

Physics Graduates in the Workforce: Does Physics Education Help?

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Abstract

In the first half of 2008 a survey was distributed to a sample of Australian physics graduates. The main purpose was to provide a realistic and up-to date view of where a Physics degree can lead, based on the experiences and perspectives of physics graduates in the workforce. The survey was the product of the Working Party on *Physics Graduates in the Workforce*, part of a project funded by the Australian Learning and Teaching Council (ALTC). Responses were received from 171 graduates of physics or physics-related courses (i.e. degree programs), both undergraduate and postgraduate. A small number of employers also responded to a version of the survey. A clear majority of graduates recommended a major in Physics as good preparation for their career, but they also highlighted aspects where physics education could be improved. Employers were less convinced of the unique qualities of physics courses. Both graduates and employers agreed that, while undergraduate physics clearly develops problem solving skills, communication and planning skills and awareness of ethical and social issues are given low priority at both undergraduate and postgraduate levels.

Keywords: physics education, physics employment, graduate attributes, skills, careers.

Introduction

The results reported here form part of the physics project, *Forging New Directions in Physics Education at Australian Universities*, funded by the ALTC Discipline Based Initiatives program. One component of this project is *Physics Graduates in the Workforce*. This graduate project aims to identify graduate destinations and employer expectations and explore the diverse employment opportunities available to Australian physics graduates to determine the suitability of current course content, structures and learning activities. In this paper we report on the physics graduates and employers sampled by the survey and primarily on one aspect of their responses – the graduate attributes developed in their physics education. Further data from the survey can be found on the ALTC Physics Project web site (<http://www.physics.usyd.edu.au/super/ALTC/>).

The survey

Graduates

The graduate project has been centred around the Graduate Destinations Survey (http://www.physics.usyd.edu.au/~obyrne/carrick/carrick_intro.html) that has attracted feedback from 171 graduates representing 22 Australian universities with physics-related courses (i.e. degrees), both undergraduate and postgraduate. Fifteen graduates responded to a further set of questions probing their earlier responses.

The size of the survey, with its emphasis on physics nationally and at all university levels, makes it unusual in Australia. In comparison, an earlier AUTC project survey (2004-5) included a set of interviews with just six Australian graduates of 3-year physics programs only [Sharma et al. 2008, Mendez et al. 2008]. Rodrigues et al. [2007] interviewed 17 graduates, targetting the “lost voices” of *science*-trained graduates (not just physics) working in other areas. These surveys should be compared to the analysis of over 1300 responses from *science* graduates in the report by McInnes, Hartley and Anderson [2000], in which physics graduates are not separately identified, and large surveys conducted overseas.

The graduates were contacted by working with staff in physics departments at each university. The intent was to use university or departmental alumni databases to contact a large number of graduates, but this only happened effectively at the University of Sydney. In that case, 51 responses were received from approximately 500 alumni contacted by email. In most other cases, contact was made with a small number of recent graduates where valid email addresses were known.

The sample of the data that follows concentrates on 108 respondents who graduated after 1990 and therefore represent relatively recent experience of university education and the job market. 42% of these graduated since 2000 and 47% have a postgraduate degree in Physics. The male-female ratio is 2:1. The majority of respondents come from just 7 universities, but these span a wide range, both in size and location (Adelaide, Central Queensland, Murdoch, RMIT, Sydney, UNSW, UTS).

The sample clearly has some bias towards ‘academic’ physicists, but it does nonetheless present a broad cross-section of the physics graduates. These features are demonstrated by the distribution of the graduates’ first jobs after graduation (Figure 1), although the distribution for their main/current job (not shown) is very similar. Considering only the respondents without postgraduate qualifications largely removes those in academic research positions and affects other categories to different extents.

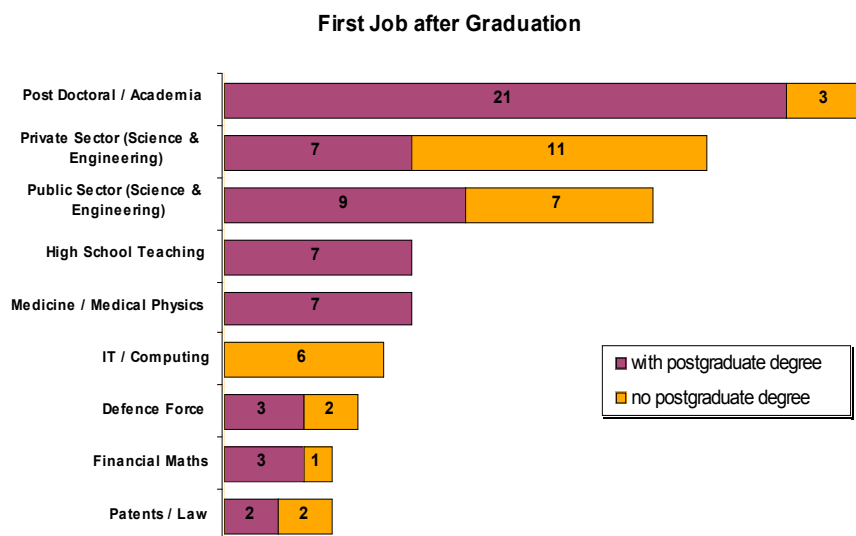


Figure 1: Broad areas of employment categorised on the basis of respondents description of their role and employer. Respondents with and without a postgraduate qualification are added to produce the full bar length.

Employers

Graduates who responded to the survey were asked to nominate their employers to be approached to complete a different version of the survey. This was only a partial success as only 10 employers completed the survey. However, they do represent a range of private sector industries including health physics, the mineral industry and various manufacturers of technical equipment, plus secondary education.

Helpful features of the physics course

Graduates were asked to identify the most helpful components of their undergraduate physics course. The laboratory/practical component stood out, being nominated almost twice as many times as the next ranked item, practical problem solving. This is interesting, given the perceived relative success of these activities as reflected in the next section (see Figure 2). The ranking of some other features of the course was more equivocal, with almost as many negative comments as positive ones about lectures, for example. Perhaps this simply reflects the varied experience anyone will encounter within a degree spanning several years.

Not surprisingly, postgraduate physics is a very different experience. The key positive features were ‘ownership’ of the PhD project in an environment that provides good supervision and collaborative support. Conversely, when these aspects are bad, they are the main reason for a negative experience.

Physics as useful education for the workplace

Graduates

Over 80% of graduates responding to the survey agreed that a physics education had been an advantage, with the remainder split between being unsure and feeling they gained no advantage. Given this, it is not surprising that almost as many respondents recommend a major in physics as useful preparation for a career in their field. Of those who didn’t, only 1 in 4 suggested that some physics background was *not* useful for their current job.

Overwhelmingly, graduates refer to the range of skills they acquire, rather than any specific knowledge, as the primary benefits of physics training. The survey offered a list of graduate attributes (also sometimes called generic attributes or generic skills) and asked respondents to what extent they believed these attributes had been developed, and to what extent they needed more attention, in their undergraduate and postgraduate degrees. Figure 2 shows the distribution of these answers for undergraduate degrees only.

Clearly, problem solving is the most developed skill and other responses make it clear that it is regarded as the most important one. Development of laboratory and computational skills are further back in second and third

place. In contrast, it seems ethical and social issues are hardly touched upon in undergraduate physics and oral communication is very poorly developed. Project planning also ranks quite low. For almost all these skills, the graduates' evaluation of their *undergraduate* physics education did not depend on whether they went on to complete a postgraduate degree. The exception is research methodology where, in at least some universities, there may be a real difference in the undergraduate research experience offered to those students who were identified early as potential postgraduates.

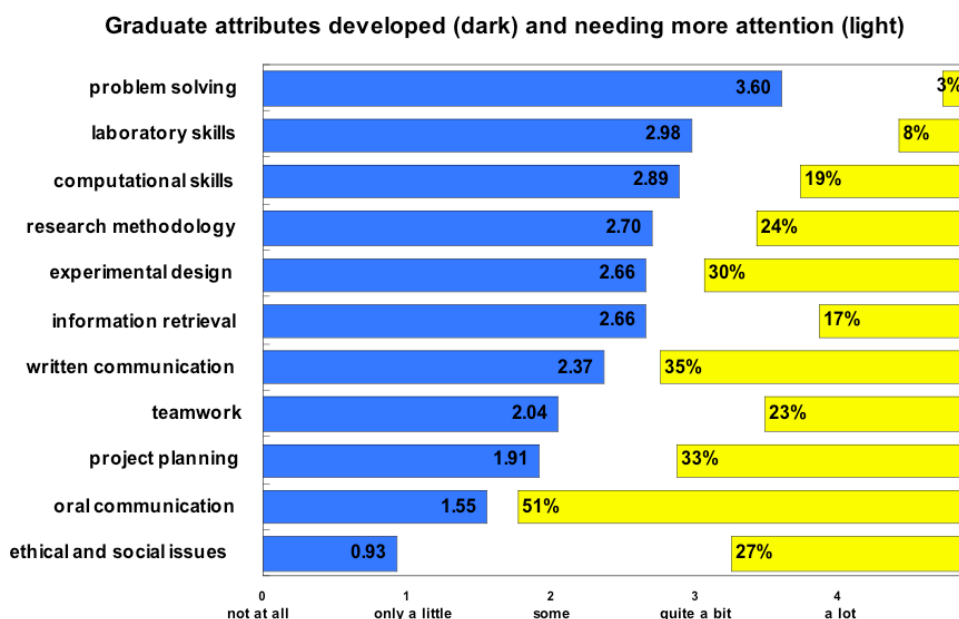


Figure 2: Graduate attributes as ranked by graduates themselves. On the left is the ranking of attributes developed in their undergraduate physics degree, in terms of the scale along the bottom. A difference of more than 0.30 between categories is statistically significant. On the right are the percentages of graduates who believe that a particular attribute needs more attention.

Not surprisingly, when asked whether graduate attributes needed to be further developed, the ranking tends towards the inverse of the earlier list. Oral communication clearly stands out as the main area of concern, with written communication also in need of more attention. Practical skills in project planning and experimental design are also a concern.

Ethical and social issues most obviously spoil the symmetry between skills developed and those needing more work. Whilst all graduates report that it is given scant consideration, only one quarter of them believe it requires more emphasis in undergraduate physics. This attitude is captured in one fascinating response that didn't "... *think ethics needs to be considered as much in physics as other fields such as biology and psychology ...*"! In contrast, a teacher at a religious school "... *felt unprepared with regard to the ethical and social implications of science*".

When asked if any of the graduate attributes are better developed in another undergraduate course there is a very mixed response, with almost half saying that the majority of attributes weren't better developed in their other courses and Physics does a good all-round job. Others strongly disagree. There is clearly a difference in opinion based on experience at university and in the workplace. This partly reflects the diversity of workplaces in which a physics graduate may be found.

A small number of responses indicated that developing these attributes should not take precedence over developing a knowledge of physics. In contrast, questions following up on the original survey responses revealed an opinion among some graduates that Engineering develops some attributes better because Engineering educators have often spent time in industry and better understand the skills required.

A smaller number of graduate responses ranked the attributes gained in postgraduate physics training with somewhat different results. Written communication skills are now on top of the rankings, presumably because of the strong emphasis on writing papers and the thesis. Problem solving remains a highly developed attribute during this period but laboratory work is now at the bottom, perhaps reflecting a small number of experimentalists among the survey respondents. Ethical and social issues are again at the bottom of the

rankings. All other graduates attributes have increased in their development from the undergraduate years and there were fewer suggestions of attributes needing further development.

The majority of graduates with postgraduate qualifications agree that postgraduate training is an advantage. However, this may simply reflect the jobs in which they find work. Opinion on whether it helped in moving into other areas was more mixed.

Employers

The relatively small number of responses from physics employers regarding attributes developed in undergraduate physics degrees results in little statistical significance in the results. However, it is interesting to note that skills such as research methodology are near the bottom of the list of attributes developed. This is consistent with results from the small AUTC survey [Mendez et al. 2008], but less consistent with the graduates perspective in the current survey. Oral and written communication skills again rank low and some employers are especially critical of the abilities of physics graduates in this area.

Almost all the employers believe that graduates need various attributes better developed at university than they are at present. However, they acknowledge that attributes should also be further developed in the workplace.

Employer attitudes to attributes developed in postgraduate studies are difficult to judge from a small sample. They mirror their opinions of undergraduate training, even in areas such as research methodology where postgraduate study would be expected to make a difference.

In general, the physics employers, almost all representing technical industries, didn't see much difference between graduates in physics and other disciplines in their ability to learn and adapt. Few said they would seek to employ a physicist in preference to a graduate from other disciplines. Factors such as experience, knowledge and understanding of the commercial and business aspects of the job, plus how they perform in an interview were more important. However, several did suggest that physics graduates remain distinguishable in the workplace from other graduates, displaying a broader perspective and an ability to "think outside the box".

Discussion

The uniformity of graduate responses reflects considerable uniformity in the university experience of physics for most graduates across the country. In contrast, the diversity of employer responses in the current survey seems to reflect the diversity of physics employment.

As in this survey, other reports such as McInnes et al. [2000] show that science students see considerable gaps between attributes they gained from their undergraduate science degree and what they see as important to their current employment. The perceived lack of skills related to communication is a common theme, apparent in this survey. Rodrigues et al. [2007] found that focus groups of *science* graduates emphasised the need for communication skills, but also problem solving. The latter seem better developed in physics graduates. However, despite the emphasis on technical skills physics graduates experienced in their courses, it is worrying that employers do not believe these translate into skills in research methodology or project planning. This suggests that students require more experience in working independently and planning their own activities.

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