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Is Off-campus Engineering Study Off the Agenda? Professional Accreditation and Distance Education

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English Abstract

In engineering, distance/off-campus study is an essential element of access to education for those in remote locations and/or seeking to upgrade their qualifications via the lifelong learning route whilst employed. Internationally, engineering education accrediting bodies have moved toward outcomes-based assessment of graduate competency, but are still struggling to relinquish their historical attachment to the measurement of inputs. A genuinely outcomes-based accreditation system based on the demonstrated individual student attainment of appropriate graduate attributes (which might be delivered/gained by a range of means) offers the best way forward for an equitable, representative and socially just undergraduate engineering education system that encourages suitably qualified candidates from a range of social, employment, educational, gender, age and geographic circumstances to aspire to the professional sphere of the engineering workforce. Until outcomes-based education becomes the norm in engineering, it is likely that distance learners in engineering will face significant difficulties.

Keywords

Distance Education, Lifelong Learning, Mature Age Students, Professional Accreditation, Graduate Attributes, Outcomes-based Education.

List of Topics

Introduction

As with many professions, the institutions (professional and educational) that control the education of engineers are inherently conservative. For public safety and international mobility, there is an essential need to maintain standards, and ensure equivalence of educational outcomes. However, institutional conservatism can lead to inflexibility in the face of social and societal change. The face and background of the 'typical' engineering student has changed dramatically. In many countries, interest from traditional secondary school students in engineering as a study and career option has waned, while demand from mature age lifelong learners seeking to upgrade their trade, technical or other qualifications and enter the professional sphere of the engineering workforce has increased. The increased diversity of engineering students challenges accepted models of professional formation premised on a uniform and particular type of preparation of candidates for engineering studies.

In engineering, distance/off-campus study is an essential element of access to education for those in remote locations and/or seeking to upgrade their qualifications whilst employed. Internationally, engineering education accrediting bodies have moved toward outcomes-based assessment of graduate competency, but are still struggling to relinquish their historical attachment to the measurement of inputs. This presents a particular challenge in the context of distance education. In Australia, the program accrediting body, Engineers Australia, espouses an outcomes-based approach to accreditation, but inconsistently, prescriptively enforces minimum mandatory residential attendance periods for students studying in the off-campus mode. This paper investigates the issues surrounding the professional accreditation of off-campus engineering education, with particular reference to Australia. While the focus of this paper is the Australian context, the underlying issue is an international one

Accreditation of Engineering Distance Education in Australia

Since 1976, Engineers Australia (the current trading name of the Institution of Engineers, Australia (IEAust)) has permitted programs utilising 'external studies'. A sequence of policies relating to external studies programs has specified the on-campus attendance requirements. The most recent policy, formalised in 2005, is the Engineers Australia Policy on Accreditation of Programs offered in Distance Mode. Item 1.5j of the policy (including Engineers Australia's bold type) is:

> "A program offered by distance education should include a number of on-campus components so that the School can ensure that graduates have attained the specified attributes and capabilities. Residential schools enhance student-staff and student-student interactions as well as enriching the learning experiences of both students and staff. Also, although most or all practical experience may have been gained off-campus, it is important that staff be convinced of students' practical capabilities at first hand." (Engineers Australia, 2005b, p. 4)

Interestingly, item 1.5, which identifies the points that Engineers Australia will "particularly look for in evaluating distance-education programs", also says that…

> "These are not prescriptive; but where they are not in evidence, the evaluating panel will wish to be convinced the techniques actually in use are equally effective..." (Engineers Australia, 2005b, p. 3)

So, while on-campus components/residentials will be 'particularly looked for', in theory, alternative approaches that demonstrably achieve the same student outcomes should be acceptable. In practice, for accreditation of programs that include off-campus study, Engineers Australia mandate that students must attend on-campus for at least two weeks for each equivalent year of full-time study – most students studying in off-campus mode are mature age students who work full-time and study part-time. The inclusion of this requirement strongly suggests that Engineers Australia is, as yet, unprepared to accept that distance education is the 'equal' of on-campus study, nor, to truly embrace accreditation based on specifying graduate outcomes, rather than through detailed control the delivery of the curriculum. Of course, it is incumbent upon any institution to be able to demonstrate that their program, regardless of mode of study, is effective in developing the required student outcomes. This sets a challenging research agenda for those with a stake in off-campus engineering education.

The 'Problem' of Engineering Distance Education

The 'problem' for accreditation of higher education caused by distance education, and the inability of accreditation systems based on traditional on-campus study models to appropriately address off-campus study without stifling innovation have been reported for many years, both in higher education generally (Eaton, 2003; Haug, 2003), and specifically in engineering undergraduate education (Bourne, Harris, & Mayadas, 2005). Engineering accrediting bodies internationally have struggled to make progress on the issue of accrediting off-campus study (Augusti, 2007; Bradley, 2006; Carnevale, 2002), in part, due to the fact that they are still having difficulty accrediting aspects of on-campus programs (Augusti, 2007; Koehn & Parthasarathy, 2005; Neal-Sturgess, 2007). The Accreditation Board for Engineering and Technology (ABET) in the USA acknowledge the growing demand for off-campus study:

> "The face of the American student is changing. Baccalaureate students fresh from high school and living on campus are decreasingly the norm…Many students are combining work and study in various part time/full time configurations. The need for convenience and accessibility has given rise to an increased demand for distance education as more students from varying situations seek a college education." (Industry Advisory Council of the Accreditation Board for Engineering and Technology Inc, 2000, p. 8)

Though not specifically referring to distance education when referring to 'diversity', the foreword to the Engineering Council UK's guidelines for program accreditation:

> "…emphasises competence as the basis for professional registration, it stresses the importance of outcomes rather than inputs as the basis for accreditation. The output-based approach which it introduces recognises the diversity of higher education in engineering…" (Engineering Council UK, 2007, p. 2)

In many countries, engineering education accrediting bodies are principally concerned with undergraduate programs leading to the qualification of professional engineer, or its international equivalent. The accreditation of the para-professional programs is still relatively limited, and postgraduate programs are not normally formally accredited. While engineers have been heavy users of distance education for many years (especially on-line education) (Ubell, 2000), and there are many fully off-campus para-professional and postgraduate engineering programs (Dowling, 2006), there are virtually no undergraduate professional engineering programs available in the fully off-campus mode, though they were predicted to be available by 2004 in the USA, "the technology is already there…It's a matter of legitimizing it." (Carnevale, 2002, p. A33) One interpretation of this is that the formal program accreditation function has acted as a barrier to the development of off-campus undergraduate studies in professional engineering. Given that current trends in education suggest that it is only a matter of time before distance education becomes the dominant mode of education (Saba, 2005), the engineering profession will eventually have to address the issue of accreditation of programs based on off-campus study.

On-campus versus Off-campus

The current Engineers Australia policy on programs offered in distance mode provides no substantive justification for mandatory on-campus attendance, other than, "…so that the school can ensure that graduates have attained the specified attributes and capabilities." (Engineers Australia, 2005b) The Engineers Australia accreditation requirements seem to assume an idealised world where all on-campus students attend "22 to 30" contact hours per week (Engineers Australia, 2002), and that all students complete a full-time study workload of "40-50" hours per week (Bradley, 2004). There is evidence that such an assumption is no longer necessarily well founded. In a review of a number of studies of the total study time (formal classes plus private study) per week of Finnish engineering students, the range of total study times reported varied from 19 to 37.5 hours per week, with most being 25 hours per week or less (Kolari, Savander-Ranne, & Viskari, 2006). This was found to be significantly less than the assumed value of 40 hours per week.

Research shows that full-time Australian higher education students work on average 15 hours per week (with 38 percent working more than this), more than one third of full-time students were prepared to miss lectures, and many 'full-time' students have a limited on-campus experience; with 40 percent indicating that work gets in the way of their academic studies, 57 percent indicating they spend little time on-campus other than for classes, and 70 percent indicating that their social life is mainly outside of the university (McInnis & Hartley, 2002). In a survey of more than 30,000 Australian undergraduate students in 2000 (Long & Hayden, 2001), 65.8 percent of all engineering students were in paid employment during the semester, working an average of 16.2 hours per week. From all students, the mean hours per week of work had risen three-fold (to 14.5 hours per week) since 1984. Some 33.0 percent of all working engineering students frequently missed classes. Many students worked during the semester simply so that they can afford to continue their studies (Long & Hayden, 2001).

If there is concern that off-campus students have a limited on-campus experience, then this should also extend to on-campus students! The 'on-campus experience' isn't what it used to be, especially when compared to the time that most of the current institutional (education and professional) administrators might have completed their undergraduate studies. McInnis and Hartley (2002) identified that patterns of student engagement with study have changed, and that full-time students have to make trade-offs between employment and study for a complex range of reasons. It is not simply a 'student problem', i.e. institutions can't proceed under outdated assumptions about student engagement with higher education, they need to strategically address these changes, not ignore them (McInnis & Hartley, 2002; White, 2005).

The modern study-plus-work arrangement of the typical on-campus student is moving closer to the work-plus-study pattern of the typical off-campus student. While some negative impacts on academic achievement due to term-time employment are noted, there are potential benefits as well (enhanced skills and employability), but whether these benefits are realised depends, at least in part, on institutional responses to student employment. Institutions (education and professional) can discourage, or perhaps worse, ignore student work, or provide opportunities for students to integrate their work experiences into their studies, and capitalise on the contribution that work can make to professional formation. In the case of engineering students, a large study showed a clear contribution to desired learning outcomes from out-of-class activities, especially employment (Strauss & Terenzini, 2005). In fact, there is evidence that we should be sending on-campus engineering undergraduate students 'off-campus' into the engineering workforce to properly develop professional practice skills (Jorgensen & Howard, 2005), rather than compelling mature age, experienced members of the engineering workforce to attend on-campus for arbitrary periods. Although espousing an outcomes focus in its accreditation literature, Engineers Australia seems more interested in specifying "hours dutifully accumulated", rather than certifying "demonstrable attainment of specified knowledge and skills" (Barr & Tagg, 1995). Time spent in class has traditionally been a key element in defining student participation and mastery of learning content - distance education poses the challenge to define this 'time' in new ways (Eaton, 2003).

The Engineers Australia accreditation process implies that on-campus study is the preferred and therefore, the benchmark mode of study, with other modes needing to demonstrate 'equivalence' to on-campus study, through the imposition of additional process requirements beyond those applied to on-campus programs. In fact, there exists an extensive literature that indicates, regardless of discipline, there is no significant difference in student outcomes between on-campus and distance modes of study (Russell, 1999). It is often claimed that engineering is a 'special case' because of the significant laboratory work component, but there are many options for off-campus delivery (Callaghan, Harkin, McGinnity, & Maguire, 2007; Guo, Kettler, & Al-Dahhan, 2007), again, demonstrating no significant difference in learning outcomes (Abdel-Salam, Kauffman, & Crossman, 2006; Watson et al., 2004). There are some skills, such a group/team work, problem-based learning, and leadership, that have traditionally required proximal interaction between students, but there also exist a range of distance education strategies for these (Aravinthan & Fahey, 2004; Brault et al., 2007; Brodie, 2007). In fact, not only does the literature suggest 'no significant difference' in outcomes between on- and off-campus education, it is suggested that many traditional forms of on-campus education are not effective learning environments, with a majority of on-campus student learning occurring outside of formal class time (Davies, Cover, Lawrence-Fowler, & Guzdial, 2001; Phillips, 2005).

Additionally, it is observed that the boundaries between on- and off-campus study are now significantly blurred, with many on-campus students making use of any available off-campus learning resources to enhance their learning and/or reduce their reliance on attendance at formal classes (Badat, 2005; Calvert, 2005; McInnis & Hartley, 2002), and developments piloted in distance education flowing on to transformations in on-campus teaching as well (Subic & Maconachie, 2004). Whereas, historically, students have been viewed as being categorised as essentially either on-campus or distance students, it is now understood that these idealised categories are really two extreme ends of a continuum of educational delivery, and that most real students are positioned somewhere along this continuum, and may change their location on the continuum as their personal circumstances change. The term 'blended learning' has been used to describe modes of delivery and study that combine a range of teaching and learning activities that might have been traditionally only associated with one end of the continuum (Muirhead, 2005).

Outcomes versus Processes

The focus on measuring the learning outcomes of distance education has also thrown the spotlight back on the effectiveness of measurement of learning outcomes for traditional education (Eaton, 2002). 'No significant difference' (Russell, 1999) doesn't absolve off-campus studies of the need to demonstrate its effectiveness, but begs the question, how can learning outcomes, regardless of mode of study, be effectively measured? The current answer appears to be graduate attributes. Arising from the push in higher education for quality assurance, accountability for outcomes and capability of graduates (Leathwood & Phillips, 2000), specifying a list of qualities or capabilities that graduates will attain provides a benchmark against which the performance of a higher education institution can be measured. In engineering, the idea of specifying required student outcomes in terms of graduate attributes has been embraced internationally for some years (Jolly, 2001; Lister & Nouwens, 2004), including Australia (Engineers Australia, 2005a), the USA (Engineering Accreditation Commission, 2007), and the UK (Engineering Council UK, 2007).

Engineering as a profession is becoming increasingly diverse, with disciplines, roles and career paths expanding over time (Lloyd, Ferguson, Palmer, & Rice, 2001). Engineers Australia is the professional body for all Australian engineers regardless of discipline, hence, the single list of graduate attributes provided in the accreditation system is necessarily loosely defined to fit all disciplines (Ferguson, 2006). It is intended that individual engineering schools then flesh out the details of their program through reference to the National Generic Competency Standards (Institution of Engineers Australia, 1999), Academic Advisory Boards, industry consultations, their own institutional missions and other sources. In practice, the membership of advisory groups is finite, and their views are subjectively influenced by their own engineering education and range of industrial experiences (Ferguson, 2006). Supplementing these sources of program advice, the accreditation process involves assessment of the program by an 'independent evaluation panel comprising senior academic and industry practitioners' (Engineers Australia, 2005c) who provide recommendations for the improvement of the program. However, this group is also small in number and likewise constrained by their own professional formation and experiences. The specification of only generic graduate attribute outcomes which then rely on the advice of a comparatively small group of experienced discipline experts for fuller expression in the context of the discipline has the potential to lead to a myopic and conventional view of the body of knowledge, skills and attitudes that graduates of a particular engineering discipline should posses, and, of the modes of education that can validly develop them. This issue comes into sharpest focus where accreditation is sought for programs addressing non-traditional disciplines and/or non-traditional modes of delivery.

A genuinely outcomes-based accreditation system based on the demonstrated individual student attainment of appropriate graduate attributes (which might be delivered/gained by a range of means, including distance education) offers the best way forward for an equitable, representative and socially just undergraduate engineering education system that encourages suitably qualified candidates from a range of social, employment, educational, gender, age and geographic circumstances to aspire to and attain membership of the professional sphere of the engineering workforce. The spirit of this approach that aims for demonstrated equivalence of outcomes (rather than process) via a range of means can be found in the ABET engineering accrediting criteria:

> "These criteria support the premise that student outcomes, regardless of the method of educational delivery, should be consistent with the stated objectives of the program… While distance education programs and traditional classroom programs may employ different instructional methods, it is essential that graduates of both programs can demonstrate the same capabilities." (Industry Advisory Council of the Accreditation Board for Engineering and Technology Inc, 2000, p. 9)

Until outcomes-based education becomes the norm in engineering, it is likely that many capable 'second chance' aspirants will find the lifelong learning path to membership of the profession remains beyond their attainment.

Conclusions

The comparative literature relating to on- and off-campus education reveals no significant difference in measurable learning outcomes. The Engineers Australia accreditation manual describes a policy based on demonstrated outcomes, but includes a requirement that all undergraduates must attend on-campus for two weeks for each full-time year of their program. An outcomes-based approach to assessment is based on the premise that the outcomes are tangible, justifiable, measurable and open to delivery by a range of means. If an outcome is not measurable, it is not an outcome, it is a prescription. The prescription that off-campus student must attend on-campus for minimum periods to get an 'on-campus experience', and that this experience cannot be developed by other means, suggests a lack of appreciation that many 'full-time on-campus' students spend little time on-campus between (or in some cases during) classes. The evidence found in the Engineers Australia accreditation documentation suggests that they cling to the outdated concept of 'attendance' as a proxy measure for achievement of learning outcomes. Of course, it is incumbent upon any institution to be able to demonstrate that their program, regardless of mode of study, is effective in developing the required student outcomes. This sets a challenging research agenda for those with a stake in off-campus engineering education.

Distance education is not an inferior, second best option for those students, including rural and remote students and mature age students, who cannot study full-time on-campus. In engineering, off-campus study is an essential element of access to education for those in remote locations and/or seeking to upgrade their qualifications whilst employed. Moving forward with distance delivery of engineering education will continue to be an international challenge while program accrediting bodies do not permit wholly off-campus engineering programs, or make minimum mandatory residential attendance for off-campus students compulsory for program accreditation.

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