The opportunities and challenges for employability-related support in STEM degrees

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Abstract

This research explores the opportunities and challenges for incorporating employability-related support into STEM (Sciences; Technology; Engineering; Mathematics) degree programmes, based in part on recent research (O'Leary, 2016a) outlining that significant variations in employability-related support exist across the STEM disciplines. These issues were highlighted at a recent conference on STEM pedagogy (O'Leary, 2016b) and this paper explores them in more depth. While O'Leary (2016a) finds that Engineering and Sciences are performing relatively well on employability-support matters, in comparison with Social Sciences and Humanities, there is still room for improvement across STEM programmes. The research suggest that students' employability can be enhanced through a combination of the content of the curriculum and the development of key student capabilities and characteristics. To achieve this, it is necessary to address several issues: the development of academic staff, the use of external speakers, the provision of business and management expertise, cross-disciplinary approaches and the integration of professional services into the curriculum. In addition, the most effective gains from a cross-Faculty viewpoint may exist in what may seem unlikely liaisons; for effective employability-related support, the Sciences and Humanities think along the same lines, while Social Sciences & Engineering think along another line. Therefore, improvements to the provision of such support may be better achieved by such non-traditional cross-Faculty partnerships. An approach based on the "3E's" is suggested: Enhanced Learning & Teaching; Employer-engagement; and Embedding into the Curriculum.

Introduction

Enhancing graduates' employability is a priority across the higher education sector, as evidenced in Neves and Hillman's (2016) Student Experience Survey, in Davy's (2016) focus on there being too much attention given to a student's progression toward academia rather than elsewhere and in Miller's (2016) work on social mobility. Recent research (O'Leary, 2016a) also highlights a clear demand from graduates for the inclusion of employability-related support during undergraduate degrees and signals that important differences exist in how this may be best achieved across disciplinary areas in undergraduate degree programmes. Across all disciplines, although one in ten of graduates prefers full concentration on the subject discipline alone, nine in ten would like to see employability-support on the undergraduate agenda, as shown in figure 1.

However, significant variations exist across the disciplines on how best to deliver that support, particularly if it should be on an elective or mandatory basis. As illustrated in figure 2, the majority of both social sciences and engineering graduates prefer integrated delivery while, for graduates of humanities and sciences, there is a more balanced preference between integrated and elective opportunities. It is particularly striking that significant differences exist across the STEM disciplines with Engineering more aligned with Social Sciences and Sciences in line with Humanities. Therefore, while the grouping of disciplines into

one entity, STEM, has had clear benefits in raising its profile and in other spheres, it appears that different branches of STEM need to be considered separately when assessing how best to deliver employability-related support. In addition, as different disciplines tend to attract significantly different balances of gender (Higher Education Statistics Agency, 2016), the issue of gender is also of importance and this is included in further related research.

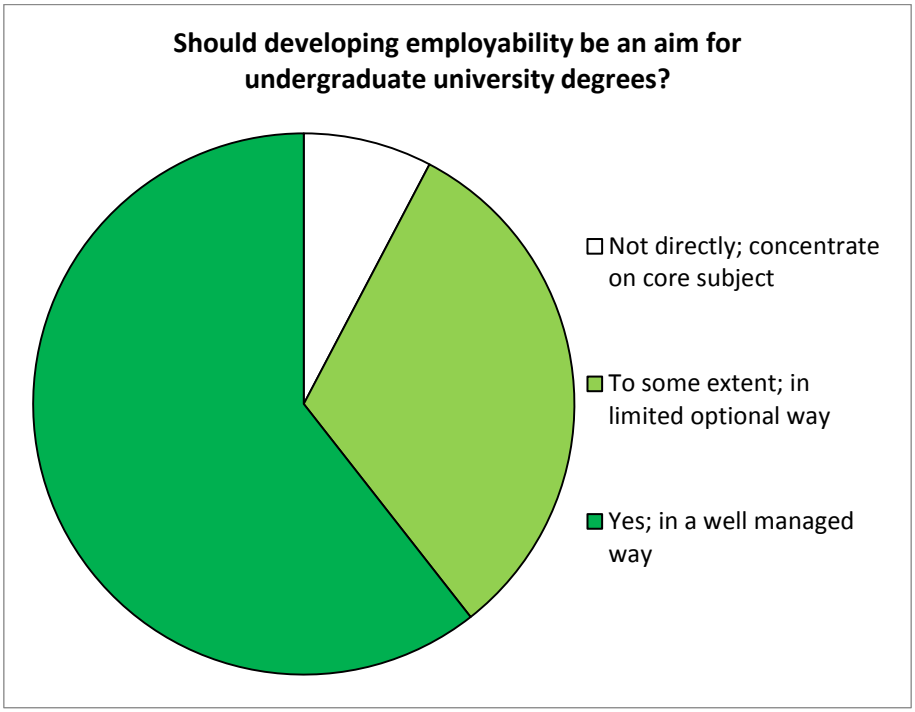

Figure 1 Graduates' attitudes towards the inclusion of employability-related support during undergraduate degree programmes (O'Leary, 2016a)

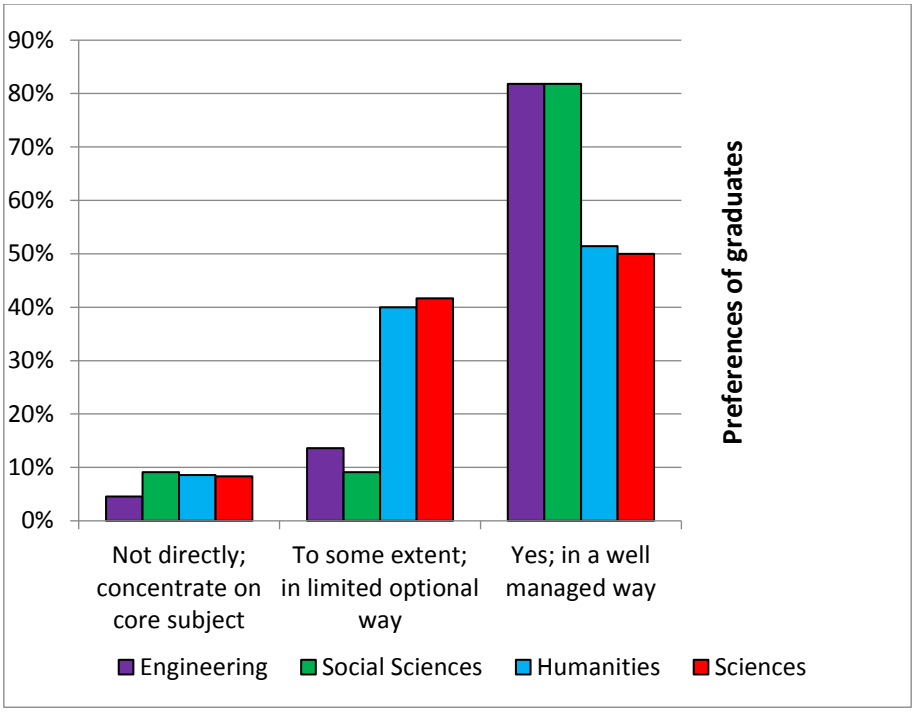

Figure 2 Graduates' preferences on how best to deliver employability-related support during undergraduate degree programmes (O'Leary, 2016a; O'Leary, 2016b)

As outlined in more depth later in this article, graduates' actual experiences of such employability-related support during their undergraduate degrees indicates that professional groups, such as Careers Services, are more active now and provision generally has risen over recent decades. Farenga (2015) highlights this enhanced provision from careers services groups and categorises three different types of support: Hands-Off; Portfolio; and Award. Nevertheless, while a rise in provision or 'quantity' is valuable, it is important to note that the link with the academic discipline needs to be ensured as this better reflects the 'quality' of such provision. The right balance, between the provision of employability-related support and its integration into the academic aims and curriculum, needs to be achieved.

Graduate employability

Many models and definitions of employability have evolved across higher education (Williams, Dodd, Steel and Randall, 2015) but a now commonly-used definition has been developed by the UK Higher Education Academy (Pegg, Waldock, Hendy-Isaac and Lawton, 2012), building upon earlier work by Moreland (2006):

> 'A set of achievements, skills, understandings and personal attributes that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy.'

The phrases 'chosen occupations' and 'more likely', as well as the breadth of stakeholders described, indicate that its purpose is to enhance the likelihood of success in achieving suitable employment and that the beneficiaries are widespread. Nevertheless, distinctions between different graduate types are not made, and indeed concerns exist as to whether the expectations of industry are actually being met (Jackson, 2014; Wilton, 2012; Hinchcliffe and Jolly, 2011), if gender is being sufficiently considered (Gracia, 2009; Wickramasinghe and Perera, 2010; Moreau and Leathwood, 2006) and if disciplinary variations are adequately addressed (Jackson and Chapman, 2012; Stiwne and Jungert, 2010).

As illustrated in table 1, there are many desirables, preferences and signals given on employability by employers. Chankselian and Relly (2016) highlight such variations in their research into young people and entrepreneurship. However, while graduate skills, attributes and competencies are clearly important for enhancing employability, insufficient differentiation exists across the subject disciplines.

Skill required	What employers are seeking	Examples of how demonstrated
Self-reliance	Self-awareness; proactivity; willingness to learn; self-promotion; networking; planning action.	Duke of Edinburgh award; music band; competitive sports; public speaking; amateur dramatics.
People	Teamwork; interpersonal skills; oral communication; leadership; customer orientation; second language.	Working in a restaurant; charity fundraising; voluntary work; team sport; Air Training Corps.
General	Problem-solving; flexibility; business acumen; computer literacy; numeracy; commitment.	Young Enterprise award; project work; member of student societies and clubs.
Specialist	Specific occupational knowledge skills; technical skills.	European Computer Driving Licence; language skills; web design skills; writing articles; other qualifications.

Table 1 Examples of employers desires of graduates (O'Leary, 2016b; HECSU and AGCAS, 2015).

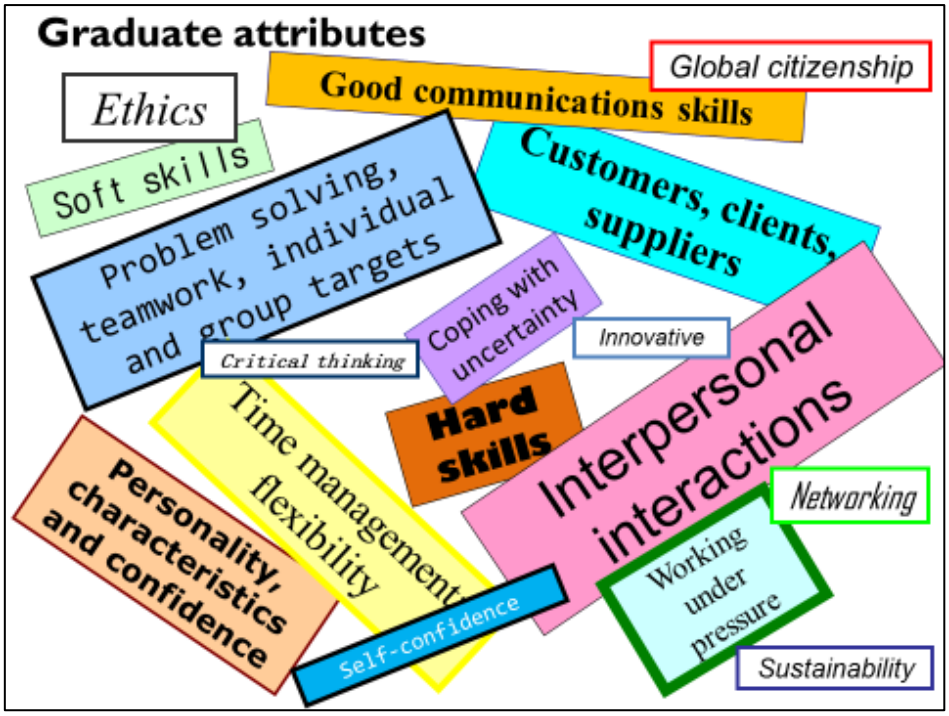

Figure 3 Examples of types of graduate attributes (O'Leary, 2016b)

In addition to what is highlighted for employers, there is also much attention given across higher education for what are termed 'graduate attributes', as illustrated in figure 3, although Kelchen and Meadows (2016) highlight tensions that exist between such general attributes and job-specific skills.

Therefore, given the breadth of definitions and descriptions of employability, it is worth exploring in more depth the actual experiences of graduates as well as their attitudes towards employability-support during undergraduate degree programmes.

Provision of employability-related support across the disciplines

The findings of O'Leary (2016a) on trends and variations in the provision of employability-related support by subject discipline are analysed in further depth as illustrated in table 2 and figure 4:

Employability Support provided	a. Business or management	b. External speakers	c. University careers service and similar	d. Other	e. None of these	Average of abcd	Rating if maximum is 40%	Ranking; versus average
Overall	**41%**	**30%**	**35%**	**6%**	**16%**	**28%**	**7 /10**	Overall
Disciplines								
Engineering	58%	58%	21%	5%	16%	36%	9 /10	1st; +2
Sciences	32%	29%	57%	7%	7%	31%	8 /10	2nd; +1
Social sciences	50%	0%	40%	0%	20%	23%	6 /10	3rd; -1
Humanities	32%	23%	18%	9%	27%	20%	5 /10	4th; -2
Trends								
Before 2000	47%	26%	22%	9%	21%	26%	6 /10	2nd; -1
After 2000	24%	43%	71%	0%	5%	35%	9 /10	1st; +2
Trend	*-23%*	*17%*	*49%*	*-9%*	*-16%*	*9%*	-	-

Table 2 Evaluations of employability-support provided during undergraduate degrees, based on analyses of prior work by O'Leary (2016a).

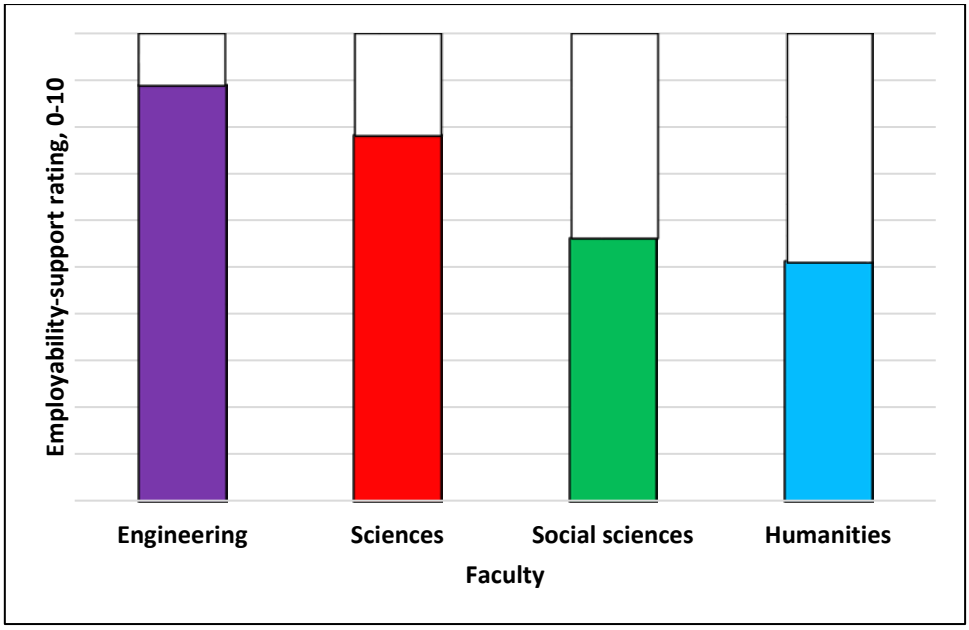

Figure 4 Evaluations of employability-support provided during undergraduate degrees, based on the data analyses in table 2.

As demonstrated by the trend figures (Before 2000 to After 2000), there have been significant efforts over recent decades into providing employability-related support to undergraduate students, with a significant growth in support from University Careers Services and similar (from 22% to 71%) and a rise in involving External Speakers (26% to 43%), while those graduates indicating that no such provision existed fell from 21% to just 5%. However, these increases are counterbalanced to some extent by a halving in the provision of business or management support (from 47% to 24%).

These overall figures do however mask some notable differences by disciplinary area and, at a Faculty level, the results suggest that the following rankings on the provision of employability-related support during undergraduates degree programme can be attributed:

1st. Engineering: Significant use of external speakers and business or management expertise.
2nd. Sciences: Good provision, although perhaps an over-reliance on University Careers Services.
3rd. Social Sciences: Business or management expertise utilised along with Careers Services.
4th. Humanities: Breadth used but lowest provision; highest indicator of no such support provided.

STEM and Employability

Prior research by O'Leary (2012) into higher education teaching and the employability of scientists and engineers concluded that the "3C's" of Content, Capability and Character were key to enhancing students' employability: Content concerning principally the curriculum itself, an area that a higher education institution can address directly; Capability meaning the modes of delivery of that curriculum and the opportunities it provides to develop soft-skills such as communications and team working abilities, this being an area where employers can add value; and Character touching upon a student's personal development throughout the overall experience of higher education, an issue that touches upon both curricular and extra-curricular activities.

Marriott (2006) has shown, using employment statistics, that scientists, engineers and technologists play an important role in high-technology industries but are also in high demand in many other sectors because of their quantitative and technical skills. Scientists and engineers generally do relatively well in gaining graduate employment and in the salary level achieved compared to the average (HECSU

and AGCAS, 2015) although subject variations exist and a limitation of these figures is that they concern only a particular moment six months after graduation. Toland's (2011) study on STEM in higher education describes a set of generic employability skills that STEM graduates should demonstrate more of at the recruitment stage; these include self-management, team working, business and customer awareness, problem solving, communication and literacy, application of numeracy and application of information technology. Such graduates should try to demonstrate that they have the ability to apply both theoretical and practical knowledge to real industrial processes.

An analysis by The Royal Academy of Engineering (Lamb, Arlett, Dales, Ditchfield, Parkin and Wakeham, 2010) on developing engineering graduates for industry, concludes that industry needs graduates with both technical and complementary skills and highlights that teaching staff experience is important to students, that understanding the relevance of an issue motivates students' development and that energy and resources needs to be invested to fully embed university and industry links. However, Toland (2011) has highlighted that the number of higher education staff with prior experience of industry has declined, especially in research-led institutions, and recommends three ways to tackle this; recognition and reward of staff that pursue employer engagement activities, raising staff experience levels through collaborative research and industry secondments, and the setting up of employer forums to help improve the curriculum and to bring industrialists and business people into the teaching space.

Chemical science graduates have raised concerns (Purcell, Atfield, Ball and Elias, 2008) that their courses did not provide enough opportunity to develop some of the necessary skills for finding employment, highlighting team-work, leadership and communication skills (written and spoken) in particular as well as problem-solving skills, management skills and creativity. Employers, in the same study, outlined that the skills that they felt chemical science graduates demonstrated were analytical skills, numeracy, research skills, logic, attention to detail and accuracy but there were often weak areas such as spoken and written communication, teamwork, social skills, leadership and an ability to deal with people. The European chemical industry (CEFIC, 2010) identified the most important business and personal skills needed by scientists and engineers. These include skills in business, innovation management (translating research into new business), project management (turning innovative ideas into profitable and cost-effective business) and strategic vision (to create new innovations and to outline long-term areas of focus). Personal skills needed include communication (to ensure effective collaboration with colleagues, business people and customers), creative thinking (to generate new ideas that could ultimately change existing businesses or develop into new areas) and team working abilities (to work with others from different disciplines, and in potentially complex projects, to develop innovative solutions). Therefore, a suggestion is that a greater focus on financial and business skills will be required in science and engineering curricular so that graduates will be better able to turn ideas into real business. In the same vein, a further graduate skills study with a focus on chemistry (Hanson and Overton, 2010) also recommends that chemistry degree programmes should provide additional opportunities for the development of oral presentation skills especially.

Concerning communications, research in the biological sciences field (Sundberg, DeAngelis, Havens, Holsinger, Kennedy, Kramer, Muir, Olwell, Schierenbeck, Stritch and Zorn-Arnold, 2011) highlights that, while students often perceive communications to be one of their strengths, this is the area that employers believe to be their primary area for improvement. The study showed this to be particularly the case for written communication skills, something students considered their top strength while, for employers in both the public and private sector, this was the top or second-top area in most need of improvement. In studying employability skill needs in engineering, Markes (2006) outlines that employers want graduates who can help them manage change and that this demands not just a set of individual skills but a combination of such skills together with technical knowledge and work experience. This could be considered possible through even closer working

relationships between industry and higher education.

Many professional bodies (Toland, 2011) also offer a wide range of support on student employability matters for scientists and engineers but it is not clear to what extent higher education institutions make use of this material or expertise. Another source of material and expertise can also often be found in a university careers services group, and it may be worthwhile for science and engineering departments to consider how best to incorporate such information into their curricular. Some higher education institution are already doing so and even offering official certificates of attainment (University of Kent, 2016) or similar.

Conclusions

Science and engineering graduates tend to do relatively well in terms of gaining employment but there is still room for improvement and the benefits of enhancing employability can be felt by many other stakeholders, including the higher education institutions themselves, employers and government. This research suggests that well-designed employability-related support initiatives can enhance a student's employability by delivering the opportunity to appreciate, learn and develop many of the skills, behavioural and personal qualities that employers are seeking. Options for STEM can be considered in two categories:

1. Identify and utilise the resources available, including any guidance provided in the institutional mission statement and in related strategies, as well as making use of guest speakers, other faculty members, careers services, professional bodies and relevant disciplinary pedagogy.
2. Achieving a balance of elective and embedded support by signposting the opportunities, supporting academic staff and seeing to develop suitable client projects, placements and study abroad options.

In summary, employability can be enhanced through a combination of the content of the curriculum and the development of key student capabilities and characteristics. Suggestions on how to tackle such issues include the development of academic staff, the use of external speakers, the provision of business and management expertise, cross-disciplinary approaches and the integration of professional services into the curriculum. To improve employability provision from a cross-Faculty point of view, the most effective gains may be made in using what at first might seem unlikely liaisons; Humanities are Sciences are most alike on this issue, as are Engineering and Social Sciences (O'Leary, 2016a).

This paper has explored these issues with the intention of highlighting both the very high desire by graduates of all disciplines to see suitable employability-related support incorporated into undergraduate degree programmes and to highlight that the most suitable partnerships to achieve this appear to cut across the traditional Faculty groupings in higher education, such as STEM and Humanities & Social Sciences. It appears that, when it comes to the provision of effective employability-related support, another set of common groupings exist; Sciences and Humanities think along the same lines; while Social Sciences & Engineering think along another line. Therefore, improvements to the provision of such support may be better achieved by such non-traditional cross-Faculty partnerships. An approach based on the "3E's" is suggested and illustrated in figure 6: Enhanced Learning & Teaching; Employer-engagement; and Embed into the Curriculum.

Further Research

More research into the reasons behind, and consequences of, the disparities across the disciplines in approaches to the provision of employability-related support would be welcome. Several other avenues of potential research also emerge from this initial appraisal: refining these concepts with employers across different industry and business sectors, assessing the current teaching delivery across different higher education institutions, integrating employability-related matters into modular delivery in curricula, developing assessment methods to include weighting for employability, reviewing geographical variations on a national and international basis and, ultimately, extending across the disciplinary fields.

Figure 6 An approach for providing employability-related support (O'Leary, 2016b)

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