How Well Are We Meeting the Educational Expectations of EIE Students?

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ABSTRACT

Students in the Electrical and Information Engineering (EIE) disciplines have expectations of their education that are formulated from a range of stimuli including employment potential. As faculty members it is part of our role, in association with our institution, National Government, Professional bodies and employers, to develop our students to meet future work opportunities in particular for their first real job after graduation, their "first employment transition". In the ideal world this supply and demand balance would be in perfect alignment, but is it? With employers these days looking more to the generic competences as the discriminator between students, this paper summarises part of the findings of the EIE-Surveyor project that statistically explored the 'gap' between the perceived importance and level of development of generic skills across Europe. The study employed a survey instrument and comparison of means, factorial analysis and homogeneity statistical methods across a sample of over 3,000 students, academics, graduates and employers. The paper shows how the results of that study have been used to inform the generic skills that should be developed within a taught Masters level programme in Engineering Management.

Keywords: *Engineering Education, Generic competences, Employability, Tuning Methodology.*

INTRODUCTION

This paper seeks to inform how well we, as in Higher Education institutions, are meeting the educational expectations of EIE students from a generic skills perspective and gives an example of how this is embedded in a taught Masters programme in Engineering Management. It is an obvious starting point to address the question of what these expectations are. The answer to this lies in the way graduates transition into their first employment. UK Graduate Destination statistics (DLHE, 2010) show that, for Engineering and Technology graduates in 2010/11, 63.7% go into employment, 22.5% into further study and 13.8% are assumed to go into unemployment. Graduates have the reasonable expectation that their programme of study will equip them with the technical skills and abilities defined in the programme learning outcomes. However these are no guarantee of a job upon graduation. Technical ability is only a component of the knowledge, skills and abilities students need to transition into employment.

In this paper the technical skills associated with the study programme are assumed to be met as a pre-requisite to meeting overall expectations and the focus is placed on the generic skills as the additional skills that will equip the student with the means to gain their first employment.

Thinking about the definitions of Knowledge, Skills and Competences was significantly influenced by Bloom in the 1960s through the publication of his taxonomy (Bloom, 1956). Out of this work grew the industrial trainers Knowledge, Skills and Attitudes (KSA) model. The notion of core competences emerged in management literature in the 1990s and KSA morphed into KSC (Knowledge, Skills and Competences). However the definitions of these terms is controversial (Winterton, 2006). In this paper, the Tuning definition "what a person is capable or competent of, the degree of preparation, sufficiency and/or responsibility for certain tasks" (Gonzalez, 2003) is used as it aligns with the first employment transition need.

The next important question is what are the generic skills for employment? There have been a considerable number of studies into the composition of generic skills in relation to: lifelong learning (European Communities, 2007); global competency (Cutler, 2010); general personal skills (Nabi, 1999), (Nguyen, 1998), (Mohan, 2010), (De La Harpe, 2000); personal and professional skills (Heitmann, 2003), learning skills (Tong, 2003); communication skills (Bhattacharyya, 2009), (Darling, 2003), (Stasz, 1997), (Lappalainen, 2009); leadership skills (Dunn, 2009), (Mumford, 2007); skills for employment (Lai, 2007), (DfEE, 2000), (DfES, 2003) (EMTA, 2005), (Shackleton, 1999), (London Riverside, 2003).

These studies have looked at different groups and have proposed different skills set priorities. The EIE-Surveyor study (the study summarized herein) sought to compare the results with a holistic set of generic skills (Gonzalez, 2003) and to test these skills across four key stakeholder groups, students, academics, graduates and employers with a view to statistically testing the alignment of students expectations with what is being delivered. This method is the same as that used in the Tuning Project (Gonzalez, 2003). The results of the Surveyor project were first published as a project report in 2008 (Ward, 2008) and an overview of the comparison of the generic skills was presented to the ITHET conference in 2010 (Ward, 2010).

METHODOLOGY

The objective of the EIE-Surveyor project was to quantitatively compare the perceived importance and level of development of a set of generic skills in respondents across Europe. Respondents were students, academics (faculty), graduates and employers.

The initial skills set, the Tuning approach set (Gonzalez, 2003) included 32 generic competences, space was, however, added for additional competences respondents view as important as they completed the questionnaire. Respondents were asked to rate the importance and level of development of each competence using a 4-point Likert scale where 1 indicates 'none', 2 'weak', 3 'considerable' and 4 a 'strong' response to the question. Basic demographic was also collected.

The primary objective of the study was to quantitatively assess how well we are meeting the educational expectations of EIE students. In addition 4 sub-objectives were addressed:

1. Test the alignment of the perceived level of importance to future career and current level of development of the generic competences.
2. Determine the most important competences for each respondent group.
3. Assess whether the generic competences group to form meaningful and usable clusters?
4. Assess whether the views of students vary between European countries.

The primary research questions and the above subsidiary ones were tested using a combination of descriptive statistical methods, factor analysis and correlation tests.

SUMMARY OF RESULTS

A total of 3,275 completed questionnaires were returned. Of these 81.1% were from students, 3.4% employers, 9.8% graduates, and 5.7% academics. Responses were received from 26 different European countries although many returned small numbers that are insufficient to allow country based analyses.

2,691 student questionnaires were returned with 2,641 gender declared. Of the 2,641, 14.5% were female, 85.5% male. This, in itself is an interesting result as it indicates a higher female student percentage than many individual institutions typically declare. 74.3% of the students were studying First Cycle degrees, 24.8% Masters level and 0.9% Doctoral/PhD. As might be expected 99.0% were from individuals in the 'conventional' (under 30) age range for students.

The full results of the student can be found in the project report, the following an overview of the relevant results used for the taught Masters programme design. Table 1 shows, in descending order of magnitude, the perceived mean importance of the top and bottom 5 generic competences for all students. In the mean column, 4 is the highest score (indicating "strong"). Note that the lowest ranked competence still has a mean of 2.52, midway between "weak" and "considerable" – hence no generic competence is really considered very low in importance. No significant difference is seen between the genders or between the Bachelor (first cycle degree, FCD) and Masters (second cycle degree, SCD) levels.

Table 2 shows the mean perceived level of development using the same rating scale. A score of 2 indicates a perception of weak development, seem most markedly in the skills around cultural awareness and entrepreneurship. Again the differences between gender and study level, whilst there are differences, are relatively small.

Finally Table 3 shows the 'gap' between the rated importance and level of development (taken as the numerical difference between the scores for each respondent). The numerical range for the 'gap' is -3 to +3 with any numerically positive gap indicating a perception that the rated importance is greater than the level of development – or students perceived need is greater than what they are receiving by way of teaching and learning. As can be seen from Table 3 ALL the

skills gaps are positive, with the obvious message for curriculum design and developers.

Table 1: Student rating of their perception of the importance of the generic competences

Rank	Generic competence	Mean
1	Problem solving	3.48
2	Elementary computing skills	3.44
3	Capacity for applying knowledge in practice	3.41
4	Team working	3.41
5	Will to succeed	3.36
...		
28	International Relations and Collaborations	2.92
29	Patents and Intellectual Property Rights	2.79
30	Appreciation of ethical issues	2.72
31	Appreciation of diversity and multiculturality	2.71
32	Understanding of cultures and customs of other countries	2.52

Table 2: Student rating of the level of development of the generic competences

Rank	Generic competence	Mean
1	Elementary computing skills	3.20
2	Problem solving	2.97
3	Capacity to learn	2.96
4	Team working	2.94
5	Basic general technical knowledge of the profession of your work area	2.91
...		
28	Leadership	2.30
29	International Relations and Collaborations	2.30
30	Appreciation of ethical issues	2.29
31	Patents and Intellectual Property Rights	2.27
32	Understanding of cultures and customs of other countries	2.03

Table 3: Student rating of the generic competences 'gap'

Rank	Generic competence	Mean	
		FCD	SCD
1	*Knowledge of a second language*	*0.76*	*0.88*
2	Capacity for generating new ideas (creativity)	0.76	0.72
3	Ability to work in an international context	0.75	0.83
4	Leadership	0.69	0.66
5	*Ability to work in an interdisciplinary team*	*0.64*	*0.49*
…			
28	Capacity for analysis and synthesis	0.41	0.38
29	*Research skills*	*0.40*	*0.28*
30	Basic general technical knowledge of the profession of your work area	0.37	0.29
31	Grounding in basic knowledge of the profession of your work area	0.28	0.27
32	*Elementary computing skills*	*0.28*	*0.20*

In the gap analysis statistically significant differences did result between academic levels (indicated in italics).

These analyses provided a basic understanding of what generic skills are important. The EIE-Surveyor analysis also included a factorial analysis of the skills to see if and how they grouped. This groupings are useful as the basis for a hierarchical structure of the skills and to reduce the complexity of an overall assessment of ability where this is an objective. The results yielded 5 subscales:

1. The "Internationalization" subscale consists of 5 items (α=0.77), the items being: "Understanding of cultures and customs of other countries.[1]" "Appreciation of ethical issues.[1]" "Appreciation of diversity and multiculturality[1]", "International relations and collaborations", "Ability to work in an international context"
2. "Entrepreneurship" subscale consists of 3 items (α=0.62), the items being:: "Patents and IPR[1]", "Creativity[1]" "Initiative and entrepreneurial spirit[1]"
3. "Professional skills" subscale consists of 5 items (α=0.69), the items being: "Grounding in basic knowledge of the profession", "Basic general technical knowledge", "Capacity for analysis and synthesis[1]", "Research skills[1]", "Capacity to learn"
4. "Interpersonal skills" subscale consists of 7 items (α=0.77), the items being: "Leadership", "Interpersonal skills", "Ability to work in an interdisciplinary team", "Ability to communicate with non-experts[1]", "Oral and written communications in native language[1]", "Critical and self-critical capability", "Team working[1]"

5. "Personal skills" subscale consists of 11 items (α=0.84), the items being: "Ability to work autonomously", "Problem solving[1]", "Capacity to adapt to new situations[1]", "Knowledge of a second language", "Concern for quality", "Will to succeed", "Elementary computing skills", "Capacity for applying knowledge in practice[1]", "Decision making", "Project design and management[1]", "Information management skills[1]"

Table 4 shows the mean importance of each group of competences by stakeholder group.

Table 4: Mean importance of each group of competences by stakeholder

Competence Group	Student	Academic	Employer
Personal skills	3.29	3.44	3.30
Professional skills	3.13	3.36	3.29
Interpersonal skills	3.06	3.23	3.09
Entrepreneurship	3.02	3.07	3.05
Internationalization	2.79	2.86	2.63

It is particularly noteworthy that the preference order of these groups, as indicated by the mean score of the factor, is exactly the same for each stakeholder group – a clear indication of the relative importance. Finally, the range of these means is 1 to 4 with the lowest mean score, 2.63 for the employers for internationalization, is still in above the mid-point of the range indicating it is perceived as more than mid-range in importance and cannot be neglected.

HOW THE RESULTS INFORMED THE DESIGN OF A TAUGHT MASHERS PROGRAMME

A taught masters (SCD) programme was designed 3 years ago to meet the progression needs of undergraduate students in the Engineering management stream in the Department of Electronics, but also to attract external students. Two specific target audiences were considered, the engineering graduate aspiring to first and second line engineering management positions and to those wishing to start their own business based on a technical product or service.

The 'technical' content of the programme was based on the typical management functions of Accounting and Finance, Marketing, Human Resource Management and so on. An international business thread was introduced to suit part of the anticipated student market but the 'colour' was added from consideration of the generic skills based strongly on the above project results. Figure 1 shows the overall programme structure.

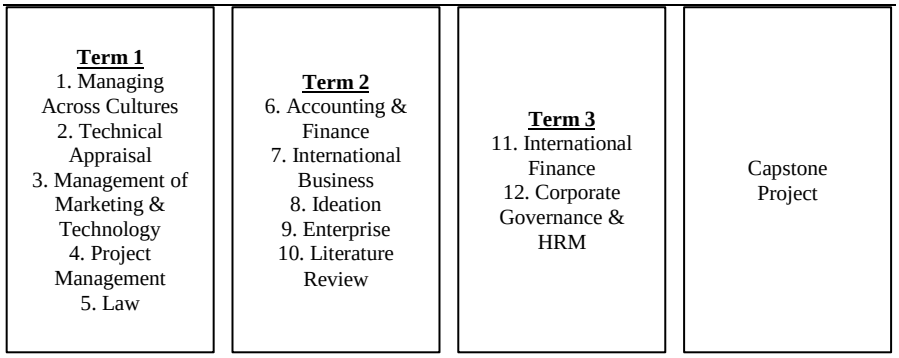

Figure 1. Taught MSc in Engineering Management Programme Structure

The generic skills are developed in a range of ways throughout the programme. The skills indicated with a [1] in the above sub-scales list are specifically noted with a learning outcome in one or more module specification forms. Development ranges from a formal teaching session followed by an evaluation, to self-learning and application. The following is an overview of where and how these skills are developed.

The *Personal skills* of "Project design and management" are taught in the Project Management module and demonstrated through the module assignment but also in the group project. Students are also reminded regularly that basic project management applies to all their activities and should be demonstrated continuously. "Ability to work autonomously" is tested mainly through the module assignments. "Problem solving" is, in part taught in the Ideation module but as Engineers, this mainly comes as second nature to our students. It is tested, in conjunction with "Capacity to adapt to new situations" and "Capacity for applying knowledge in practice" through the very applied assignments used in the modules. The assignments all require the application of the management theories given in class to a new situation. "Information management skills" is taught as a generic skill during the first term and is tested initially in the Technical Appraisal module, then, in a more formal way in the Literature review module and finally, and most importantly, in their research and data management they need in their group project. "Decision making" ability is tested through the project and "Concern for quality" is tested throughout the programme. The only components of *Personal skills* construct that are tested weakly if at all are "Elementary computing skills", which we take for granted in graduate engineers, "Knowledge of a second language", which we do not include at all, and "Will to succeed", which we indirectly assess by the student's end result.

The *Professional skills* are largely tested through specific module assignments. "Grounding in basic knowledge of the profession", the basic technical knowledge in the context of the Masters programme are the elements of management knowledge, as is a "Basic general technical knowledge". "Capacity for analysis and synthesis", "Research skills", "Capacity to learn" are all tested in the context of the specific modules as is the case in most engineering programmes.

The *Interpersonal skills* of "Leadership" is tested and, to some extent assessed through the group project where students rate their peers on quality of input (including leadership) of the group project. "Interpersonal skills", "Team working" and "Ability to work in an interdisciplinary team" skills are developed throughout the study year. All students are allocated to a supervision group as part of the induction programme in the first week. They work in this group where there is a group activity in any of the taught modules as well as during the capstone project. Their understanding of working in groups is supported by a team role inventory and a session on team working and on the stage of team development. They are periodically asked to reflect, albeit in an unstructured way at present, on how the team is working and who is contributing what to the team output. In this way the study programme uses peer support systems to maintain motivation and help students develop. "Ability to communicate with non-experts" is tested through a specific assignment that requires the student to prepare a presentation for a non-technical audience – there is also an assignment that requires them to present as to a technical audience. "Oral and written communications in native language" – this is tested as if English is the native language – which is not the case in all students but then many of the generic skills frameworks also include a foreign language dimension. "Critical and self-critical capability" – reflection plays an important part in learning and is embedded in the assessment structure – including the evaluation of peers both in terms of public speaking generally and in contribution to group activities.

Entrepreneurship skills, and here we do need to tread very carefully as the word entrepreneurship is used very widely with radically different meanings not least depending on whether it is meant in noun or verb form – but also across the different perspectives (economic, sociological, psychological for example). Herein it is used to describe having knowledge, skills and understanding of "Patents and IPR", "Creativity" and having "Initiative and entrepreneurial spirit". Patents and IPR are first taught in the Law module, the need to consider this aspect in business is then tested in the Enterprise module and again in the Corporate Governance and HRM module. "Creativity" is introduced to the students in the Ideation module where they learn about and how to apply a number of different creativity tools in the frame of identifying and then taking forward new innovations. This theme of looking for new opportunities either for possible development as a new venture (entrepreneurship) or within another company (intrapreneurship) is reinforced in the Enterprise module, the International Finance, International Business and Corporate Governance modules and through this building the "Initiative and entrepreneurial spirit".

Finally Internationalization, comprising "Understanding of cultures and customs of other countries." "Appreciation of ethical issues." "Appreciation of diversity and multiculturality", "International relations and collaborations", "Ability to work in an international context" is primarily developed through the Managing Across Cultures taught module (and the Law module for ethics) and tested by the International Finance and International Business assignments. In part it is also seen in action through the supervision groups – all of which are specifically selected to be diverse in student culture.

PROGRAMME DELIVERY AND FEEDBACK

The taught MSc in Engineering Management is now in its third year of delivery having been two years previous to this in design and development. The original plan was for a steady state of 13 students. The actual number of students in the first year was 24 and has risen to 51 in the current cohort. It attracts a significant number of international students, which adds to the cultural diversity.

Feedback from students has been very favourable from the outset, some examples of direct student comments being:

"So far, my experience has been a wonderful one, the courses are well structured and all I have learnt since I began in October has equipped me with new skills and enhanced skills I already possess; skills like project management, communication skills (especially across different cultures), marketing skills and teamwork skills."

"I particularly love the way the course modules are interconnected as I have the opportunity to apply the knowledge I have gained in one course module to other course modules."

"I recognise that local culture acts a crucial part in employees work attitude, and therefore productivity, which in turn requires different managing methods. I held a high expectation on the module, 'Managing Across Cultures' and hoping it would further provide me with information and methods to allow me to work across different cultural environments. Unmistakeably, this module has worked up to my expectation and vital knowledge was gain from it."

CONCLUSION

The objective of the EIE-Surveyor study was to test whether we are meeting student expectations in the EIE disciplines across Europe. A statistical approach was taken using a questionnaire that tested the perception of importance and current level of development of a set of generic skills. Students, academics, graduates and employers were sampled to enable a range of different gaps to be analysed. From an overall sample of over 3,000 respondents clear gaps appear. Additionally the skills statistically reduce to 5 clearly identifiable groups, personal skills, professional skills, interpersonal skills, entrepreneurship and internationalization – these groups not only provide a basis for structuring a hierarchy of skills but also provide a basis upon which development of the concept of 'graduateness' can be built. The outcome of this study has been used to inform the design of the generic skills part of a taught Masters in Engineering Management. This programme is currently in its third year of delivery, its popularity has grown far in excess of initial expectation and student feedback has been very positive from the outset.

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