COMMONWEALTH of LEARNING

POLICY BRIEF

Engineering Education: Online and Distance Programmes

The Commonwealth of Learning (COL) is an intergovernmental organisation created by Commonwealth Heads of Government to promote the development and sharing of open learning and distance education knowledge, resources and technologies.

The information and data in this policy brief is based on the report on the *Status of Research and Engineering Programmes Offered Online* written by Professor Romeela Mohee, Education Specialist, Higher Education at the Commonwealth of Learning and the submission reports of Professor Peters, Emeritus Professor, Open University of UK and Dr Susan Bainbridge, doctoral graduate from Athabasca University.

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Recommendations

1. Governments should consider how flexible modes of study might expand the overall numbers and composition of the engineering professions through high-quality distance and online learning.
2. Governments should ensure the development of frameworks for the authorisation, regulation and quality assurance of distance and online engineering programmes.
3. Policy must be in place to ensure recognition and accreditation by relevant professional bodies for distance and online engineering programmes.
4. Specific engineering strands in online and distance learning should be developed in line with academic and professional competence in particular universities or colleges.
5. Quality assurance systems for engineering programmes should cover all modes of delivery: campus based, distance, online and blended.
6. Regulation and quality assurance for online and distance engineering programmes must ensure the appropriate availability of field activities, laboratories and industrial placements.

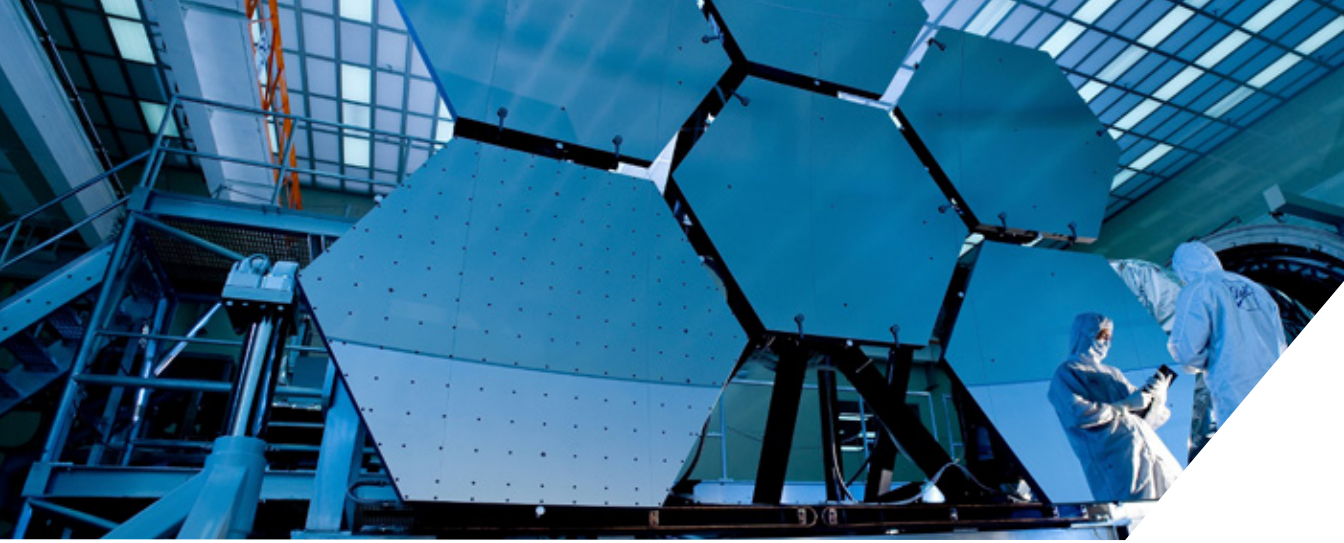
Introduction

Engineering in its many branches is a crucial occupational field for national development. Education in initial programmes and for continuing professional development (CPD), in partnership with professional bodies, provides the requisite knowledge and skills for the engineering professions. The provision of online and distance education for engineering degrees and CPD programmes is now established in many countries. This policy brief sets out the background to this expanding mode of provision and its place in complement to campus-based programmes.

Engineering education online and at a distance plays a valuable role in the overall educational offered in colleges and universities for a number of reasons. These include the opportunity to increase both the absolute number and the composition of the engineering professions, principally through:

- participation by adult learners who are unable to access full-time campus education due to family responsibilities, rurality, cost or work commitments;
- supporting a wider range of adult entrants, offering part-time studies and providing a career ladder for those with working experience in the field; and
- more gender-friendly modes of study for women entrants in what has been historically a male-dominated profession.

Also important is the potential for providing cost efficiencies. Kanwar (2015), in a comparison of online education costs for on-campus students, said: “The annual cost per student at the Korean National Open University is US$186, compared with nearly $3,000 for a campus student; Georgia Tech is offering its prestigious Masters in Computer Science course as a MOOC—massive open online course—because of which its existing cost of $40,000 is being reduced to $7,000.”



Approaches and Results

Engineering degrees have complexities not seen in traditional business and arts degrees, the most important ones being the recognition of professional degrees by professional bodies, and need for access to laboratories, workplaces and design facilities.

There is a shift towards programmes being delivered increasingly online, although there are still challenges to overcome. However, in an early study on the effectiveness of online education, Piccoli, Ahmad and Ives (2001) found no significant difference in the performance of students receiving online delivery rather than face-to-face (F2F) instruction. Similarly, LaMeres and Plumb (2014) compared the performance of online and F2F students in a classroom and lab-based electronics course and found no significant difference in their achievements.

Engineering degrees have been offered by open universities and their equivalent almost since the Open University UK (UKOU) recruited its first students in 1971. The three largest open universities in Europe — UKOU and its Spanish and German equivalents, Universidad Nacional de Educación a Distancia (UNED) and FernUniversität — have engineering programmes accredited by their appropriate national bodies. In the USA, where there are no sizable single-mode distance universities, online and distance degrees in dual-mode universities often follow a remote classroom model (i.e., on-campus and off-campus students can see the same lectures online). The delivery of engineering degrees through an online mode in campus-based universities is common, especially at the master's level, where higher-level study requires more theoretical and advanced academic work and the practical elements are assumed to have been gained earlier in the student's studies. The University of Illinois' master's degrees and Stanford University's master's in Electrical Engineering are examples of such degrees where most modules are available online.

Regulatory Frameworks

The engineering degrees offered by the open universities are recognised locally and accredited by national accreditation agencies, whose basis of evaluation is the learning outcomes, not the mode of study. Master's degrees are particularly appropriate for innovation with MOOCs and open educational resources. The online engineering degrees delivered by UKOU are accredited by the Quality Assurance Agency for Higher Education (QAA) using benchmark statements for engineering and professional engineering bodies such as the Institution of Mechanical Engineers, the Institute of Engineering and Technology, the Institution of Engineering designers and others. These degrees are also accredited by the Middle States Commission for Higher Education in the USA. The learning outcomes of the BEng and MEng programmes are closely aligned with the UK Standard for Professional Engineering Competencies (UK-SPEC) and generic output standards for degrees in engineering. The civil, chemical, computer and electrical engineering programmes at the Open University of Sri Lanka (OUSL) are approved and recognised by the Institute of Engineers, Sri Lanka, while the technical and engineering degrees at the University of South Africa (Unisa) are registered by the South African Qualifications Authority and accredited by the Engineering Council, South Africa (ECSA). The University of North Dakota's online mechanical engineering degree is fully accredited by the US Accreditation Board for Engineering and Technology.

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Curricula and Qualifications Range

Open universities have been selective in the engineering subjects they provide. This reflects local demand and the availability of alternative provisions by other institutions, but it also reflects the willingness of the relevant individual engineering accreditation bodies to support online/distance teaching of their subject. UKOU delivers a foundation degree, Bachelor in Engineering, as well as Master in Engineering and MSc in Engineering degrees online. At OUSL, around 1,000 students are registered annually in civil, computer, electrical, electronic and mechanical engineering programmes. There are departments of civil, chemical, electrical, industrial, mechanical and mining engineering at Unisa. European distance teaching universities such as UNED and FernUniversität offer degrees in mechanical, electrical, and computer engineering by distance. In China, the National Open University teaches a range of engineering subjects, and its regional affiliates provide variations depending on local needs.

In general, the level of qualification may reflect the ease with which distance learning can be orchestrated to meet the needs of the engineering curriculum. In some jurisdictions, this can result in higher-level qualifications with a more research and theoretical focus being offered (e.g., in the USA and UK), whereas in other places, more technician-orientated qualifications are provided for those already in employment (e.g., in South Africa).

> “In most cases, the requirements on entry to the courses are the same as in F2F programmes.”

Entry Requirements

In most cases, the requirements on entry to the courses are the same as in F2F programmes. There are a couple of exceptions, such as at UKOU, whose engineering degrees have no specific entrance requirements and need little previous formal education. However, the entry point to engineering programmes is the “Foundation” degree, which is only available to students already working in engineering. OUSL has similar entry requirements to the F2F programmes, where at least two GCE A levels are required in maths and physics or an equivalent qualification in the OUSL foundation programmes. The entry routes at Unisa demand a minimum standard in maths and science-related subjects or a National Certificate award. These three examples demonstrate that the online or distance engineering programmes are all specific in their entry requirements, similar to on-campus engineering courses, although there may be more flexibility appropriate to adult learners with relevant work experience.

Quality Assurance

The same quality assurance (QA) mechanisms and regulations apply whatever the mode of study, and in many cases students can select F2F or online versions of the same module. In single-mode open universities or their equivalent, the emphasis is on comparability and equivalence with what F2F institutions provide, and the involvement of external assessors and examiners is made explicit. Similar standards apply for the delivery of campus-based or online engineering degrees. At UKOU, regulations have been introduced to ensure that students are successful at one level before they can progress to the next. For example, the BEng students start with the compulsory module *Personal and Career Development in Engineering*, which includes evaluation of their skills and knowledge and an analysis of gaps they need to fill. Progression rules require that students must have completed the equivalent of two years’ full-time study before they study the honours-level module *Key Skills for Professional Engineers*. Similarly, students must complete feeder modules before they undertake the project module.

One of the most significant QA challenges of online engineering provision is providing and assessing practical aspects of the subject and any associated workplace learning.

Practical Aspects of Engineering

All engineering programmes require that a considerable time be spent in field activities or laboratories and industrial placements. The model being practised in open universities includes practical work being carried out centrally at the university or in other universities' laboratories. OUSL has compulsory laboratory/workshop practice sessions and field work to be carried out on a F2F basis. Unisa has arrangements with industry whereby the laboratory component is carried out under the supervision of professional engineers. In the USA, at the University of North Dakota, the programme follows the same curriculum as the university's on-campus engineering programmes, but for distance students, "campus labs" taking 5–14 days are held on campus.

In the European open universities and in North America, very short periods (up to a few days) are used for intensive practical training and competence assessment. Increasingly, online simulations and models along with professional software are replacing laboratory-based work in both open and campus-based universities. UKOU also has compulsory residential schools to deal with practical work. These sessions can be held at other UK universities but with staff recruited by UKOU. It also has an interesting online platform, the *OpenScience Laboratory*, where resources are shared across a number of degrees and are also available on a subscription basis to other universities. The Open Engineering Laboratory allows students to complete hands-on activities and work collaboratively on design projects with peers.

Workplace Learning

The purposes of workplace learning extend beyond exposure to industrial processes and equipment to include the development of professionalism in would-be engineers. As per the Institute of Engineers of Sri Lanka, exposure to professional engineering practice "complements the formal studies at the educational establishment" and provides the "opportunity to observe human and industrial relations, job organisation, maintenance, safety and environmental procedures from the point of view of the general workforce, which is an important component in the early preparation for a career as an engineering technologist."

OUSL arranges industrial placements for engineering students. At Unisa, the student must secure an appropriate work situation and a workplace mentor approved by the university. In this case, the mentor must be a professional engineer who is registered with ECSA.

Policy Recommendations

This policy briefing points to a number of matters to be addressed by universities and regulatory bodies while considering the online and distance delivery of engineering and research degrees.

Regulatory Framework and Accreditation

As online learning becomes more prevalent, policy considerations become important, especially pertaining to recognition, accreditation and jurisdiction. Usually, accreditation of higher education is conducted by a national body or a governmental agency; in most countries, the same agency would be looking at on-campus higher-education programmes and online ones. For example, in Canada, online programmes are recognised by virtue of being offered by a higher-education institution that has been licensed by the provincial government in whose jurisdiction the institution is located. The Career College Accreditation Program accredits online courses. The courses at Athabasca University have additional accreditation from the Middle States Commission on Higher Education. In terms of QA in the UK, Malaysia, South Africa and Australia, the guidelines and procedures are set by the local QA agency/authority — for example, the Malaysia Qualifications Authority, the QAA, the South African Qualifications Agency, and the Tertiary Education and Quality Standards Agency.

It is crucial that a proper regulatory framework be put in place to set regulations governing the provision of online engineering education and to provide for an independent QA body to oversee enforcement. A significant issue for policy makers is ensuring that online education providers observe the highest-quality academic requirements and do not become degree mills. To protect online learners, national authorities have to pay particular attention to the role of accreditation agencies.

"It is crucial that a proper regulatory framework be put in place to set regulations governing the provision of online and distance doctoral and research degrees and to provide for an independent QA body to oversee enforcement."

Approval of Engineering Provision Through Online and Distance Education

Universities should be allowed to proceed with certain strands of engineering online and at a distance, with other strands approved only once credibility has been fully established. For example, subjects such as software engineering, where much of the practical teaching in any university will use online platforms, could be readily approved. Other engineering subjects, such as civil and aeronautical engineering, could require a detailed case that explains how aspects that are not readily taught online are to be handled.

Adequate provision of practical and workplace elements should minimise the risks in allowing online programmes to offer teaching in engineering. Both approaches that have worked in other countries (i.e., online resources and workshops/practical laboratories in other institutions) could be adopted. Individual universities could adopt different strategies for laboratory practice, such as provision of their own facilities or collaboration with other providers. Formal agreements have to be established with corresponding institutions for the provision of facilities. However, there is merit in considering a national or at least collaborative approach to online resources.

Conclusions

It is clear from this overview that engineering degrees and CPD for professional engineers are widely available from a range of colleges and universities via online and distance programmes, both those that are primarily campus-based and those that are primarily or solely online or at a distance. The reputation and recognition of these qualifications depends more on the standing of the individual institution than on the mode of study, which in itself makes no difference to the quality of the outcomes. For institutions or governments that wish to include a wider range opportunities for engineering education, both in terms of absolute numbers and for adult and part-time learners in particular, online and distance modes offer a recognised and effective complement to campus-based study.

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