The challenge of soil science undergraduate education

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One of the not-so-delicious ironies of soil science undergraduate education in Australia, and probably most other parts of the world, is that the more 'big ticket' soil issues emerge and get airplay in the public domain, the fewer students seem to engage with degree courses containing significant components of soil science. Over the last five years, the demand from Australian employers for soil science graduates has outstripped supply from Australian universities. Globally, the interest in food, fuel and latterly climate change, has "…brought soils back onto the global research agenda" (Hartemink and McBratney 2008). Despite this, the discipline of soil science does still not appear strongly on the radar of school-leavers looking to make their mark in the world (Collins 2008). It would seem that as discipline-promoters, soil scientists make good soil scientists.

Putting aside the difficulties of undergraduate recruitment, however, there is a separate set of challenges that face soil science educators once a pedon of soil science students actually enrol. These challenges can be glibly encapsulated as 'what and how do we teach them?' Addressing first the 'what', over the last 20 or 30 years there are a number of developments in both university structures and the profession of soil science that have 'changed the landscape' of soil science education. As Collins (2008) points out, the majority of university soil science units are embedded in agriculture courses, but with declining enrolments in these courses, the number of soil science departments and indeed the faculties of agriculture that generally house them, have been gradually whittled away. Consequently, the number of individual units that any given faculty can offer in soil science, and the breadth and depth of teaching in soil science, has slowly been reduced also. Smiles *et al.* (2000) assert that "…in Australia, no school of soil science is big enough to offer a reasonable spectrum of skills required…'

Using my own experience as an example, when I undertook the introductory soil science unit (8 credit points) in the 2nd year of my agricultural science degree in the late 1980s, I endured 46 hours of lectures and approximately 60 hours of practical sessions, including two afternoon fieldtrips. The content included coverage of soil morphological properties, structure, soil strength, pore space relations, infiltration, the moisture characteristic, static columns, drainage models, irrigation models, clay mineralogy and structures, rocks and minerals, geology, soil thin sections, soil water extracts, EC, pH, OC, P, lime requirement, soils of New South Wales, district soils and climate, t-tests and ANOVAs. If we wind the clock forward twenty years to the present introductory soil science unit (6 credit points) at The University of Sydney, students are subjected to 36 hours of lectures and approximately 30 hours of practical session, including 1.5 days of fieldwork. Although there has been some (university-imposed) deflation in the number of contact hours per credit point (13 to 11), the bigger change has been in the amount of content covered. In today's introductory unit we cover soil morphological properties, soil formation factors, structure, soil strength, pore space relations, infiltration, the moisture characteristic, clay mineralogy and structures, rocks and minerals, soil water extracts, EC, pH, OC, P, N and lime requirement. Some of the material covered in the introductory unit 20 years ago has now either been shuffled up into the intermediate or senior soil science units or omitted altogether. A similar story can be told for the content of intermediate and senior soil science units of yesteryear.

It can be argued, however, that the loss of some content from these soil science units is not necessarily a bad thing, as the expectations of students and of employers have also changed over the last 20 years. Rightly or wrongly, many of today's undergraduates appear to believe that a university education is a transaction – money for knowledge. A perceived lack of 'useful content', or a perceived heavy workload, usually results in some punishing student evaluations of teaching; as student evaluations are routinely obtained for units of study, academics are acutely aware that evaluation results may be used outside the confines of the unit, such as by a panel deciding on a promotion case. Such tensions may not encourage innovative teaching practices or clear-headed reviews of content. Judging by the changing suite of employers of soil science graduates, the expectations of those employers must also have changed. A review of the employers of members of the Australian Society of Soil Science Inc. in 2008, 1998 and 1988 revealed some seismic shifts in where soil scientists work. In 1988, around 140ASSSI members worked for the research organisation CSIRO; by 2008, this number had dropped to around 40. A similar dramatic fall is evident for ASSSI members employed by government departments (250 in 1988, 125 in 2008), while the number of university employees (including postgraduate student members) belonging to ASSSI has been largely stable (around 150) over that time period. The only category of employer with a substantial increase in ASSSI members has been that of consultants (15 in 1988, 125 in 2008) – anecdotal evidence suggests that this employer group will continue to increase its share of the ASSSI membership in the future.

So how will this change in the workplace of soil scientists affect what we teach them? Well, for a start, in this age of out-sourcing routine laboratory analysis of soil to commercial laboratories, it is probably not so critical that soil science undergraduates be trained to use every shiny piece of gear in an analytical laboratory. Certainly, graduates need to be aware of what the acronyms AAS, GC and XRD mean, what the new and emerging bits of technology are, and how they might interpret the data to emerge from such machinery, but for many of them a university practical might be the first and last time they ever use such a machine. Instead, as indicated by others already (e.g. Smiles *et al.* 2002; Hartemink and McBratney 2008; Ferris *et al.* 2010), soil science graduates must be prepared to use their discipline knowledge and understanding to solve complex environmental and agricultural problems as part of multi-disciplinary teams. They must be able to apply their knowledge to a variety of scenarios, be able to confidently analyse and interpret soil data, know where to go to get relevant information and be able to communicate effectively to a wide range of clients or stakeholders. With the steady infiltration of soil science graduates into the world of policy and regulation, more than ever our graduates need to be able to clearly put across technically strong information to an often disbelieving and ignorant client.

The 'how' of undergraduate soil science teaching is slowly changing in reaction to the changing role of soil science graduates. As unpalatable as it might seem to traditional educators, most undergraduates feel no qualms about 'Googling up' answers to quizzes or exams set by academics. The days of students needing to rote learn Darcy, Langmuir and Stokes have passed ('why, when I can get it from the internet?'); the modern mantra is 'problem-based learning is best'. Of course, there's always got to be a solid nugget of domain knowledge that needs to be passed on before students can reasonably be expected to solve multi-faceted soil problems, but the in-built extras of problem-based learning include the development of student independence, the development of team-work, an appreciation of the social and economic contexts in which soil science operates, and an appreciation of the sorts of soil-related problems that confront Australia and the world. The challenge of soil science undergraduate education is to give our students the interpretation and communication skill-set to effectively utilise their nuggets of soil science knowledge in a moveable feast of opportunities.

References

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