

Enhancing the Employability Skills of Undergraduate Engineering Students

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Much has been written about how universities can enhance the employability skills of its graduates. A major challenge facing engineering faculties is how to produce engineering graduates who have not just the traditional technical abilities and skills but who also have the necessary business acumen and managerial know-how to contribute positively to local business development. This is of particular importance to regional universities where graduates are often employed in local industries. Today’s employers are increasingly focusing on hiring graduate engineers who possess a broader skill-set than in the past. It is accepted that good communication skills and team-working ability are the two most important soft skills for graduates but it is often difficult to develop these adequately in an already packed curriculum. Commercial awareness is also identified as a key employee attribute however students on undergraduate engineering programmes often struggle to understand its significance. This paper describes an innovative approach taken by course designers within the School of Engineering at the University of Ulster to narrow the skills gap in interpersonal and business management skills as identified by graduate employers. The approach aims to produce engineering graduates that have the necessary business management skills to be readily employable. Opportunities for developing key soft skills have been embedded across the whole curriculum and across all years of the mechanical and engineering management programmes. Practical examples of industrial collaboration are provided and the benefit to the student, industry and to the university is described. Surveys designed to assess the students’ attitudes towards these softer skills were completed by undergraduate students and results are presented. The National Student Survey 2009 shows that 95% of mechanical and production engineering graduates from the University of Ulster are employed in graduate positions, evidence that engineering graduates from the University of Ulster have indeed developed appropriate employability skills.

INTRODUCTION

A number of studies have been undertaken recently to determine how academia can better meet the needs of engineering industry [1-4]. Although they all agree that engineers are employed primarily for their technical skills, the general consensus is that employers are looking for graduates who possess excellent interpersonal skills, are commercially aware and who can contribute to the business success of the organisation. This is particularly important for small to medium-sized enterprises (SMEs) that, unlike large multi-national corporations, do not generally have customised graduate training programmes and where the graduate engineer is often in a managerial position within a very short time of taking up employment. The majority of engineering employers within the UK and Ireland are SMEs. Since most employers within Northern Ireland falls within this category [5], it follows that engineering courses within a regional university such as the University of Ulster should seek to embed these essential skills within its engineering programmes.

Engineering programmes in many UK universities offer curricula that are already packed with modules that lay the foundations for the mathematical, scientific and technical knowledge base that is fundamental to the formation of the professional engineer. The challenge for programme developers within Higher Education is to maintain the technical excellence within engineering degrees whilst simultaneously developing the business awareness and soft skills that industry has identified as being so important when recruiting graduate engineers. Most professional engineers aspire to become Chartered Engineers and the Chartered Engineer is expected to provide leadership; not just technical but commercial and management leadership, mediated through effective interpersonal skills [6].

EMPLOYABILITY SKILLS FOR ENGINEERS

Enhancing the employability skills of university graduates is an area that is receiving much attention at present. Although there is much debate on what constitutes graduate employability skills, they are generally accepted as the knowledge, skills and attributes that graduates should have developed to be effective in the workplace, to the benefit of themselves, their employer and the wider economy. In the UK, the Council for Industry and Higher Education's (CIHE) report on graduate employability revealed that communication skills, team-working skills, integrity, intellectual ability and self confidence are ranked by 80% of graduate recruiters as the five most important skills and capabilities sought by employers [7]. As engineering educators, we recognise that our graduates require all these generic skills together with those attributes and skills that have been identified as important by engineering industry. A recent Royal Academy of Engineering report identified six key attributes as being of particular importance to engineering employers [8]. These are;

- practical application of theory to real industrial problems
- theoretical understanding
- creativity and innovation
- team-working
- technical breadth and
- business skills.

Together these UK findings on employer views are mirrored in other international studies [9].

Although most engineering students can immediately recognise that theoretical understanding and the ability to apply it to real-life engineering problems together with an ability to work and lead in a team environment are key employability attributes for the successful engineering graduate, the majority tends to underestimate the importance of acquiring business management know-how and struggle to appreciate its significance in the workplace. Interestingly, the CIHE report [7] found that the three areas that had the highest gaps between importance- satisfaction ratings among graduate employers were communication skills, commercial awareness and relevant work experience.

Each university approaches the development of these soft skills and commercial awareness in its own way. Some use Career Development departments to offer optional additional training in employability skills; some use the thick-sandwich work placement approach and others rely on loose industrial partnerships to nurture the students' professional development [10]. The School of Engineering in the University of Ulster has sought to embed these soft skills and commercial awareness as integral and substantive within its mechanical engineering and engineering management programmes.

MEETING INDUSTRY NEEDS

The Engineering Management and Mechanical Engineering programmes share a number of common subject themes associated with most professionally accredited programmes: maths and science; engineering analysis; design and innovation; economic, social and environmental context; and engineering practice [6]. These themes are introduced in year one of the programmes and then progressively developed during subsequent years. The differences between the courses arise mainly from the relative emphasis placed on these common themes. One perspective on the differences between the courses is provided by the students themselves. The results of a survey conducted in the School of Engineering that sought their views on the relative importance of the main subject areas in their curricula are shown in Figure 1. Both programme cohorts rated the Design and

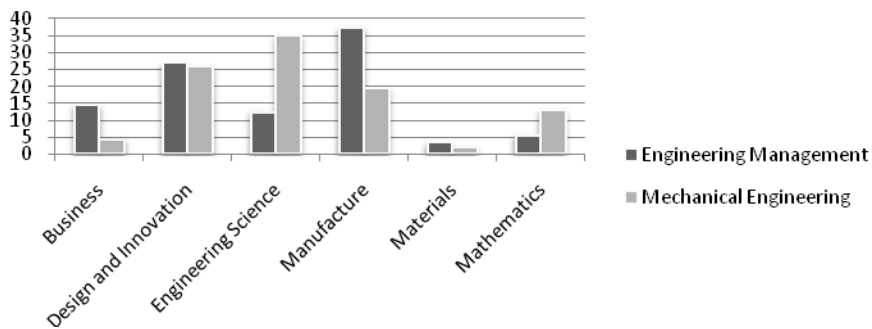


FIGURE 1
STUDENTS' PERCEPTION OF RELATIVE IMPORTANCE OF MAIN SUBJECT AREAS

Innovation subject areas as equally important. As one might expect, the key subject themes for mechanical engineering students were engineering science and manufacture; whereas the engineering management students placed a greater importance on manufacture and business.

A threshold level of technical competence is fundamental to the formation of the professional engineer - the greater the development of this technical competence then the greater the analytical and quantitative flair of the graduate. Competent graduate engineers need to be able to relate relevant scientific and mathematical principles to practical applications. Consequently, the acquisition of technical knowledge and understanding, together with the ability to apply them, are central to our curriculum design. Like elsewhere, engineering programmes at the University of Ulster provide students with many opportunities to develop these technical, analytical and practical skills. Our approach to developing the soft skills and commercial awareness that are so important to employers has been to interweave and integrate them throughout the curriculum in a developmental continuum, interfacing with industry as opportunities arise. The approach is illustrated in Figure 2.

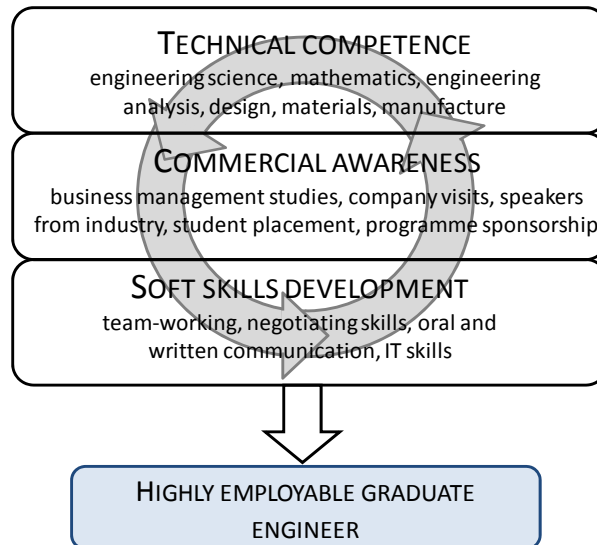


FIGURE 2
 EMPLOYABILITY SKILLS OF GRADUATE ENGINEERS

DEVELOPING COMMERCIAL AWARENESS WITHIN THE ENGINEERING CURRICULUM

A significant number of staff within the School have an industrial background and are encouraged to engage with local industry in university-industry business improvement partnerships. Industrial experience empowers staff to deliver business-type modules that have real industrial relevance and exemplars from industry can be used to facilitate student engagement with business materials.

In year 1 each student's Studies Advisor concentrates on the student's development of practical management skills, for example, self-discipline, independent study-skills and

time management. Students on the engineering management programme have a formal taught module in business and management.

One particularly innovative module in year 2 involves the participation of a number of local engineering companies hosting a series of visits for students to hear at first-hand about manufacturing methodologies, commercial environment, business management techniques and manufacturing processes. Mechanical engineering students especially, often underestimate the importance of acquiring business management skills and we have found that these visits are an excellent way to ‘sub-consciously’ improve students’ business knowledge and broaden students’ understanding of the engineering function within the business enterprise. These industrial visits are also an effective means for companies to promote themselves to prospective employees and develop further our University’s links with local industry.

In the third year, commercial awareness, communication skills, team-working, self-confidence and self-esteem are attributes that are all significantly enhanced by the supervised paid work placement experience. This twelve month ‘sandwich-year’ of real engineering work experience has proven to be a very important formative experience for the student engineer who gets an excellent opportunity to understand how the theoretical principles that they have learnt about in the preceding two years are put in to practice in the ‘real world’. Although they are on placement primarily for the technical experience, the students are required to research and report on the business aspects of their host organisation. An innovative web-based system has been developed within the School of Engineering to facilitate and support the recruitment, supervision and assessment of the placement student [11]. This, together with the development and fostering of links with local and international industry has supported the on-going success of our work placement activity - in contrast to experience generally in the UK. The Confederation of British Industry report [10] on work experience found that in engineering and technology programmes, the number of UK sandwich course students fell by approximately 8000, or 33%, over the ten years from 1994/95, despite an overall expansion in student numbers. Across programmes as a whole, the drop in participation was even more dramatic.

Having had the benefit of work placement, final year mechanical engineering students are much more receptive to formal lectures in industrial management and since the material is delivered with reference to typical scenarios in the work environment, the student is well equipped to link management theory to its practice. Overall, the students’ satisfaction levels are summarised in Figure 3.

This survey revealed that over 55% of students in the final year of the mechanical engineering and engineering management programmes were satisfied that their business awareness was highly or significantly developed. This compares very favourably with the 18% of undergraduates nationally who believe that they fully developed their business and commercial awareness skills while at university [10].

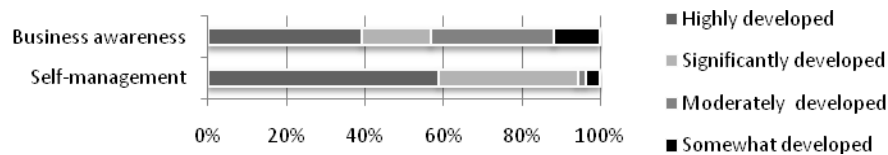


FIGURE 3

FINAL YEAR STUDENTS’ ASSESSMENT OF THEIR BUSINESS MANAGEMENT SKILL DEVELOPMENT

A range of engineering companies within the region have worked with us to provide real-life design projects for final year students. Final year Design is a team-based module that involves students working in a multi-disciplinary team environment where engineers from a local company prepare a project design brief, the students then work on concepts and designs for the duration of the semester and finally they present their detailed design solution to the company in a semi-formal business environment. A detailed business plan is part of that presentation. Sometimes the company will give a monetary prize to the most innovative and/or cost effective solution. Examples of the wide variety of these real-life projects include specialist furniture for disabled children and stone crushing equipment for the quarrying industry.

These are examples of active industrial involvement where everyone involved, the university, the students and the company benefit from each other's involvement. Students understand better the commercial pressures and constraints of industry and industry understands better the students' perspectives. A learning synergy is thus established.

DEVELOPING SOFT SKILLS WITHIN THE ENGINEERING CURRICULUM

A feature of modern society is that young people increasingly communicate with each other remotely. Consequently, educators are challenged to find ways of enabling students to better interact face-to-face with others. Our approach has been to embed the development of these soft skills initially within an extended induction period and then progressively within the subject area of Design. The extended induction period involves the students visiting a local manufacturing company where they get the opportunity to meet past graduate engineers from the University and are introduced to the business environment via the industrialist's explanation of the commercial pressures faced by companies.

Over 80% of our year 1 modules contain team-based coursework elements that involve students from the same cohort working with each other. Just under one-fifth of them contain an element of oral presentation. In year 2, all modules contain team-based coursework tasks, some of which involve students from one programme working with students from other programmes. One-third of modules involve an oral presentation. The compulsory work placement in third year provides an excellent environment for the students to further develop their interpersonal communication and team-working skills. Final year students on the programmes deliver oral presentations in at least one-quarter of their modules. Three-quarters of their modules involve team-working. Student teams in final year use a peer marking process to assess the contribution of other members of their team. This has proved particularly effective as students are working in multi-disciplinary groups to solve real-life engineering design problems. Negotiating skills, conflict resolutions skills, self and time management skills are all developed using this approach [12].

Students completing the final year of their programmes were asked to judge the extent that their programme had developed their team-working, IT, oral and written communication skills. There was a very high level of satisfaction that these skills were being highly or significantly developed as shown in Figure 4.

The National Student Survey 2009, NSS, shows that 95% of students from mechanical engineering and engineering management programmes at the University of Ulster are employed in graduate positions [13]. The 2008 NSS reported that 85% of our graduates in this subject area had obtained graduate employment. Although it is expected

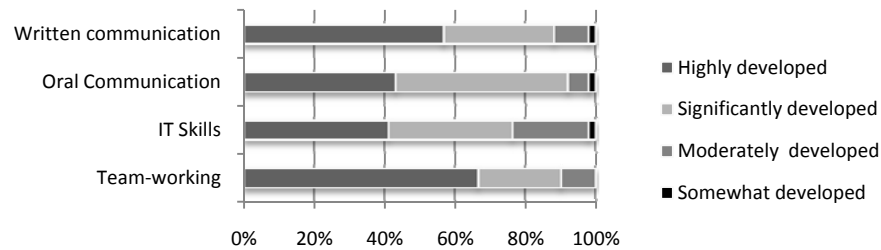


FIGURE 4
FINAL YEAR STUDENTS' ASSESSMENT OF THEIR SOFT-SKILLS DEVELOPMENT

that the employment rates for 2010 graduates will be lower due to the global economic downturn, the data shows that graduates from this category are highly employable.

CONCLUSION

Our methodology for developing engineering students at the University of Ulster has been described. The approach delivers the traditional scientific, technical, analytical and mathematical subjects that are fundamental to the area of mechanical and manufacturing engineering but with an emphasis on developing the students' commercial awareness and communication skills that employers within Northern Ireland, and beyond, have identified as being so important. Students finishing engineering programmes at the University of Ulster have reported high levels of satisfaction with the extent to which their business awareness and soft-skills have been developed. Finally, employers are very satisfied in that a very high percentage of our graduates obtain suitable employment in graduate positions within a short time of completing their studies. We believe that we have enhanced the employability skills of our graduates thereby giving them a competitive edge in securing suitable graduate employment.

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