Why do a science degree? The influences on students choosing to study science in Australia

Kerri-Lee Harris
Centre for the Study of Higher Education
The University of Melbourne

A paper presented at the Teaching & Learning Week Science Education Symposium
Research, Teaching & Learning in Higher Education
29 Oct 2007, The University of Queensland

The headline stories around science education, in this country and elsewhere, focus on the need to attract more students into studies of science. In particular, students’ lack of enthusiasm for studying the enabling sciences – physics, chemistry and mathematics – causes concern among scientists and governments alike. The factors at work here are many, and interrelated. If universities are to do anything to address this apparent ‘problem’ we need to examine not only students’ motivations, but also our own. The curricula of undergraduate science programs are important, but equally important are the explicit and implicit messages we send to students during the course of their study.

The intention is for this paper to be somewhat provocative. I am taking the position that we, as institutions and as individual academics, have two sometimes competing responsibilities. First, we have a responsibility to students. Students’ reasons for studying science are many and varied, just as their subsequent study and work paths will be – so we need to understand this and respond appropriately.

We are also responsible for our disciplines. We need to ensure that curricula remain current, not only in terms of new knowledge but also in reflecting significant changes in the relationship between disciplines and sub-disciplines. Given the highly dynamic nature of science, this is necessarily a continual process for those involved in designing science courses. Without deliberate planning, however, changes in disciplinary boundaries tend to be slow to flow through to undergraduate curricula.

Responding to students’ needs and keeping abreast of discipline developments are clearly not in conflict. The conflict arises when disciplinary allegiances lead to unfettered competition for students. Funding formulae of universities often create conditions under which departments are in direct competition for limited resources. With student numbers a factor in such formulae, departments seek to maximise enrolments into their particular later year undergraduate courses, and beyond. This, I would argue, can skew course structures and even influence course advice in ways that are not always in the best interests of students.

Career paths and destinations for science graduates

The traditional view of a Bachelor of Science (BSc) is as preparation for a career in science, technology or a science-related field. Twenty or thirty years ago an honours degree followed by a PhD and several years as a post-doctoral researcher reliably led to a research position in an institute or a university academic appointment. For most senior university academics in the sciences this was their experience of university study, and this continues to be the chosen pathway for a minority of university science students. Increasingly, however, BSc graduates follow more diverse paths to a broader range of career destinations.
Studies have shown that many science graduates from Australian universities go on to work in areas unrelated to science (e.g. Dobson & Calderon, 1999; McInnis et al. 2000). For some this is a necessity – competition for ‘entry-level’ science-related positions among graduates is high. Even highly qualified science graduates are forced to follow other pathways due to the limited availability of continuing positions in research institutions and academia. Many other science graduates actively choose to follow non-traditional pathways, including into other professions and management positions (McInnis et al. 2000).

The increasing numbers of students entering tertiary education, including undergraduate science, over recent decades raises questions about the purpose of tertiary science education. Why do students choose a science degree? And how well do their education prepare them for their diverse post-degree study and work places?

The following section presents a recent snapshot of the diverse aspirations of university students. Understanding students’ motivations for choosing science is important to curriculum design, recruitment and marketing, and student advising and support. These findings highlight the liberal view of university education held by many BSc students, in contrast to students in some other fields such as Education and Health who tend to be far more vocationally oriented and instrumental in their decision making.

Data from the 2004 First Year Experience in Australian Universities study

The national study of the first year experience (FYE) carried out by CSHE in 2004 (Krause, et al. 2005) included students across the disciplines, including many students studying in the sciences. First year students from thirteen universities were surveyed mid year and asked, among other things, about the factors important to them in deciding to go to university. They were also asked about their attitudes toward their current studies.

The FYE survey discriminated fields of study into eleven categories as listed below. The first five listed are science or science-related, while the remainder include a range of fields including humanities and business studies:

- Natural and Physical Sciences (includes Mathematics, Biology, Chemistry)
- Engineering and Related Technologies
- Information Technology
- Agriculture, Environmental and Related Studies
- Health (includes Medicine, Nursing, Veterinary Studies)
- Society and Culture (includes Law, Economics, Literature, Behavioural Science)
- Management and Commerce (includes Accounting, Business)
- Education
- Creative Arts
- Architecture and Building
- Food, Hospitality & Personal Services

While most Bachelor of Science (BSc) students are likely to be in the Natural and Physical Sciences (NPS) category, it is not possible to confidently distinguish degree types from the FYE data. For example, the NPS category is likely to include BSc students and those enrolled in named degrees such as Biomedical Science or Mathematical Science. And BSc students will be included in a range of categories, including IT, Environmental Studies and even Society and Culture.

However, for the purposes of this analysis, the categories at least indicate which fields of study students identify with – which is, arguably, more important than the name of their particular degree program.
Why students choose science

Intrinsic interest in the field of study is a powerful determinant in choice of course. Students in all disciplines rated interest in their chosen field as an important factor in their decision to go to university (Fig. 1), and nearly four in five science students were accepted into their first or second preferred course (Fig. 2).

NPS students are among the least likely to choose their degree as “training for a specific job” (Fig. 3), on par with Creative Arts students at 60 per cent and in stark contrast to students choosing study in Education (88%) and Health (89%). While not necessarily driven by the desire for a specific job, students in most disciplines come to university to improve their “job prospects” (Fig. 4). However, many NPS students are unclear about the “type of occupation they want” (Fig. 5) and one in three say they don’t know.
There are significant discipline-based differences between students in terms of how readily they can identify why they decided to come to university (Fig. 6). NPS students are the least likely of all to know exactly why they are here.

Like arts students, science students report that they enjoy the “intellectual challenge” of their studies (Fig. 7), and many enrolled hoping to develop their “talents and creative abilities” (Fig. 8).

Nearly one in three NPS students said they would have preferred a general first year at university, delaying choice of a specific course or program (Fig. 9a). This was second only to Engineering and Management & Commerce, each at 40 per cent. The strongest opposition to a generalist first year was voiced by students in Health and Agriculture/Environment (Fig. 9b).
This data from the FYE study demonstrates that a large proportion of undergraduate science students have no clear idea of where they will take their degree. They are simply interested in learning more about science, and in enhancing their skills and employability. This seems perfectly justifiable, given that we, as university staff, promote the transferable skills and general value of an education in science.

The view of science we create

Universities’ depictions of science, and the value of tertiary science study, are remarkably consistent in the messages they send to prospective students and their parents. They appeal to young people’s desire to make a difference to the world around them. Science training is presented as empowerment for tackling the big issues facing society, such as climate change and sustainable resource management. A science degree is described as a pathway to working in the exciting ‘new sciences’, such as biotechnology and informatics. Yet science is also sold as a versatile education, with science graduates having highly developed and valuable transferable skills in independent and critical thinking, problem-solving and communication.

Once enrolled, however, students experience a much narrower representation of science. The importance of scientific knowledge and discovery are certainly showcased, with deliberate emphasis on the topical relevance of the latest research findings. Missing from the picture, however, is any real evidence of the broader value of a science degree. Generic skills and graduate attributes are listed in program outlines, but real examples of the application of these are much harder to find.

Universities, and particularly the Group of Eight, are very good at promoting research. Success of institutions, faculties and departments is largely measured and celebrated in terms of research strengths. Individuals are lauded for winning research grants and publishing in high impact journals. Even the size of a research group serves as a proxy for success, particularly in the sciences.

The high value placed on research extends to the teaching of science. Research students are purposefully involved in undergraduate teaching in an effort to inspire and motivate undergraduate students. Practical classes are opportunities for students to have hands-on experience of scientific research, with many activities presented as research problems and tackled using the particular methodologies and technologies of the discipline. And teaching staff are encouraged to make links from the course content to their own or colleagues’ research wherever possible.
Where does this leave the students – and we know there are many – who don’t imagine a career in research? Where are the equivalent exemplars of the broader benefits of a science degree? Occasional seminars by celebrated science communicators or science-trained entrepreneurs are not uncommon, but their value is questionable. From the students’ perspective, such pathways are clearly not the ‘real game of science’ as far as universities are concerned. These are seen as alternatives offered for those who ‘don’t quite make it’ into a research career.

The situation described is perhaps inescapable. Yet we need to be aware of the messages this sends to students – explicitly, by equating success in science to success in research; and implicitly, relegating alternative careers to the ‘second division’ by way of their invisibility within the institutional landscape.

Supporting the learning that matters

Does the curriculum itself align with the learning outcomes that we say matter? This question, of course, at the heart of curriculum review. In this case – is the current science curriculum designed to develop students’ skills in independent thinking, problem-solving, and quantitative analysis? Does the curriculum really develop students’ ‘interdisciplinary knowledge’? And how do we ensure sufficient breadth in science, given that most degrees allow a high degree of student choice?

The place of generic skills in university curricula has received widespread attention in recent years. This is no less true of science than it is of other disciplines. There is general agreement that students are provided with opportunities to develop such skills, although where classes are large, ‘creative’ solutions are needed. There remain recognised challenges, however, in assessing generic skills and in ensuring students recognise and value their skills in these areas – and there is clearly a relationship between the two.

An integrated curriculum is likely to be a prerequisite for effective interdisciplinary learning. Integrated curriculum design is not new, yet effective integration remains a challenge for most universities. Institutional structures are often compartmentalised along more historical disciplinary boundaries. Course offerings reflect this. Effectively integrating the various sections and topics of an ‘integrated course’ is no simple matter, particularly when staff from across a range of disciplines are involved. Integration becomes even more challenging at the level of the degree program.

A third challenge for curriculum design centres on the overall course composition of a student’s program of study. In a typical Bachelor of Science, students are offered choice from a wide array of ‘majors’, and there may be little or no common core. Courses in particular fields, such as genetics or mathematics, form a suite by way of prerequisites and the requirements for a recognised major. Students can – and usually do – begin to specialise from first year.

The lack of interest in physics and mathematics, compared to biology, is considered a problem. Yet science degree structures do little to ensure that students are exposed to the broader sciences before narrowing to a particular sub-discipline. Add to this competition for students into particular majors, and the problem is not likely to resolve any time soon. We will continue to graduate many PhDs in the life sciences who have absolutely no familiarity with physics or advanced mathematics.

Issues facing university science faculties

As institutions, we need to think carefully about our conceptions of a science education. If we agree with the principles promoted in our marketing strategies, we must then ensure that curriculum structures, teaching and the science culture of universities do indeed develop and support the range of students we enrol.
Some specific issues for consideration are listed below:

- Curriculum design – does the development of students’ transferable skills take place across the year levels, or is it left to the third and fourth years?
- Curriculum design – is sufficient attention given to interdisciplinary teaching and learning? Mathematics and biology provide an example of two historically distinct fields with a growing area of synergy. While it is common to include ‘biostatistics’ in biology courses, does this provide students with any real exposure to the field of mathematics itself, or the growing possibilities from interdisciplinary approaches?
- Course structures – are there benefits to a mandatory science core in terms of providing students with exposure to the broad field of science? If so, what should it look like?
- Course structures – are majors and prerequisites designed in the best interests of students, or are they primarily determined by the organisation structures and the needs of departments?
- The value of research training – do we demonstrate the broader value of training in research, beyond the value to those who go on to ‘do’ research?
- The PhD in science – is a science PhD solely intended as preparation for a career in scientific research? If not, do we sufficiently endorse and support other aspirations?

Students choose to study science for a variety of reasons, and will take their qualifications into a variety of work places. The challenge for universities is to ensure we do all we can to support this.

References


Kerri-Lee Harris is a senior lecturer with the Centre for the Study of Higher Education at The University of Melbourne. She is principal author of two national reports for the Australian Council of Deans of Science, looking at the tertiary preparation of secondary school science and mathematics teachers [Who’s Teaching Science? (2005) and The Preparation of Mathematics Teachers in Australia (2006)]. In 2006-7, Kerri-Lee directed a national project on assessment of undergraduate students’ learning in the Biological Sciences [www.bioassess.edu.au]. She holds a science PhD and has extensive experience teaching undergraduate students in BSc and related degrees.