is already out-dated, the technology to do with telecommunications would have changed. What I learnt three four years back is no longer in the network now… although the basics remain the same" (MEM/MES graduate).*

> *"Software modelling, in 2005 was a hot topic. But industrial people don't use it anymore, so it is now less important. Others (subjects) are really out-dated, they are still teaching stuff like HTML, PHP, these are no longer used in industry. For me, I have no IT background, I know it's not just about having the latest technology but to know the fundamentals. But it is not cool, and I don't really use it." (MIT student).*

What this implies is that educators need to take on an adaptive and open approach in subject and program design in order to be sustainable in the longer term, and that possibly, students could be equipped for self-directed learning to keep abreast with technological changes as and when they occur. Additionally, master classes or a 'cool-school' for postgraduates may be an option for students to want to advance specific technical skills following the latest technological trends. This could take the form of electives, project groups or short certified courses.

Discussion

Recent graduates face the challenges of ensuring relevance and currency in their skills and knowledge, as well as dealing with the economic and global trends and growing unemployment rates. More could be done with regards to industrial collaboration involving stakeholders including employers, recruiters and industry associations into further research, planning and implementation of industry-relevant capabilities to ensure sustainable market-ready graduates. Other interesting strategies include advanced master classes and 'cool-school' sessions to address current and future industry trends. The comments imply that students appreciate learning beyond the classroom. Beyond an industry focus, projects need be viewed as current, collaborative, solves a real-world problem or engages with the industry in some form. A case can be argued to provide a well-rounded yet advanced technical and/or managerial qualification to build professional capabilities beyond technical skills, whilst preparing professionals for targeted and specialised industry certifications. A number of strategies to accomplish industrial relevance and currency are suggested.

Suggested strategies that drive industry-relevant education

Underpinning these strategies is the inter-connectedness of employers, students, educators and policy-makers. The suggested strategies embrace a dynamic, adaptive and collaborative approach to accomplish relevance and currency.

Strategy 1: Industry involvement in teaching and learning

Approach and impact: Industry guest lecturers provide authentic industry viewpoints**;** support for employees through study leave, resources and organisation-related projects, aligns industrial and organisational needs.

Strategy 2: Practice-based knowledge through joint industry projects and internships

Approach and impact: Industry-relevant projects supplied, supported and valued by the organisations; high-level structured internships and mentorships; educationally sound; mutually beneficial. Builds networks and relationships across research, academics and industry; real solutions and learning; knowledge transfer.

Strategy 3: Continuous collaborative partnerships and engagement

Approach and impact: Industry, employees, students, graduates/alumni and academics in networking and industry events. Ensures exposure and engagement with new technologies and inter-disciplinary areas, ability to stay up-to-date in teaching content, knowledge and resource sharing across industries.

Strategy 4: Industry-engaged educators and flexible teaching methods

Approach and impact: Educators with current and relevant industry experience can share knowledge and experiences to foster a deeper appreciation of 'real world' issues and applications; flexible modes of delivery means that students can fit study schedules with industry-related work experience and projects; flipped learning environment, peer learning and collaboration enhances self-directed learning to keep up with current advances in students' fields of practice.

Strategy 5: 'Tech-transfer' projects

Approach and impact: Projects with a practical component focussed on potentially viable commercial industry interests develops innovation in processes or products and has the potential to be commercially valuable.

To this end, specific staff support and training in industry-relevant learning is needed. This includes support in planning, implementation, managing and assessment methodologies that retain the rigours of EIT fundamentals whilst incorporating industry-relevant learning philosophies.

Conclusion: Professional relevancy as a collaborative partnership

This paper highlights issues in industry relevance and professional sustainability from the perspectives of recent EIT postgraduates. The research suggests that universities need to adopt a strategic approach that supports the individual and educator's capability to keep abreast with and adapt to industry and technological trends. At the postgraduate level, universities strive to be in line with AQF and TEQSA standards requirements where graduates engage with their fields of practice at an expert level. The issues discussed provide some good opportunities for EIT postgraduate education in meeting the requirements of industry whilst maintaining the underlying scientific and fundamental base in EIT education. Real-world EIT challenges are not solely technical. They encompass new paradigms to meet challenges in an increasingly multi-dimensional and dynamic context and incorporates many of the 'softer' skills required in the workplace (Duderstadt, 2010; King, 2008; Markes, 2006; Miller, 2010; Webster, 2000). Professional relevancy is not limited to program and curriculum design, neither is it the sole responsibility of educators, but a progressive collaborative partnership with students, industry and universities. The authenticity and relevance of EIT students' education can be strengthened through a close partnership of industry practitioners and educators (King, 2008; Wohlin & Regnell, 1999). Therefore, efforts to ensure relevance and increase graduate employability need to be holistic, strategic and based on close collaboration between educators, employers, industry associations and government bodies (Clayton et al., 2013; Markes, 2006; Wohlin & Regnell, 1999). This also ensures that industry-relevant issues are addressed in the students' learning experiences and thus contribute to the shelf-life of their postgraduate qualification.

Nevertheless, there are current issues in implementation that calls for further research: How is it that we are good at gaining knowledge and less agile in responding to, implementing and measuring the changes made? Change to ensure relevance can be a continuous process incorporating a broadened view of EIT education of adaptive thinking and collaborative learning for all parties in a dynamic environment. Perhaps small, continuous, gradual changes in a collaborative partnership that incorporates a rounded and balanced view of EIT education is one way to start.

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