Educating professionals for practice in a complex world – a challenge for engineering and planning schools

Sarah Bell
Civil, Environmental and Geomatic Engineering
University College London
Gower St, London WC1E 6BT
United Kingdom
s.bell@ucl.ac.uk

Planning and engineering are close cousins in the family of built environment professions. Living separate lives preoccupied with our own nuclear families we can forget how much we have in common. Things have not been easy for the built environment family in recent decades. Rapid urbanisation, climate and environmental change, economic uncertainty, the changing role of the public and private sectors in service provision and development, and shifting social expectations are but a few of the challenges we face together in our professional practice, research and education. As well as dealing with the actual problems of the world, we are constantly addressing the need to keep own houses in order. How do universities, practitioners, professional institutions, students, graduates and employers interact within the disciplines to ensure a robust contribution solving to the complex, interdisciplinary problems we all face?

Engineering are planning are both professional and academic disciplines, with overlapping interests in the built environment. Some of the common issues facing engineering and planning education include the balance between graduate job readiness and professional formation, the relationship between theory and practice, the role of professional institutions in shaping curriculum, and delivering curricula that engage both staff and students, as well as meeting the requirements of different stakeholders in universities and professions.

In this Interface contribution I will consider these issues from the perspective of engineering education, to draw lessons that may be of value to planning schools. I will describe recent curriculum reform in civil and environmental engineering at University College London (UCL) based on the principles of Problem Based Learning (PBL). These changes to undergraduate curriculum were implemented from 2005 onwards and have been used internationally as a model for other engineering programmes (Graham 2012).

University courses in planning and engineering share the challenges of preparing graduates for professional practice in a complex and dynamic world, making them not only ‘work ready’ but also ‘future proofed’. Our graduates need to know enough about current professional issues of concern so as not to be naïve, yet they also need a strong foundation of knowledge, skills and habits of mind to call upon whatever the particular context they find themselves working in throughout their careers. For engineers this is most obvious in relation to public health and safety. Employers expect graduates to be familiar with current legislation and regulations, yet universities must prepare graduate to make safety their first professional priority as a matter of course, in any international jurisdiction and whatever changes future governments might make to the law. The profession of planning is even more dependent on ever changing legislation and regulations, requiring a strong understanding of underlying principles in order to be able to adapt to and influence the dynamics of change as well as the specifics of law and policy.

Engineering graduates need a strong foundation in the engineering sciences of their sub-discipline, just as planners need theory to underpin their analysis and practice. Despite constant development in science and technology there remains a core canon of formulae, methods and knowledge that engineers are expected to hold. These form the basis of higher skills and knowledge, and are also important in the early socialisation of professional engineers. Very few civil engineers will ever apply the detailed formulae that are taught in university fluid mechanics courses, yet all are required to work through this most mathematical and challenging of subjects. Through this encounter with complicated mathematical expressions of counter-intuitive physical phenomena students learn to think like an engineer, and they learn that it is not always straight forward. The capacity to observe physical phenomena, to develop abstract models of physical behaviour, and then to use this abstract knowledge to analyse and solve a particular class of practical problems is central to ‘the engineering method’. For students who go on to work in water supply, coastal engineering or building ventilation, the details of the formulae of fluids matter. For those who specialise in structural engineering or road construction, fluid mechanics is more important as a vehicle for learning how engineering knowledge works in solving complex physical problems. Planning theory may likewise seem of little direct relevance to the practice of graduate planners, but through learning theory students are socialised into the epistemological and methodological foundations of the profession, as eclectic as they may be.

A key challenge for engineering education is to enable students to learn difficult concepts in engineering science in a way that is more engaging than the 'eat your theory, it is good for you' message that underpins conventional curriculum delivery. In recent years there has been considerable interest in Problem Based Learning (PBL) approaches in engineering, either in individual classes or as the basis for radical curriculum reform. PBL is most established in medical and veterinary education and is based on the principle that students learn theory best by solving problems, in contrast to conventional linear models of learning where students are taught theory first, then expected to apply it later (Newman 2005, Mills and Treagust 2003). Well-designed problems, supported by appropriate learning materials and activities, engage students more effectively and allow them to develop important generic skills such as research, communication, time-management and team work, at the same time as covering the canon of the discipline.

The first two years of the undergraduate civil and environmental engineering programmes at UCL are based on an adaptation of PBL that can be characterised as scenario-based learning. Most of the students' time is spent in traditional lecture, lab and field work courses, interspersed with week-long 'scenarios' that are held every four weeks and fulfil many characteristics of PBL. The scenarios are held four times each year and present the students with real world problems, many involving data and expertise provided by external practitioners and collaborators. Scenario topics include: designing an offshore wind farm; designing a pedestrian footbridge; managing the development of a community centre; performing a feasibility study of transport links to an airport; designing a passive ventilation system for a university building; and analysing water supply options and designing a reservoir. The scenarios aim to:

- provide opportunities for students to integrate the learning outcomes from the lecture and laboratory based teaching sessions;
- enhance generic skills such as team work, problem solving and communication; and
- extend their knowledge using some of the principles of PBL.

Evaluation of the student experience of the scenario-based curriculum at UCL indicates that it has achieved its aims of motivating and inspiring students, providing them with opportunities to integrate and apply what they learn, and to improve their generic skills (Bell *et al* 2010). The implementation of the curriculum change provides a model for radical reform of engineering education, demonstrating the importance of commitment and leadership from the Head of Department and senior university administrators, as well as dedicated curriculum leadership and team work within the department to ensure smooth implementation of the details that are of vital importance in ensuring a good student experience and learning outcomes (Graham 2012).

In implementing such radical reform of the curriculum at UCL a key concern was the response of the professional accreditation panel from the Institution of Civil Engineers and other professional bodies. Requirements of professional accreditation are often seen as an obstacle to radical curriculum reform, constraining innovation in professional education. Early contact with the accrediting authorities during the process of change was vital for reassuring UCL staff and administrators that the new degree programmes would still be able to fulfil the requirements of the professional institutions (Graham 2012). Despite radically distinct curriculum design and delivery the programmes have secured accreditation and have been used as a model for other engineering schools. The UCL experience has been that professional institutions are largely supportive rather than obstructive of reform, recognising the need to realign engineering education for the complex problems graduates will face during their careers.

PBL or scenario-based learning as implemented at UCL is unlikely to provide a model for curriculum design or educational reform that can be easily transferred to planning schools. However, it demonstrates the value and the viability of root and branch redesign of curriculum for professional education. The professions of civil and environmental engineering have undergone radical transformation in recent decades, yet most university courses remain largely unchanged. University graduates who should be prepared for the future are instead often educated in courses that were designed to meet the skills requirements of the past. Updating content and delivery in individual modules or courses is necessary for continuous improvement from year-to-year, but longer cycles of review and renewal are needed to make sure that the education which universities provide is fit-for-purpose in delivering planners and engineers who are equipped to deal with the complexity and uncertainty that characterise professional practice.

The challenge for curriculum design in both engineering and planning is to identify the knowledge and skill that are the unchanging bedrock of professional practice and identity, the immediate demands of employers for work-ready graduates, and the mechanisms that engage students as they develop the knowledge and skills that are the foundation of their professional careers. PBL is an approach that has moved out of medicine into engineering and other professional education, with necessary modifications along the way. As our respective professions face up to the challenges of delivering healthy, prosperous and sustainable built environments for the twenty-first century we need to ensure that our curriculum is providing graduates that are ready for the task.

References

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