

Interpersonal skills in Engineering Education

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CONTEXT

Engineering education communities have long recognised that graduates not only need to possess technical knowledge in their chosen disciplines, but also need to be better educated in communication skills, teamwork, leadership, creativity, problem solving and a host of other human factors. Several studies mention these so-called "soft skills" as increasingly important to future engineers. This popular but unfortunate colloquial term is often used to describe the development of a person's professional relationships with other people and the building of their emotional intelligence. On the other hand, it can suggest that these skills are low grade. Graduates with enhanced "soft skills" are certainly at an advantage in the job market.

PURPOSE

To investigate the following research questions: How important are soft skills? Are they perceived as low grade? What are the most appropriate methods for skills development and where does the responsibility for this lie? And ultimately, how effectively is the current education system preparing students for employment?

APPROACH

This paper reviews the current literature and compares this with the findings of a significant new investigation involving students, lecturers, careers personnel and employers. The primary research correlates quantitative and qualitative research methodologies using an online student survey; plus structured interviews with academics, careers advisors and industrial employers.

RESULTS

'Soft' skills are difficult to quantify compared with hard (technical) skills. Conversely, less merit is often attached to soft skill competence in academia and hence they may be perceived as easier. Nevertheless, they are externally perceived as extremely valuable. Most highly specialised academics, however, are typically not sufficiently well trained in the most appropriate teaching methods and believe (or hope) that the skills are simply acquired through experience. Participants overwhelmingly agreed that the development of 'soft' employability skills is important in higher education but few thought the responsibility for their development was the sole responsibility of HE institutions. All the interview participants believed that soft skills are insufficiently emphasised in the University curricula at present. Students believe that the best way to introduce more soft skill development is to change the method of learning in the technical subjects, rather than to directly teach soft skills.

CONCLUSIONS

The common term 'soft' skills is ambiguous and unhelpful. Transferable, interpersonal and people skills were preferred descriptors: the research found them difficult to bound, quantify, and teach. They tend to be subjective and were perceived, by some as low value. Nevertheless, the research suggests they are of equal or more importance than technical skills in respect of employability.

The literature identified a graduate soft skills gap but on balance the research findings did not support this proposal. The new research data highlighted that work experience; mentoring and industrial placements are the most appropriate educational methods and that soft skills development should be a shared responsibility; lower and higher education institutions, employers, parents and the individual all have a part to play. Universities, however, are presently too heavily focused on technical skills and they have the key responsibility to ensure graduate employability.

KEYWORDS

Employability, Skills development.



Introduction

An engineering company's competitive advantage comes, not only from its products but also from the professional service it delivers. Companies need employees who have the necessary interpersonal skills and personality traits to succeed in project delivery as well as being technically proficient. A clear distinction is drawn between so called 'hard' technical or scientific skills'; such as the ability to solve mathematical problems, the ability to design systems or proficiency in a computer programming; and 'soft skills' which relate to the way people relate to and interact with others, more specifically referred to as interpersonal skills. The fact that so many different terms for these important attributes are in common usage, almost interchangeably, to describe the 'soft' skill set serves to demonstrate how difficult it is to pin down. Other commonly used terms are transferable skills, key skills, people skills, professional skills and life skills. This capacity for understanding and communicating one's own emotions and the effect your actions and emotions have on others is, perhaps more correctly defined as emotional intelligence (EI) and this has been the focus of much research, particularly by American psychologists who usefully compared and contrasted the capacity to monitor and control one's own and others feelings and emotions with the better established 'hard skills' measure: intelligence quotient (IQ). However this construct is not often discussed in Engineering Education today.

This paper reports on a research project that used both existing literature and new primary research data to explore the apparently growing importance of interpersonal skills within engineering professionals. From the outset it was decided to use the colloquial terms 'soft' and 'hard' in the present investigation as these are in common usage and appear to cover the whole skill set required by engineers. In addition, they are potentially controversial terms as they imply different levels of difficulty so might be used in a derogatory fashion and this would form part of the investigation.

Literature Review

Emotional Intelligence and skills competences

Emotional intelligence (EI) is the capacity of individuals to recognise and manage their own, and other people's emotions, to discriminate between different feelings, label them appropriately and to use emotional information to guide thinking and behaviour. EI is about being 'heart smart' whereas IQ is about being 'intellectually smart'.

Whilst 'hard' intellectual skills still dominate in academia, there appears to have been a transition in the workplace where it was suggested that EI skills are just as important. Thirty years ago, Gardner (1983) recognised that intrapersonal and interpersonal intelligences were just as important as the type of intelligence typically measured by IQ, while later studies have declared them to be even more important. For example, Feist & Barron (1996) wrote that social and emotional abilities were four times more important than IQ in determining professional success and prestige, while Chou (2013) proclaimed that "hard skills help us qualify for a job but soft skills dictate our career growth". Put another way, "People tend to rise in organisations through the presence of hard skills but fail due to soft skill inadequacies" (Deepa & Seth, 2013).

Highly developed EI is particularly important for tomorrow's leaders. The UK Institute of Leadership and Management quotes Daniel Goleman's work (1998) in which he suggests that these skills contribute more than 85% of what enables star performers to become great leaders. Anecdotally, the recruitment of graduate engineers seems to focus more than ever on soft skill competencies and students regularly report this after attending for job interviews or assessment centres.

The need for teaching and learning in 'soft skills'.

Twenty years ago, the ASEE (Augustine and Vest, 1994) proclaimed that "engineering education programs must not only teach the fundamentals of engineering theory, experimentation, and practice, but be relevant, attractive, and connected," preparing students for a broad range of careers and lifelong learning. Goldberg (1994) suggested that students spend 80% of their time studying technical subjects but these technical skills developed only constitute 20% of an individual's working day.

Despite this, and similar proclamations in other parts of the world, several later studies highlighted the perception from industry professionals of a soft skills gap within graduates. Jackson (2009) identified a modern day graduate skills gap in the UK, Australia and USA that exists and the soft skill deficiency that higher education institutions are held responsible for. They identified that employers are becoming more and more reluctant to invest in graduate training and development due to the perception of them being of a generation that are more likely to leave the company in the short term. Kumar and Hsiao (2007) stated that "*Engineers learn soft skills the hard way*" supporting the theory that engineers are continuously entering the market place technically qualified but not sufficiently competent in soft skills. The situation may, however be improving. The Confederation of British Industry conducts regular education and skills surveys. It had also reported a "growing" skills gap in STEM subjects. In their most recent report (CBI, 2016) much is made of advances in building apprenticeship schemes at sub-degree level where, it says, there is the greatest need. In contrast, they found some recent improvement in graduate skills and, at this level, stated "many businesses are now reporting a positive evaluation of graduates' basic skills and general readiness for employment".

There are many examples, however, in the recent literature of opinions that the education system is currently too focused on quantifiable hard skills such as qualifications, certifications etc. meaning that soft skill development is often neglected. Findings from a survey study conducted by Sharma (2009) including 50 middle to top level executives in Human Resource found that recruitment managers are not satisfied with the current graduate workforce; believing that the graduates should be better equipped with soft skills as well as hard skills that can become quickly outdated. Both ABET and UK-SPEC, the respective bodies in the USA and UK that currently define engineering course accreditation routes list the required 'professional competences'. These include skills considered both 'hard' and 'soft'. UK-SPEC (2014) for example, insists that professional engineers seeking registration should specifically be able to "demonstrate effective interpersonal skills" and sub-divides these, specifically into three areas. The ability to; 'communicate with others at all levels; present and discuss proposals; and demonstrate personal and social skills.' The ABET requirements include abilities to "communicate effectively"; understand professional and ethical responsibility"; understanding in the "global/societal context"; and "function on multidisciplinary teams".

It has been proposed that soft skills are the most difficult to teach and assess in education, notwithstanding the fact that most teachers in engineering higher education are technical specialists who often also lack relevant formal skills training themselves. Soft skills are extremely hard to quantify, and assess (Mala, N/D). Communication and interpersonal skills are continually identified in the literature to be the most important soft skills in engineering. Shuman et al (2005) enquired whether or not it is possible to teach these skills effectively and answered with a qualified yes, but believed the traditional lecture format was an inappropriate mechanism here. Like many before them, they challenged engineering educators to build more real world experiences and placements into the curriculum. It is gratifying, therefore that the CBI reported (2016) a general increase in industry's involvement with Schools and Universities over the last year.

Felder and Brent (2013) described how teaching and learning should be altered to meet the ABET skills requirements and cited the research that supports the proposed methods. They

focussed on Problem Based and cooperative Learning methods to address these outcomes. On a practical level, Willmot and Perkin (2011) described a range of competitive challenges and problem solving activities designed to improve first year engagement had actually resulted in significant improvements in students' interpersonal skills. The experience of Lindsay et al (2008) confirmed this philosophy and described how a shift to embedding interpersonal skills training into the technical context, rather than teaching skills in a separate unit had improved learning.

Methodology

Research Questions

- How important are 'soft skills'?
- Are they perceived as low grade?
- What are the most appropriate methods to promote skills development and where does the responsibility for this lie?
- How effective is the current education system in preparing students for employment?

Approach

Primary research was conducted through a combination of quantitative (i), and qualitative (ii) research methodologies:

- i. Online Survey Questionnaire available to Engineering Students
- ii. In-depth interviews with Engineering Students, Academic Professionals, Recruitment Professionals and Industry Professionals

A small local pilot study was used to trial and amend the survey questionnaire and the resulting online survey questionnaire achieved 108 responses. 89% of the participants were from Loughborough University, with the remaining 11% representing a range of other universities including the University of Warwick, University of Manchester and University College, London. Students from all four years of study were surveyed with the largest constituents being taken from year 3 (34%). A number of recent graduates also took part. The survey was distributed through social media groups.

Eighteen individual structured interviews were carried out as part of the qualitative data collection. The participants are shown in table 1 and represented four different spheres of interest; all had a direct connection with engineering.

A pre-prepared interview script, after establishing the personal and status information about the interviewee, comprised questions designed to promote a discussion that was audio recorded (with permission) and thematically analysed later. Each interview lasted approximately 45 minutes. The questions were divided into groups under the following three sub-headings:

The interviewee's perception of 'soft skills'; establish a definition. Recruitment requirements and HR methods? The effect on career prospects. Which soft skills are most important? Comparison with 'hard' skills.

The skills gap; does it exist? Are soft skills sufficiently emphasised in HE? How could the gap be closed?

Teaching and learning soft skills; who has responsibility? What are the most appropriate methods? Caught or taught? Assessment?

Although there was a core set of interview questions, some of the questions were found to be non-transferable between the four sample frames in the first interviews. To increase effectiveness of the interview process, scripts were later tailored for each of the groups.

Table 1: Structured interview participants.

Sample frame	Percent	Details
Industry professional	42%	representing; aeronautical, nuclear, manufacturing, chemical, and materials engineering.
Academic staff	26%	from two UK universities (Loughborough and Bradford)
Recruitment professional	16%	representing a human resources department in an industrial employer and two careers consultants.
Undergraduate	16%	studying aeronautical engineering, automotive engineering and engineering management in their third year of studies.

Results

The following section summarises the key findings, theories and opinions collected from the quantitative, qualitative and observational research.

Defining skills

Participants were asked to define a range of skills as either 'soft' or 'hard'.

Table 2: Survey opinions on hard and soft skills

Skill	Hard	Soft
Communication	5%	95%
Teamwork	6%	94%
Mathematics	97%	3%
Analvtical	81%	19%
Time Management	27%	73%
Interpersonal	2%	98%
Computing	94%	6%
Technical Knowledge	97%	3%
Leadership	8%	92%
Conflict Management	7%	93%
Statistics	93%	7%
Resourcefulness	19%	81%
Problem Solving	57%	43%
Presentational	26%	74%

The results were broadly in line with those expected from the literature review with one exception. From the literature review, the skill of problem solving was expected to be identified as a soft skill, however, 57% of the student participants identified problem solving as a hard skill. Following qualitative analysis it was concluded that the identification of problem solving as soft or hard depends on the type of problem being solved.

How important are soft skills in engineering education?

While 71% believed hard skills are more important than soft skills in engineering, 92% of the survey population stated that soft skills are also important, which suggests that soft skills support the core of technical knowledge and skills.

82% of participants agreed that hard skills help engineers qualify for a job or role, but soft skills dictate career growth and progression. After further thematic analysis it was confirmed that the majority believed soft skills are more closely associated with a candidate's employability than hard skills which are seen as a pre-determinant.

Interviewees stressed that modern day engineers never work in isolation as they continually work in diverse teams and are often required to collaborate with others on multidisciplinary projects. This puts a very high importance on soft skills to ensure the projects are successfully completed on time and on budget. In addition whilst the size and complexity of projects has increased, there is also increased diversity and the associated needs for greater flexibility. The ability to report, orally and in writing at a high level of competence was also highlighted because of the ever increasing need for transparency in business.

80% of the survey respondents identified communication (oral, written, body language, listening skills and etiquette) as very important, 72% identified teamwork as very important and 44% identified time management as very important. With regards to the top three hard skills identified by the survey population, 78% identified technical problem solving as very important, 65% identified technical knowledge as very important and 54% identified analytical capability as very important.

Communication skills are the building blocks to many other skills including effective teamwork. The ability for an individual to be able to tailor their communication style to the audience and environment is very difficult to master, but is essential in a successful manager.

Are 'soft' skills, low grade skills?

The word 'soft' has several different meanings. Soft skills are referred to as soft because they are particularly difficult to quantify. They are more difficult to define and thus to effectively teach by conventional methods such as the lecture and the exam which are most familiar to engineers. Engineering students, for example, typically place little value on stand-alone lecture programmes concerning skills development. Much more imaginative learning styles are required to properly engage students in such non-technical subject matters (Done and Willmot, 2015). Unhelpfully too, less merit is commonly attached to soft skill competences in academia and hence they are often perceived to be easier than 'hard' skills even though many external bodies see them as the most valuable skills to have. Soft skills are strongly associated with a person's emotional intelligence. To express emotion is, however, alien to many engineering professors who confine their thoughts to higher technical concepts, and therefore, consideration of such expressions be considered of little significance or perhaps, weak or 'soft'.

The term 'soft' contrasts with the term 'hard', which also happens to be a synonym for difficult, so the meaning is unclear. A useful analogy was introduced by a University academic at interview. He compared soft and hard skills to software and hardware, suggesting that hardware like hard skills is more tangible, visual and easier to understand.

An industrial contributor suggested that traditionally an engineer's role was to provide excellent technical engineering expertise. Today the lines between functions, managers and across the whole hierarchy are much more 'blurred'. Similarly another industrialist stressed that, with the increases in technology and automation, human soft skills will continue to become more dominant in the future as engineers become ever more commercially aware. While projects continue to grow in complexity and become more multidisciplinary, the hierarchy of organisations has become much flatter. These factors emphasise the modern necessity of working together as a large team and hence amplify the need for leading players to understand the needs and emotions of their fellow workers and subordinates, which provides a strong case for the increased importance of emotional intelligence skills. Clearly, increased integration means that engineers need to become more rounded.

What are the most appropriate methods to promote skills development?

Participants believed that soft skills can be both learned through application (caught) and taught in theory. The following paragraphs, however suggest that formal teaching actually plays only a minor role in skills development. It was suggested that the base level ability of an individual's soft skills is an innate ability from birth and developed from a very early age in the home. This supports the importance of the primary and secondary education system in developing the younger population in soft skills

Demands from employers for graduates with better employability skills has led to the introduction of more practical hands-on activities in the courses and simulated industrial experience. (Arlett et al, 2010). Many of the recruitment professionals along with the students believed that the best way to develop soft skills is through application and experience. The students in particular identified the industrial year-long placements as part of their degrees as key to their personal and professional development and in preparing them for working life. However, the majority thought that there should be a combination of classes and experiences.

It appears that the environment in which people learn contributes greatly to soft skills development. For example, the interviewed professionals reported that students who had attended private (fee paying) schools, where they are generally encouraged to take on responsibility, develop organisational skills and learn to speak in public through clubs and committees, were typically more able, at least in their early careers. However it was noted that these same students are only exposed to a narrow range of people, values and backgrounds, and that if the more diverse state (free) schools could adopt similar practices, this would be an ideal environment to develop soft skills at an early stage. A similar argument can logically be made for increasing exposure to situations where they are required to take responsibility for their actions and the actions of their fellow students later in life, at university.

One important aspect that is often overlooked is the active development of leadership skills. Willmot and Twigg (2006) identified that most University degrees include leadership elements but do not actually teach it. They had earlier proposed two alternative strategies for teaching leadership to final year Engineering (M.Eng) students. The first was a year-long mentoring programme where students are given the responsibility of a team of junior students completing an industrial based project. The second was built around a short four-day intensive outdoor management module.

Where does the responsibility lie for graduate soft skill development?

Only 8% believed the responsibility for graduate soft skills development should belong with Higher Education (HE) institutions alone; 67% of participants believed that the responsibility for soft skill development should belong with all parties (HE, schools, employers and with the individual). This was fully supported by the qualitative interviews. The results are shown in Figure 1.

Many respondents thought that Universities primarily exist to teach students in the discipline being studied and it is the graduates' individual responsibility to develop their soft skills,

however, there must be adequate support provided to facilitate their development. When in employment, it is the individual's responsibility to implement continuous professional development (CPD). However, employers should have structured training available to support this development.

Where should the responsibility for graduate soft skill development belong?

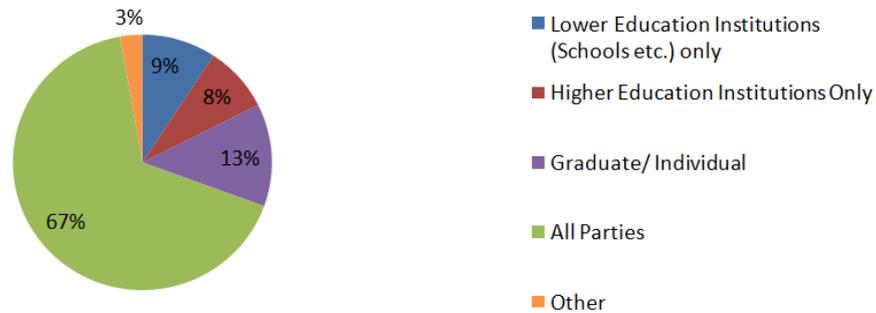


Figure 1: Online survey responses

How effective is the current higher education system in preparing students for employment?

For the purpose of data analysis with regards to this specific research question, the survey five point Likert scale options strongly agree, agree, neutral, disagree and strongly disagree were condensed in to agree, neutral and disagree.

From the online survey questionnaire, when asked, *do you agree that graduates enter employment with a sufficient competence in soft skills*, 39% agreed, 36% neutral and 25% disagreed, showing a large spread of beliefs across the student survey population.

In response to the questions: *do you agree with the statement; Higher education institutions curricula include sufficient emphasis on soft skill development?* A spread of responses was collected. 40% agreed, 24% were neutral with their opinion and 36% disagreed with the statement. However when asked *do you agree that Higher education institutions curricula are too focused on teaching hard skills*, 60% agreed.

Notwithstanding the foregoing comments, all interview participants supported the separate survey findings that currently, soft skills are not sufficiently emphasised in the University curricula. However the time constraints that exist mean that inclusion of all hard skill requirements are the priority.

The student participants believed that the best way to introduce more soft skill development is to change the method of learning in the technical subjects, rather than directly teach soft skills, which suggests that the adoption of more innovative teaching methods is required. At Loughborough University, for example, students found group based work extremely beneficial to learn and develop how they operate together and indirectly develop their competences. Students also commented that once in employment, the hard skills learnt can become quickly outdated, and therefore the HE curricula should try to create a better balance between soft and hard skills, to create more rounded and flexible individuals who become more effective employees and managers.

From the academic professional perspective, work experience was seen as the main contributor to soft skill development. Academics are often heavily involved in research which is generally hard skills based and dictates University curricula. This creates a bias towards hard skills and pushes soft skills aside, often to the point of disdain.

Conclusions

There are several different terms that have been referred to here as 'soft' and 'hard' skills. These commonly used terms were identified from the outset as ambiguous and potentially derogatory (soft skills). As such, transferable, interpersonal and people skills were preferred terms to refer to these skills.

The research emphasised the importance of soft skills in respect of employability, personal development and career progression and, ultimately, to business growth and success both within and outside the engineering profession. It found soft skills difficult to bound, quantify, observe and teach; they tend to be subjective and perceived, by some technocrats as unworthy'. Soft skills, on the other hand, support and implement 'hard', quantifiable skills and are identified as soft because of their personal, emotional and less tangible nature. The enveloping concept of developing Emotional Intelligence (EI) development in contrast with intellectual intelligence (IQ) was found to be important.

The traditional perception that soft skills are less important than hard skills identified in the literature was explored. It was widely agreed that this perception exists, however, the present research supports the ideas that soft skills are equally important and often undervalued in the modern engineering profession.

The online survey questionnaire identified communication as the most important 'soft' skill within engineering. Communication is essential to ensure the project groups are aligned and working collaboratively. Furthermore when engineering provides a service to the client, good communication is imperative to providing a professional service.

The literature identified a graduate soft skills gap but suggested the gap may be closing. On balance the present research did not identify any specific skills shortage. However, given that the majority of participants here were undergraduate students, they are likely to be predisposed not to acknowledge their own weaknesses in employability, or worse, may not be aware of them. A more positive explanation may be that the close links that already exist between the two UK universities in the survey and industry within their degree courses and in defining the curricula are working well.

It has been suggested that a person's ability in soft skills and EI largely depends on their innate personality traits. However these findings show that soft skills can be both taught and developed through innovative experiences and application. The development of individuals from a young age is extremely important to create a strong base to build on throughout their lives. The data collected highlighted that work experience; mentoring and industrial placements have been identified as vital methods for developing graduates in soft skills and therefore employability.

This research suggests that soft skills development is a shared responsibility and is developed throughout a lifetime. There is also significant evidence here that higher education institutions are currently still too heavily focused on technical skills and that they have the main responsibility to ensure graduate employability. To teach these skills effectively, however, may require a shift in educational philosophy and the adoption of more innovative teaching methods.

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