Skills

Skills required by new

PHYSICS

graduates and their development in degree programmes

development

The Higher Education Academy

UK Physical Sciences Centre

Skills required by new physics graduates and their development in degree programmes

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in collaboration with the

Institute of Physics

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Contents

1. Aim of Study

This report is the outcome of a survey of recent graduates of physics programmes across the UK. The aim of the survey was to identify which areas of the physics curriculum including generic skills are particularly useful for new graduates and to evaluate how well they are developed within undergraduate physics degrees.

2. Scope of Survey

The survey focused on the 2007 graduate cohort, ie about two and half years after graduation. Such graduates have had sufficient time to gain some understanding of the skills requirements of their employment (or further study), whilst retaining a reasonably up-to-date knowledge of their physics degree programmes. Another factor influencing the choice of this cohort was that the longer the time after graduation, the more difficult it becomes to contact graduates. The sample covered BSc and MPhys/MSci physics graduates and included those who had taken 'Physics with' degrees, but not joint 'Physics and' degrees other than 'Physics and Mathematics'. Both UK and international students were included. Seven universities in England, Scotland and Wales were surveyed, including both pre-1992 (Russell Group and non-Russell Group) and post-1992 institutions. The survey was undertaken between November 2009 and June 2010.

Parallel surveys of chemistry and forensic science graduates were carried out, the other disciplines supported by the HEA UK Physical Sciences Centre. The results of these surveys are reported separately (HEA UK Physical Sciences Centre, 2010a, 2010b), although reference to some of the results is made in this report.

This report is concerned with the combined results for all the universities surveyed, rather than university-specific results and inter-university comparisons, although these will be made available to the individual universities concerned.

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3. Background

Although several reports have discussed the graduate skills required by employers, eg QAA (2003) and CIHE (2008), relatively little has been reported on the knowledge and skills which graduates have found of value when they enter into employment or further study. The UUK/CBI report entitled *Future fit: Preparing graduates for the world of work* (2009) recommended that universities should obtain regular feedback from former students/alumni on how well the universities are fostering employability skills in their students.

The lack of evidence of the skills needed by graduates is a major gap in this important pedagogic area. For example, their views should be very pertinent to development of subject benchmark statements. Graduates are also in a unique position to comment on whether these skills are being developed within degree programmes. Their views, including results and comments that are university-specific, can feed directly into curriculum development.

In order to gather some of this evidence, a pilot survey of chemistry graduates was carried out in 2008 by the HEA UK Physical Sciences Centre on behalf of the Royal Society of Chemistry Education Division. This unpublished study of 2006 graduates from three universities allowed the development of an effective survey methodology. Results indicated that some generic skills were considered very useful by graduates, but were relatively poorly developed within degree programmes. The methodology developed in the pilot study was used with modifications for this survey of physics graduates.

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4. Methodology

4.1 Survey

The survey questionnaire aimed to determine which areas of knowledge and skills developed in the degree programmes had been of most use since graduation and how well they had been developed within the degree programmes.

The areas chosen, given in Table 1, were based on the QAA *Subject benchmark statement Physics, astronomy and astrophysics* (2008), the Institute of Physics *The physics degree 2009* (since revised, 2010), and the CIHE *Student employability profiles* (2006).

Table 1 : Areas of knowledge and skills included in the survey questionnaire

A	Mechanics and relativity	Physics knowledge/ skills
B	Quantum physics	
C	Condensed matter physics	
D	Oscillations and waves	
E	Electromagnetism	
F	Optics	
G	Thermodynamics and statistical physics	
H	Planning and executing an experiment or investigation	
I	Comparing results critically	
J	Appreciation of ethical scientific behaviour	Generic skills
K	Analytical skills	
L	Mathematical skills	
M	Computing skills	
N	Report writing skills	
O	Oral presentation skills	
P	Information retrieval skills	
Q	Problem-solving skills	
R	Team-working skills	
S	Time management and organisational skills	
T	Managing own learning	

In this report, the first nine listed, A to I, are referred to as the 'physics knowledge/skills' and the final eleven, J to T, as the 'generic skills' (also known as 'transferable skills'). This is based largely upon the Institute of Physics *The physics degree* statement, although it is appreciated that some of the intermediate skills don't fit clearly into these designations. Generic skills, such as analytical skills and problem-solving, are of course also developed when acquiring the physics knowledge/skills.

An additional question asked the graduates to choose which five areas of knowledge/skills out of the 20 listed above, they wished, in retrospect, they had been given the opportunity to develop more fully within their undergraduate degrees.

Other questions gathered evidence on the graduates' careers since graduation and their general views (in open form answers) on how their degree programmes might be modified and developed.

4.2 Contacting the graduates and response rates

Graduates are contacted each year by all UK universities about six months after graduation in order to collect the Destinations of Leavers in Higher Education (DLHE) data for the Higher Education Statistics Agency (HESA). Normally these data are collected and held by the university Careers Services. Hence all universities have databases of graduates containing contact information, with some or all of postal addresses, telephone numbers and e-mail addresses. Some universities update this information, often via their Alumni Offices. Collection of the DLHE data is by postal survey, followed by telephone surveying, the latter being the main source of data. E-mailing is used to a small extent.

In 2006, HESA sponsored a longitudinal survey of the 2003 graduate cohort (HESA, 2007). The survey covered 20% of graduates from all subject areas at all UK universities who had responded to the initial DLHE survey. The survey involved e-mailing twice (inviting graduates to use an online survey form), followed by two postal surveys, followed by up to seven attempts to contact by telephone. Overall a 40% response rate was achieved.

Our approach was similar to this HESA survey. An initial postal survey (with a covering letter signed by a member of staff of the university Physics Department) was followed by two e-mails and then several attempts at telephone contact. However, constraints of data protection legislation resulted in only three out of the seven collaborating universities being able to provide telephone contact information, which severely reduced the overall response rate. Graduates could, if they wished, fill in the survey online in response to postal, e-mail or telephone contact. As an incentive, the names of all graduates completing the survey were included in a prize draw for each university.

For the three universities where telephone surveying was possible, the response rate was 57%, whereas for the four universities where only postal and e-mail contact was possible, the response rate was 14%. Completed survey forms were obtained from a total of 139 graduates, an overall response rate of 35%.

The graduates were clearly informed that although their names were requested in the survey, this was only to track who had completed the survey, and any information shared by the HE Academy UK Physical Sciences Centre, including with their university, would be completely anonymous. Graduate contact information was collected from the universities concerned on the basis that the universities would not be identified in any external reports and that the results collected for their graduates would be made available to them, but without graduates' names.

5. Results

5.1 Activities since graduating

Figure 1 gives the main activities of the physics graduates at the time of the survey, with chemistry and forensic science data included for comparison. The main differences are in the percentages undertaking study as their main activity, illustrating the high uptake of PhD study in physics and chemistry. Of those physics graduates engaged in study, either as the main activity or otherwise, 31 were undertaking PhDs (22% of the total number of graduates), 8 Masters degrees, 4 actuarial courses, 4 financial courses, 4 PGCE/GTP, 1 a medical degree and 1 a pilot training course. Of the 90 graduates in employment (65%), 11 were in financial posts, 7 in actuarial posts, 9 were secondary science teachers, 6 in IT posts and 3 were meteorologists.

Figure 2 gives the results for the question: ***To what extent have your activities since graduating involved a knowledge of physics?*** The figure also includes the results from the respective question in the chemistry and forensic science surveys and, separately, for the 90 physics graduates who indicated employment as their current main activity.

Comparing the three subjects, it is seen that the physics graduates had a lower subject involvement in their activities than chemistry, but higher than for forensic science, which is noted as being a discipline with relatively few directly related job opportunities. If only the graduates in employment are considered, then the subject involvement drops from 44% selecting ‘Large extent/Very large extent’ to 29%, nevertheless, 69% have had some involvement of physics in their activities since graduation.

... the physics graduates had a lower subject involvement in their activities than chemistry, but higher than for forensic science

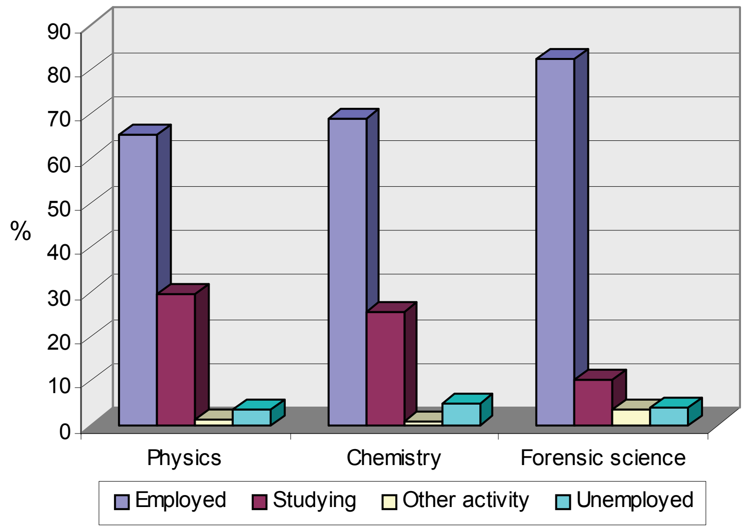

Figure 1: Current activity

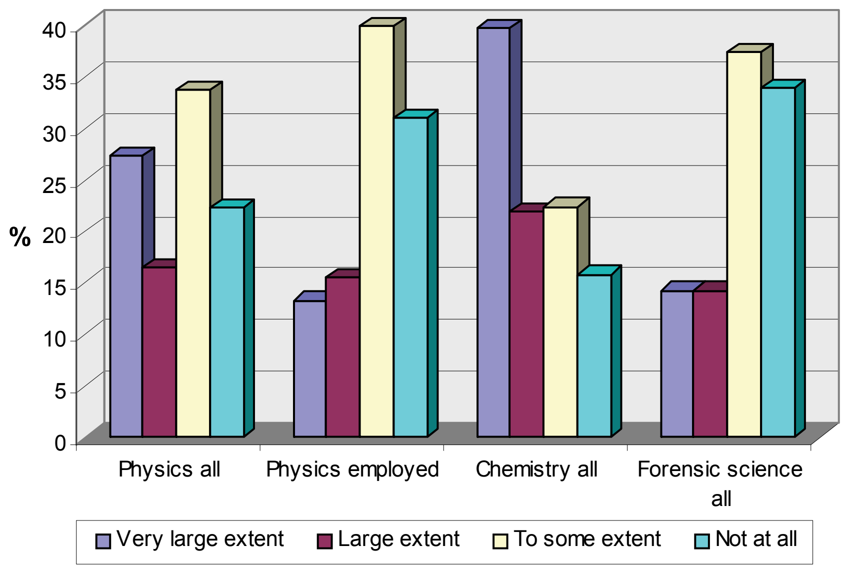

Figure 2: Involvement of subject in activities since graduation

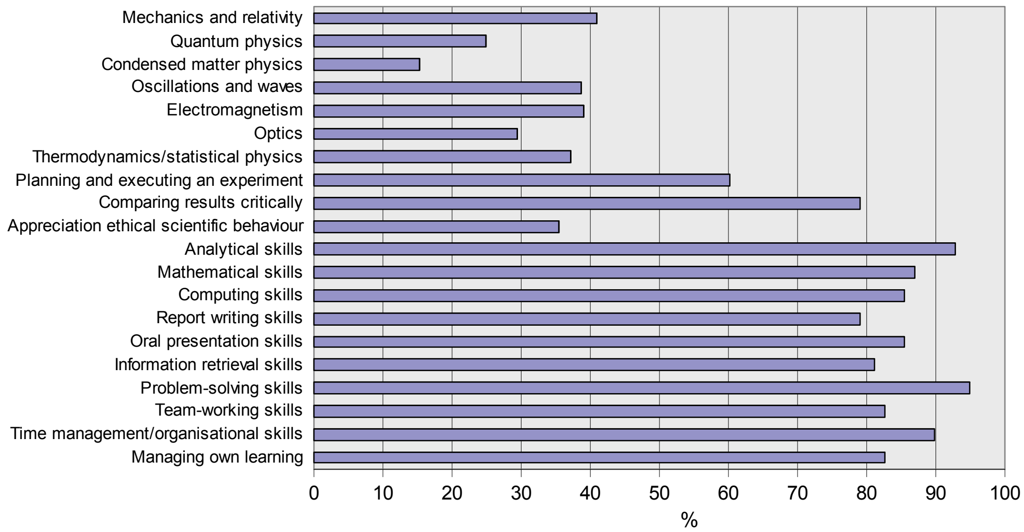

Figure 3: Percentage of all graduates selecting 'Useful/Very useful'

5.2 Knowledge/skills used since graduating

Figure 3 gives the results for the question: ***With respect to your career since completing your undergraduate degree, whether working, training or undertaking other activities, please indicate the value of the areas of knowledge or skills listed.*** Respondents could select one of: 'No use', 'Little use', 'Useful' or 'Very useful'. The percentage of graduates selecting 'Useful' and 'Very useful' is given.

It can be seen that the generic skills generally tend to be scored at a higher level of usefulness than the physics knowledge/skills. This is not surprising in that generic skills are needed by all graduates, whereas physics knowledge/skills are not. There is little difference between the generic skills with all, except 'Appreciation of ethical scientific behaviour', having over 75% of graduates selecting 'Useful/Very useful'. Of the physics knowledge/skills, the experimental skills ('Planning and executing an experiment or investigation' and 'Comparing results critically') were considered to be of most use.

To give an idea of the spread of the results, the data from three universities are shown in Figure 4. Universities A and B are Russell Group and University C is non-Russell Group pre-1992. The main point to note is that the same general trends are seen for these three universities (and this is indeed the case for all seven universities), with the generic skills scoring higher than the physics knowledge/skills. The differences in the physics knowledge/skills probably relate to the types of activities undertaken by the graduates, with a far higher proportion of graduates from University C in physics related employment than Universities A and B.

On breaking down the data according to activities undertaken since graduation, some interesting, if not unexpected, trends are seen. Figure 5 gives the results for the 90 graduates who had indicated that employment was currently their main activity. The data are split according to whether their activities since graduation involved a knowledge of physics 'To some extent/Not at all' or to a 'Large/Very large extent'.

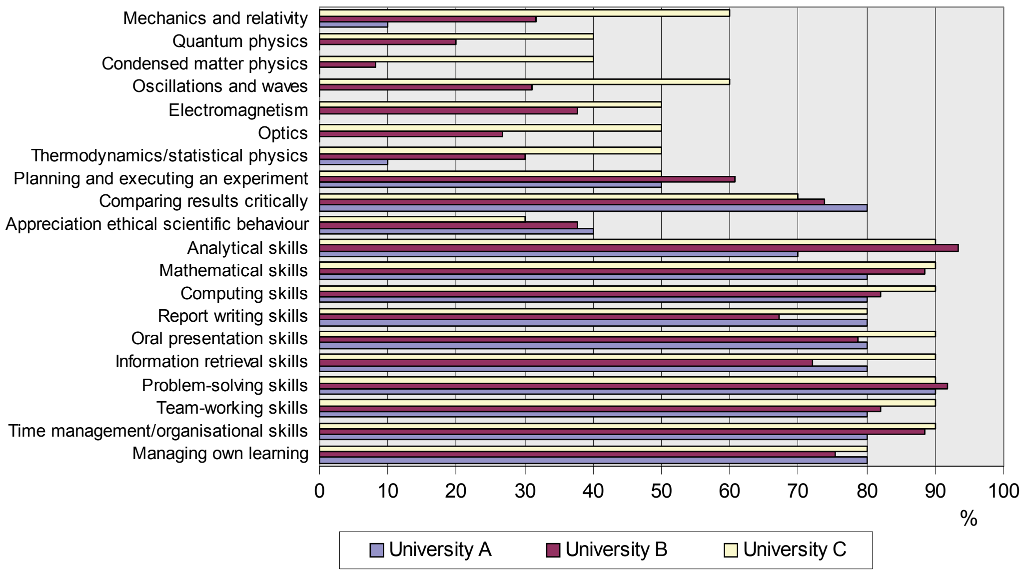

Figure 4: Percentage of graduates from three universities selecting 'Useful/Very useful'

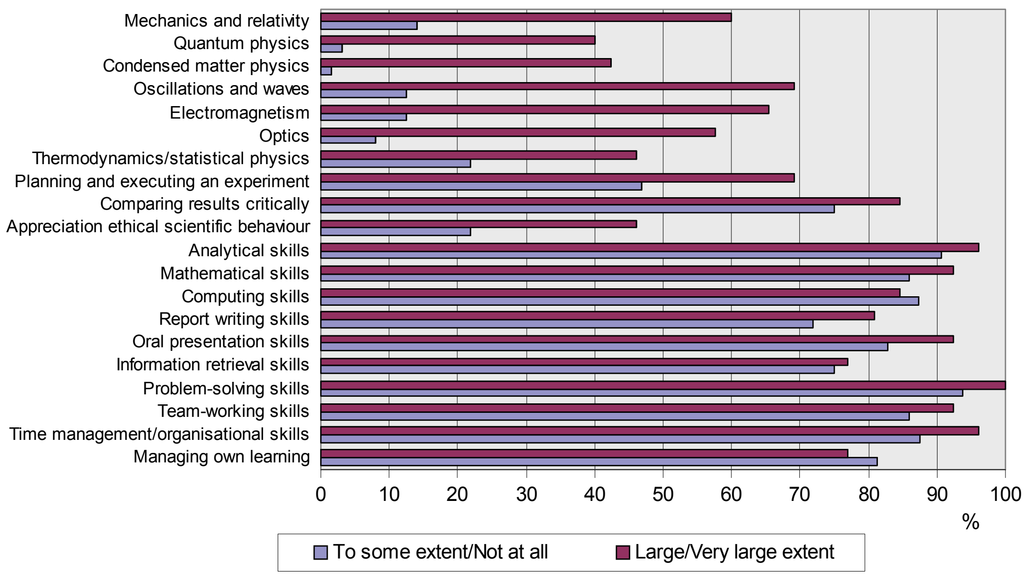

Figure 5: Percentage of employed graduates selecting 'Useful/Very useful' with respect to physics in their activities

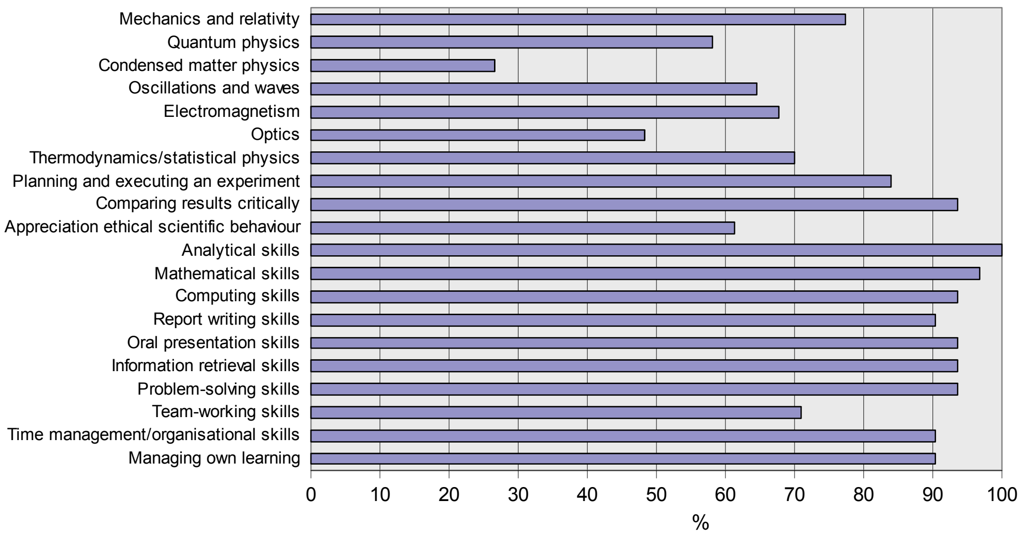

Figure 6: Percentage of graduates undertaking PhDs selecting 'Useful/Very useful'

Not surprisingly, those graduates whose employment required little or no knowledge of physics gave relatively low scores for the physics knowledge/skills. It is seen that the generic skills (other than 'Appreciation of ethical scientific behaviour') are given similar high scores by both groups, indicating again the relative importance of these skills, even for graduates in employment which has high physics content.

The results for the 31 PhD students (Figure 6) show a similar pattern to the employed graduates who have a 'Large/Very large extent' involvement of physics in their activities. Once again the generic skills are seen to have a high level of usefulness, although team-working skills were marked significantly lower than for the employed graduates (p = 5%, Student's t-test, testing for 5% and 1% significance), perhaps indicative of the individual nature of much postgraduate research. In the parallel chemistry survey, team-working skills were similarly marked lower than other generic skills by graduates undertaking PhDs.

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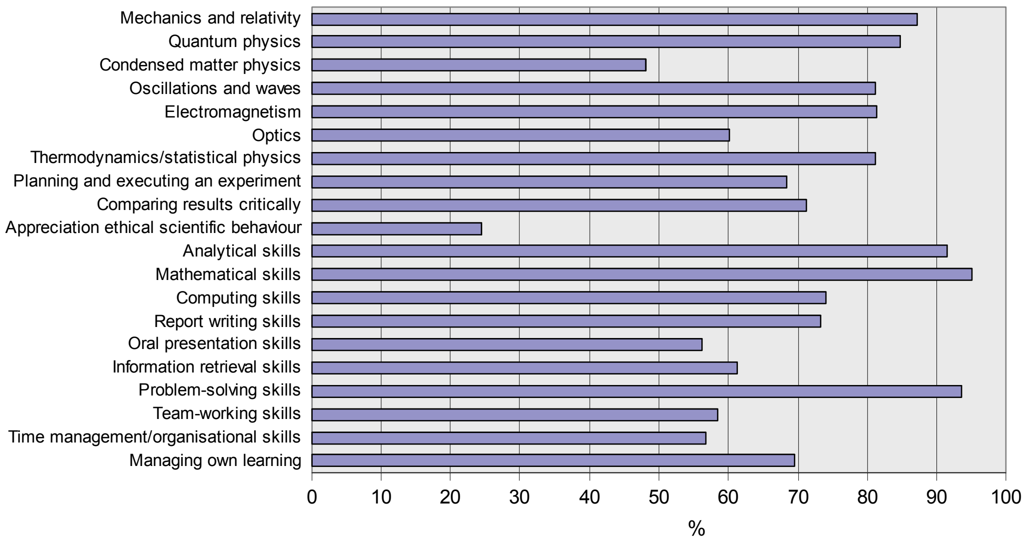

Figure 7: Percentage of all graduates selecting 'Well/Very well' for development in their degree

5.3 Knowledge/skills development in the degree programme

Figure 7 gives results to the question: ***With respect to your undergraduate degree (including work placement when included), please indicate how well the course assisted you in developing the knowledge and skills listed.*** Respondents could select one of: 'Not at all', 'To some extent', 'Well' or 'Very well'. The percentage of graduates selecting 'Well' and 'Very well' is given.

For all of the areas of knowledge/skills, except 'Condensed matter physics' and 'Appreciation of ethical scientific behaviour', more than 55% of graduates considered they had developed them 'Well/Very well' within their degree programmes. The average score of 71% is less than the 78% for chemistry and 76% for forensic science found in the parallel surveys.

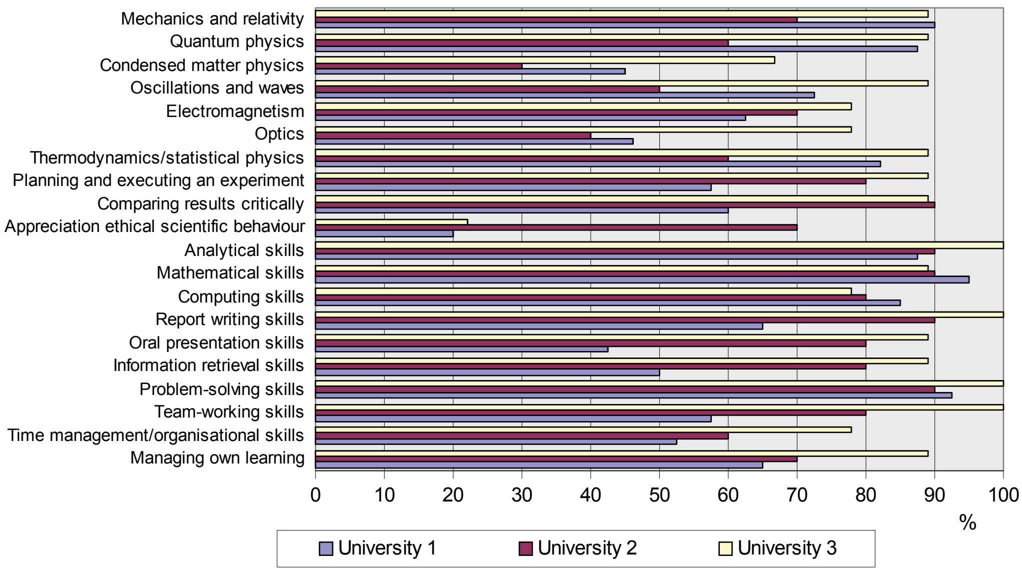

Figure 8: Percentage of graduates from three universities selecting 'Well/Very well' for development in their degree

The three universities included in Figure 8 were selected to show the spread of results for development (they are not the same universities as A, B and C in Figure 4). University 3 scored significantly higher than Universities 1 and 2 (p = 1% and 1% respectively), but scores are not significantly different when Universities 1 and 2 are compared. Some significant differences are also found when considering the other four universities. However, as mentioned above, this report is concerned with the overall results for all universities rather than university-specific results, although these will be made available to the individual universities concerned.

In order to investigate whether the type of degree programme undertaken affected the graduates' scores for skills development, results were analysed for:

- BSc degrees (normally 3 years in England and Wales, 4 years in Scotland), 77 graduates,
- MPhys/MSci (normally 4 years in England and Wales, 5 years in Scotland), 49 graduates.

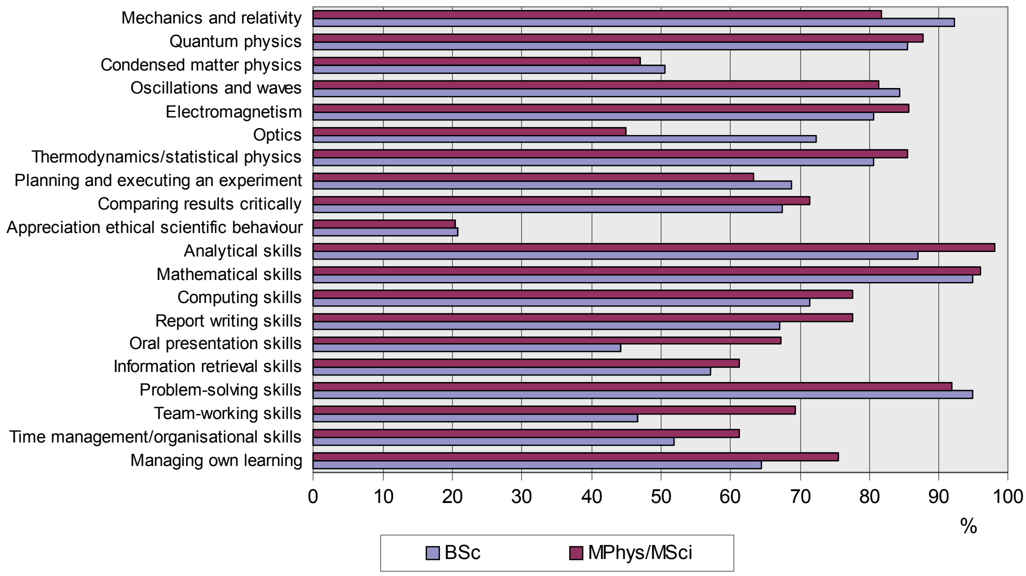

Figure 9: Percentage of graduates selecting 'Well/Very well' for development in their degree with respect to type of degree

Two universities which had no MPhys/MSci students were excluded from this analysis. The results are given in Figure 9.

The scores for the MPhys/MSci are significantly higher for the generic skills (p = 1%), but there is no significant difference for the physics knowledge/skills. The lower score for 'Optics' for MPhys/MSci graduates appears in part to be due to a timetabling anomaly for the 2007 cohort at one of the universities. It is interesting to note that the extra year at university leads to a significant development in a wide range of generic skills, in particular oral presentation and team-working. Care must be taken in interpreting these results as MPhys/MSci courses vary substantially and some are much more heavily geared to skills acquisition.

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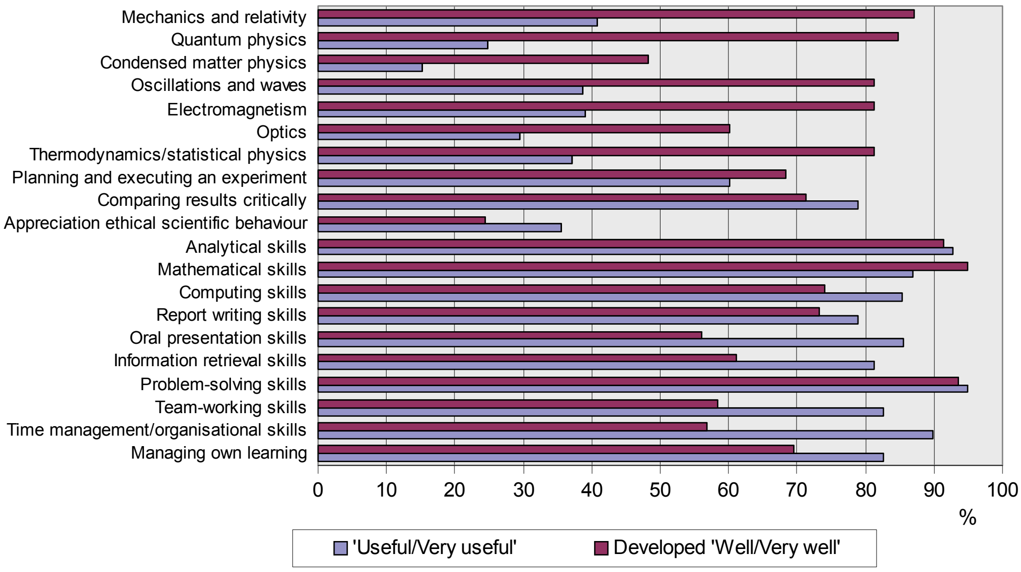

Figure 10: Use versus development for all graduates

5.4 Use versus development

In order to ascertain how well the skills usage by graduates relates to their development in degree programmes, 'Use' and 'Development' data are plotted together in Figure 10. This shows that with respect to usage, the generic skills are in general less well developed than the physics knowledge/skills within the degree programmes.

This is illustrated more clearly in Figure 11 where the differences between 'Use' and 'Development' data, as given in Figure 10, are plotted as a so-called 'Development deficit'. A positive 'Development deficit' indicates that the area of knowledge/skill has been developed to a low level relative to usage, a negative value that it has been developed to a high level relative to usage. Although a rather crude measure, this does highlight well the apparent deficit in development for most of the generic skills.

In Figure 12 'Development deficit' results are broken down for the 90 employed graduates according to the extent their activities since graduation involved a knowledge of physics. Note that the scale here runs from -90% to 40%. For those graduates who have had relatively little or no involvement of physics in their activities since graduation, most of the generic skills have positive 'Development deficits', but none of the physics knowledge/skills. For those graduates with a high level of physics in their activities, in addition to generic skills, 'Comparing results critically' also has a positive 'Development deficit'.

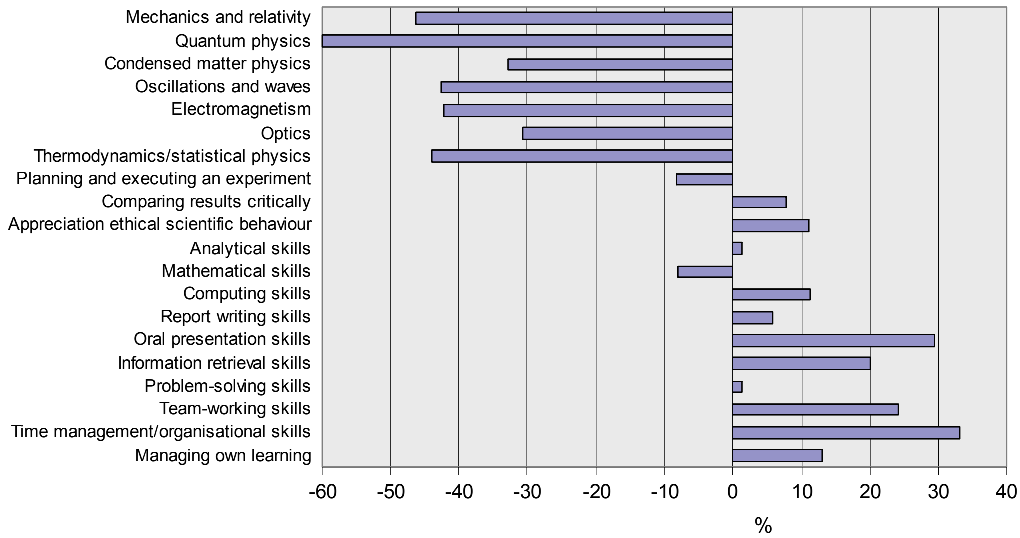

Figure 11: 'Development deficits' for all graduates

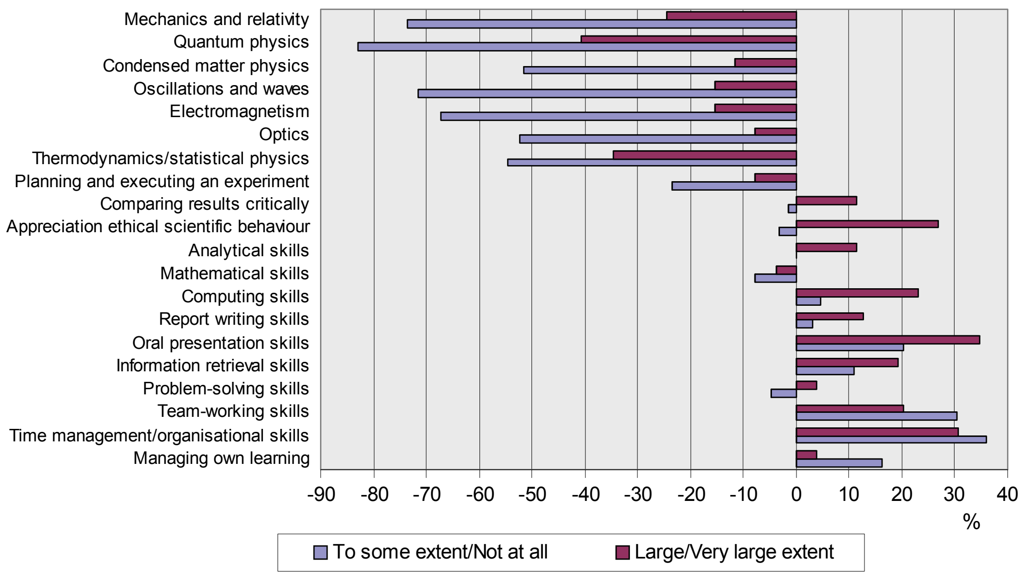

Figure 12: 'Development deficits' for employed graduates with respect to physics in their activities

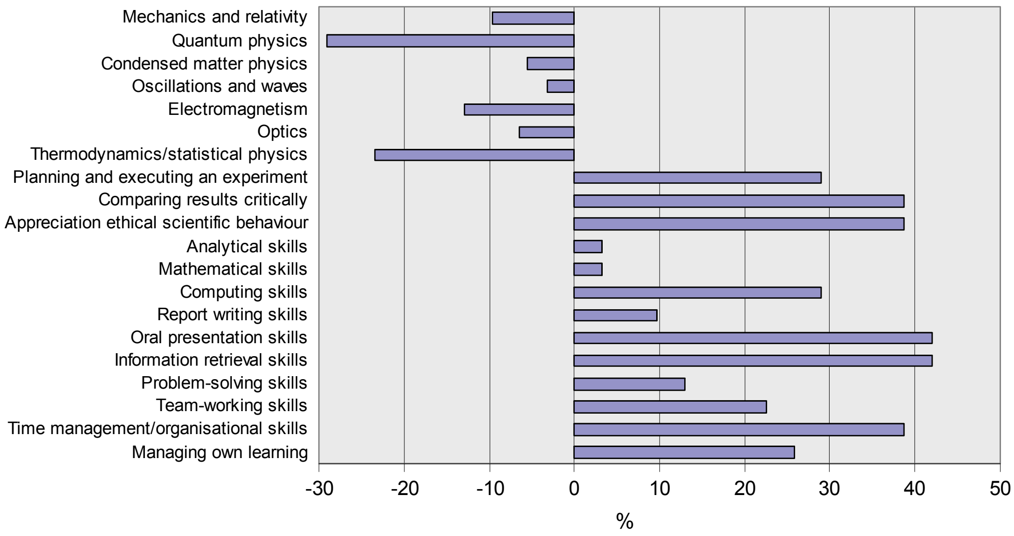

Figure 13: 'Development deficits' for graduates undertaking PhDs

To assess how effectively physics degree programmes prepare students for PhD study, 'Development deficits' are given in Figure 13 for the 31 PhD students. Note the scale here runs from -30% to 50%. Positive 'Development deficits' are seen here for 'Planning and executing an experiment or investigation' and 'Comparing results critically' as well as for all of the generic skills, with 'Oral presentation skills' and 'Information retrieval skills' showing the highest values.

5.5 Knowledge/skills graduates would have liked more opportunity to develop within their degree

The analysis in the previous section has identified areas of knowledge/skills, particularly generic skills, where their use after graduation appears to be high compared with their development within degree programmes. However, it does not necessarily follow that graduates would have liked to have developed these more within their physics degree programmes; they may, for example, consider the development of some of these skills to be more suited to extra-curricular activities. To address this point, the following question was asked: ***Of the 20 areas of knowledge/skills listed above, please indicate the FIVE which, in retrospect, you wish you had been given more opportunity to develop within your undergraduate degree.***

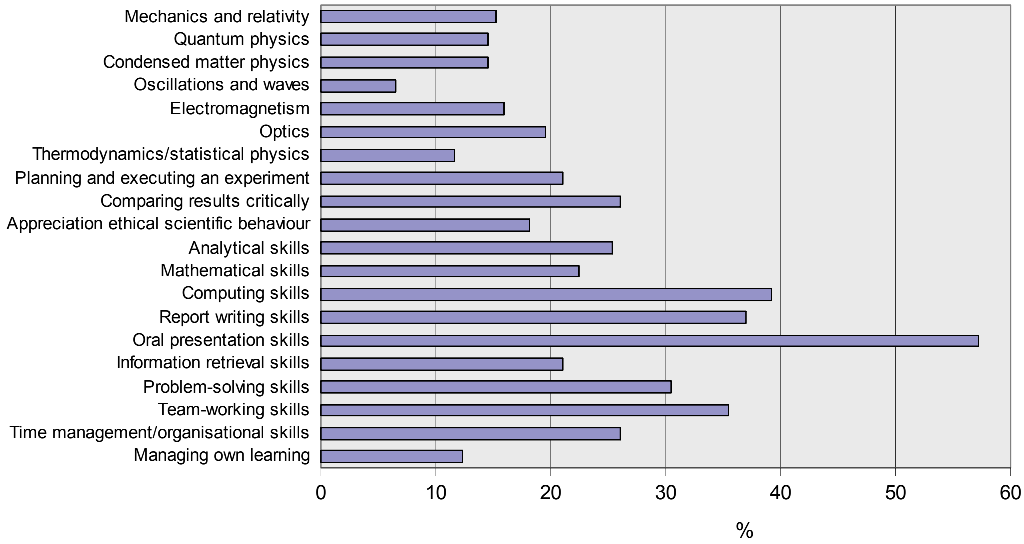

Figure 14: Percentage of all graduates indicating they would have liked more opportunity to develop the areas of knowledge/skills in their degree

The results for all graduates are given in Figure 14. It is seen that 'Oral presentation skills' have the highest score, being selected by 57% of graduates. It scored highest for five out of the seven universities when they were considered individually. The other areas of knowledge/skills which scored above average were, in order: 'Computing skills', 'Report writing skills', 'Team-working skills', 'Problem-solving skills', 'Comparing results critically', 'Time management and organisational skills' and 'Analytical skills'. When compared with 'Development deficits' (see Figure 11), these results are in broad agreement although 'Managing own learning', 'Information retrieval skills' and 'Time management and organisational skills' are seen as lower priority in answer to this question.

It is interesting to note that in the parallel surveys, 'Oral presentation skills' scored highest for this question in the chemistry survey (selected by nearly 50% of graduates) and was in the top five for the forensic science survey (selected by about 30% of graduates).

In Figure 15 results are broken down for the 90 employed graduates according to the extent their activities since graduation involved a knowledge of physics. Again 'Oral presentation skills' scored highest for both groups. Most of the other generic skills scored more highly for those graduates with little or no physics involvement in their activities. The physics knowledge/skills scored more highly for those with a high level of physics involvement in their activities, with 'Optics' and the two experimental skills scoring well above average.

The results for the 31 graduates taking PhDs are shown in Figure 16. 'Oral presentation skills' again scored highest with 'Computing skills' having the same score, followed by the two experimental skills and 'Analytical skills'. When compared with 'Development deficits' (see Figure 13), these results are in broad agreement although 'Managing own learning', 'Information retrieval skills' and 'Time management and organisational skills' are seen as lower priority in answer to this question.

The physics knowledge/skills scored more highly for those with a high level of physics involvement in their activities

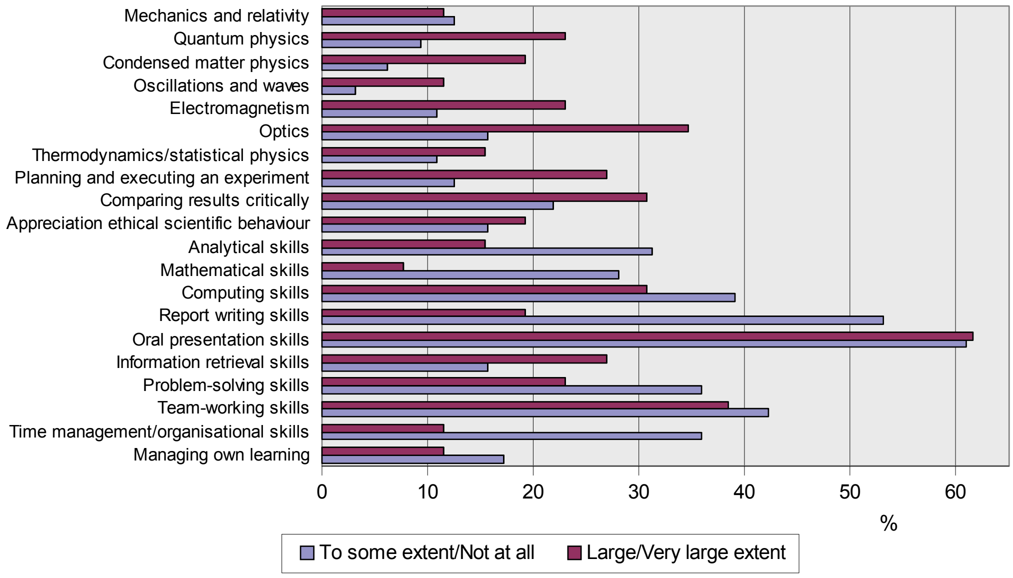

Figure 15: Percentage of employed graduates indicating they would have liked more opportunity to develop the areas of knowledge/skills in their degree, with respect to physics in their activities

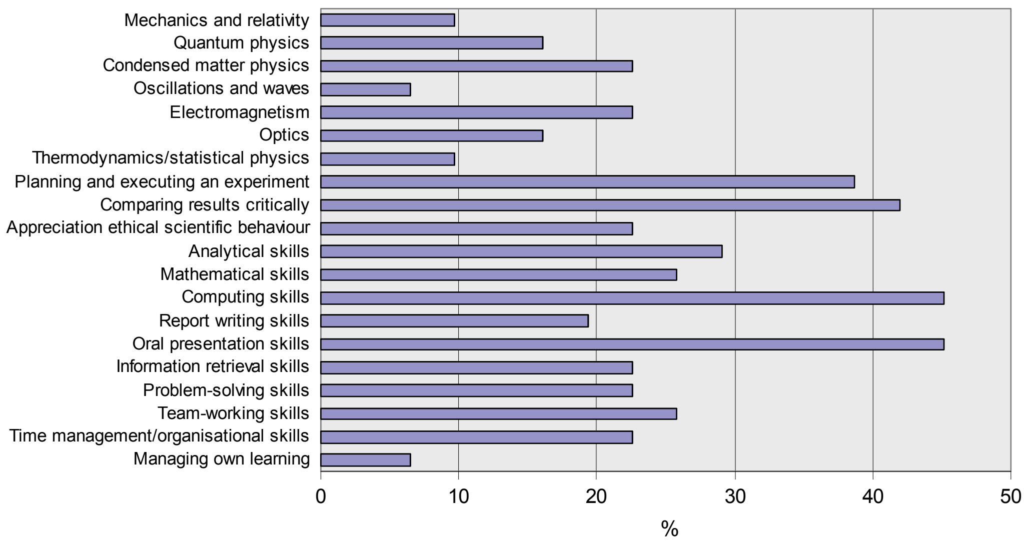

Figure 16: Percentage of graduates undertaking PhDs indicating they would have liked more opportunity to develop the areas of knowledge/skills in their degree

The survey included three open form questions.

Please indicate any areas of knowledge or skills, other than the 20 given above, which you have had to acquire in your career since completing your undergraduate degree and which were not covered, or were not covered sufficiently, in your degree.

This produced 44 responses. Most frequently mentioned (by 14 graduates) were computing skills (even though they were included in the 20 given above), including advanced features of MS Office and Visual Basic. Individual answers, which may be university-specific, included:

- *Computer programming should have been covered more thoroughly and started from the first year.*
- *Although we learnt some programming during our degree this was of little use as it's very unlikely your employer will use the same software. I think training should be given in widely available software like Visual Basic, the skills gained learning this can then be used if learning other software.*

Four graduates gave business and management skills in their answers. Several areas of physics were mentioned, including acoustics and nuclear physics, but none by more than two graduates.

Please indicate any areas of knowledge or skills, other than the 20 given above, which were part of your undergraduate degree, but have been of little or no use in your career.

This produced 24 responses. The low response rate is probably indicative of a general satisfaction with the content of the degree programmes. Some areas of physics, such as astrophysics, quantum physics and relativity, were picked out by a few graduates, but this seemed to relate more to the graduates' career activities rather than being suggestions for changing degree programmes. Individual answers included:

- *Most of the course content is not of use to me now, but in a more broad sense I think that the ability to grasp the concepts and working of the theories that are taught is the real skill that can be transferred to any job I take.*

I think that the ability to grasp the concepts and working of the theories that are taught is the real skill that can be transferred to any job

Please provide any comments which you think may be useful in developing the curriculum of undergraduate physics degrees. Additionally, if you wish, please explain or expand on any of the answers you have given above.

This produced 59 responses. Many graduates expressed satisfaction with the programme they had undertaken, irrespective of whether their activities since graduation were physics-related. Some answers were specific to the particular university programme taken and, although these comments will be of value to those universities, they are of limited general interest.

Many graduates commented that they would like more generic skills development in physics degrees, but two graduates opposed this proposition. Several graduates suggested that there should be a greater emphasis on computing skills/programming and on data analysis and statistics. A few graduates indicated they would have liked more careers advice and help with interviews and some suggested that more science philosophy/history should be included in physics degrees. Individual answers included:

- *Course should be more vocational rather than purely for research.*
- *Although everyone hates doing presentations it would be useful to get more experience giving presentations.*
- *Transferable skills are the most important thing any graduate takes away from their degree. The most useful modules for me were the analytical skills and communications modules. All modules should contain transferable skills and these in particular, with more focus on presenting assignments than just completing a list of questions.*
- *Working as an actuary I've had to develop my knowledge of statistics and financial mathematics. While this was not taught specifically on my course, studying physics was an excellent primer that prepared me to learn quickly what I needed to work effectively. I think some element of working in business/finance would be a welcome addition to a physics course for those students who do not pursue a scientific/ academic career.*
- *Specific jobs using a physics degree are quite narrow, so I feel the broader the course can be the better, teaching best practice when analysing data etc and more group project work would aid students when they enter a working environment, as these are the transferable skills that can benefit 100% of postgraduate careers.*
- *The skills/knowledge focused on in university are the ones I am using primarily in my job. However I did not go to university to learn about team working, presentation skills etc, I went to learn physics.*
- *Not enough emphasis placed on having to convert skills learnt in the degree to skills useful in a job.*
- *General help career-wise would have been helpful. Not all physics students go into science related jobs and more general information about job search and other career options using a scientific degree would help.*
- *Final year use of student directed teaching was excellent, very useful for learning* (MSci graduate).
- *Degree needs a more reflective edge to it, investigating how answers came to be known, philosophical aspects.*

6. Discussion

For new physics graduates it is clear from this study that generic skills are very important, irrespective of whether the graduates are employed in physics or non-physics related jobs. This is very much in line with reports, mentioned above in the Background, that list the graduate skills required by employers. This evidence should be valuable to academic staff when advising undergraduates on the importance of generic skills development during their undergraduate programme. It has been observed by the authors that the views of recent alumni are often more convincing to undergraduates than the views of employers.

Graduates studying for PhDs also consider generic skills to be very important. This evidence may be useful to academics in convincing research-focused colleagues of the importance of skills development activities in the physics curriculum.

This study shows an imbalance between the use of skills after graduating and their development within degree programmes. This is demonstrated both by 'Development deficit' data and by answers to the question about which skills the graduates would have liked the opportunity to develop more within their degrees. The highest scores for these parameters are given in Table 2 for all graduates and for graduates studying for PhDs, along with some results from the parallel survey in chemistry. The results provide evidence for greater inclusion of generic skills, such as oral presentation, in physics degree programmes and a greater emphasis on computing/programming skills. This is confirmed by many of the answers to the open form questions. There is also evidence for inclusion of more opportunities for planning and executing experiments or investigations and interpretation of results. Such evidence can be very useful to academics involved in programme design, in particular to those wishing to take initiatives which incorporate generic skills development within a laboratory setting.

Results from a focus group of chemistry graduates undertaken during the pilot survey of 2006 graduates provided some useful information in interpreting these results. The graduates were not surprised that the value of generic skills came out strongly relative to the chemical knowledge skills. When it was put to them that this appeared to indicate decreasing the chemical knowledge/skills content in the degree programmes relative to the generic skills, the general consensus appeared to be that they didn't wish this to happen. Rather, they would like the methods of teaching to be such that more training in generic skills could be included whilst maintaining the chemical content. It is likely that this also applies to physics degrees, as evidenced by graduates' answers to the open form questions, suggesting an increase in generic skills whilst not indicating a decrease in physics knowledge/skills, and comments such as "all modules should contain transferable skills". This therefore appears to be an issue of pedagogical innovation rather than curriculum content.

Table 2: Results given in rank order for the ten highest scores for all graduates and graduates taking PhDs, taken from this survey and from the parallel survey in chemistry
(Note: Areas of knowledge/skills in merged cells have equal scores)

<table>
<tr><th rowspan="3"></th><th colspan="3">All graduates</th><th colspan="3">Graduates taking PhDs</th></tr>
<tr><th colspan="2">Physics</th><th>Chemistry</th><th colspan="2">Physics</th><th>Chemistry</th></tr>
<tr><th>‘Development deficit’</th><th>Like more developed</th><th>Like more developed</th><th>‘Development deficit’</th><th>Like more developed</th><th>Like more developed</th></tr>
<tr><td>1</td><td>Time management</td><td>Oral presentation</td><td>Oral presentation</td><td rowspan="2">Oral presentation
Information retrieval</td><td rowspan="2">Computing
Oral presentation</td><td>Planning and design of experiments</td></tr>
<tr><td>2</td><td>Oral presentation</td><td>Computing</td><td>Planning and design of experiments</td><td>Oral presentation</td></tr>
<tr><td>3</td><td>Team-working</td><td>Report writing</td><td>Chemical instrumentation</td><td rowspan="3">Comparing results critically
Appreciation ethical sci. behaviour
Time management</td><td>Comparing results critically</td><td>Chemical instrumentation</td></tr>
<tr><td>4</td><td>Information retrieval</td><td>Team-working</td><td>Analytical techniques</td><td>Planning and executing an experiment</td><td>Interpretation experimental data</td></tr>
<tr><td>5</td><td>Managing own learning</td><td>Problem - solving</td><td>Time management</td><td>Analytical</td><td>Analytical techniques</td></tr>
<tr><td>6</td><td>Computing</td><td rowspan="2">Comparing results critically
Time management</td><td>Report writing</td><td rowspan="2">Planning and executing an experiment
Computing</td><td rowspan="2">Mathematical
Team-working</td><td>Numeracy and computational</td></tr>
<tr><td>7</td><td>Appreciation ethical sci. behaviour</td><td>Numeracy and computational</td><td>Information retrieval</td></tr>
<tr><td>8</td><td>Comparing results critically</td><td>Analytical</td><td>Interpretation experimental data</td><td>Managing own learning</td><td rowspan="3">Condensed matter
Electro-magnetism
Appreciation ethical sci. behaviour
Information retrieval
Problem - solving
Time management</td><td rowspan="3">Kinetics of chemical change
Report writing
Team-working</td></tr>
<tr><td>9</td><td>Report writing</td><td>Mathematical</td><td>Independent learning ability</td><td>Team-working</td></tr>
<tr><td>10</td><td>Analytical
Problem - solving</td><td>Planning and executing an experiment
Information retrieval</td><td>Team-working</td><td>Problem - solving</td></tr>
</table>

7. Conclusions

7.1 Completed survey forms were received from a total of 139 graduates from seven universities, an overall response rate of 35%.

7.2 A total of 90 graduates (65%) were in employment and 31 graduates (22%) were undertaking PhDs. Of graduates in employment, 69% indicated some involvement of physics in their activities since graduation.

7.3 The generic skills were in general scored at a higher level of usefulness than the physics knowledge/skills. With the physics knowledge/skills, the experimental skills were considered to be of most use. A similar pattern was found for all seven universities.

7.4 For all of the areas of knowledge/skills except 'Condensed matter physics' and 'Appreciation of ethical scientific behaviour', more than 55% of graduates considered they had developed them 'Well/Very well' within their degree programmes.

7.5 Significant differences were found between universities in how well the different areas of knowledge/skills had been developed.

7.6 Development scores for the MPhys/MSci degrees were significantly higher than for BSc degrees for the generic skills, but were not significantly different for the physics knowledge/skills.

With the physics knowledge/skills, the experimental skills were considered to be of most use

7.7 Relative to usage the generic skills were less well developed than the physics knowledge/skills within degree programmes. This is highlighted in terms of 'Development deficits', which were highest for 'Time management and organisational skills', followed by 'Oral presentation skills' and 'Team-working skills'.

7.8 Graduates would have liked more opportunity in their undergraduate degrees to develop 'Oral presentation skills' in particular. This is followed by 'Computing skills', 'Report writing skills', 'Team-working skills' and 'Problem-solving skills'.

7.9 Graduates who were studying for PhDs would have liked more opportunity in their undergraduate degrees to develop 'Computing skills' and 'Oral presentation skills'. These are followed by 'Comparing results critically', 'Planning and executing an experiment or investigation' and 'Analytical skills'.

7.10 The open form answers back up many of these conclusions and provide a useful source of information for degree programme development.

Graduates who were studying for PhDs would have liked more opportunity in their undergraduate degrees to develop 'Computing skills' and 'Oral presentation skills'

8. Recommendations

It is recommended that when undergraduate physics degree programmes are being revised, additional opportunities should be provided for developing generic skills, in particular oral presentation and computing. Additional opportunities should also be provided for planning and executing experiments or investigations and interpretation of results.

Undergraduates should be advised about the range of skills new graduates require. Presentations by recent alumni may be one of the best ways to put over this message.

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