Review of the Student Learning Experience in:

PHYSICS

2008

The Higher Education Academy
Physical Sciences Centre

Consultant and Author
Professor Mike Edmunds, Cardiff University

Researcher
Dr Ruth Wellock, Higher Education Academy Physical Sciences Centre, University of Hull

Advisory Panel
Dr Robert Lambourne (Chair), The Open University, IOP Vice-President for Education
Professor Jim Al-Khalili, University of Surrey
Philip Diamond, Institute of Physics
Dr Michael Gagan, Consultant, The Open University
Professor Peter Goodhew, Director, Higher Education Academy UK Centre for Materials Education;
Project Director, National Subject Profile for higher education programmes in Materials
John Harris, SEMTA Sector Skills Council
Professor Hugh Jones, University of Hertfordshire
Professor Ray Jones, University of Birmingham
Professor Derek Raine, University of Leicester
Dr Bruce Sinclair, University of St Andrews
Professor Tina Overton, Director, Higher Education Academy Physical Sciences Centre, University of Hull

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1. Foreword

In 2007 the Higher Education Academy commissioned three Subject Centres to produce National Subject Profiles in Materials, Microbiology, Biochemistry and Art, Design and Media. Although not part of this pilot scheme the Physical Sciences Centre believed that the time was right to carry out a similar review of the undergraduate experience of teaching and learning in chemistry and in physics. This report is the product of that review in physics.

The aim of this report is to provide a snapshot view of the state of the student experience in UK physics departments in 2008. We have used online and paper questionnaires to determine the views of undergraduate students and all levels of staff across a wide range of institutions. This information has been supplemented by detailed interviews with Directors of Study in several institutions. Although these samples were not large we are confident that they do represent a cross section of views.

Overall, this review demonstrates that physics education in the UK is in good shape. Recruitment is showing indications of upturn and students are very well qualified. They are overwhelmingly satisfied with their experience. Perhaps most surprisingly, the nature of the student experience differs very little across different types of institution.

We hope that this report will be of value to all those involved in teaching undergraduate physicists and to those in a position to influence curriculum developments. It should make a useful companion to the report "Physics – building a flourishing future: Report of the Inquiry into Undergraduate Physics" which was published by the IOP in October 2001, and is available at: <www.iop.org/activity/policy/Projects/Archive/file_6418.pdf>

We do not attempt to emulate the form of that report, rather our concern here has been to concentrate particularly in more detail on the *student* experience. The design and analysis of our student questionnaire was carried out completely independently of the survey that forms an annex to the IOP report, and we briefly compare the results of the two surveys in Appendix 3. Since 2005 there has also been the National Student Survey, and we include an analysis of the responses from physics students in 2007 in Appendix 3, also with comparison to our results.

We would like to thank the members of the Advisory Panel for their constructive support and sound advice. Thanks are also due to the academic staff and undergraduate students who took the time to complete the substantial questionnaires and to provide advice and feedback through the development phase by attending focus group meetings. Mike Edmunds and Michael Gagan, consultants on the physics and chemistry reviews respectively, have produced reports of outstanding quality and should also be thanked.

Professor Tina Overton
Director, Higher Education Academy
Physical Sciences Centre

2. Preface

It is a simple matter to uncover a range of opinions concerning the learning experience of university students. Many of us have more or less fond memories of our own student days, however long ago they may have been, and almost all of us have a whole battery of prejudices about the learning experiences of others. Uncovering the truth, at least in a statistical sense, about the current student learning experience in any subject, is a far more daunting task but one that is of the utmost importance to those engaged in teaching or educational planning, management and governance. It therefore gives me great pleasure to present this well-researched Review of the Student Learning Experience in Undergraduate Physics.

Work on the Review was prompted by the Higher Education Academy's decision to produce a set of National Subject Profiles that would provide contemporary characterisations of selected subjects in higher education informed by discipline communities and practitioners. Physics was not included in the list of subjects to be profiled, but the need for an objective, up-to-date survey that concentrated on the learning experience of physics students was widely appreciated. Fortunately, the existence of the HEA's Physical Sciences Centre and the energetic leadership of its Director, Tina Overton, provided a context in which such a Review could be undertaken, supported and brought to a successful conclusion.

Many of the results presented in the Review will not surprise those who are familiar with the state of physics teaching in universities. Those results will, nonetheless, allow a number of common beliefs to be given a firm factual basis and they will provide reliable evidence that can assist in decision making for many years to come. Undoubtedly though, some of the results will come as a surprise and it is here that planners and teachers may find the greatest value in the Review.

The crucial role of Tina Overton in the creation of this Review has already been noted, but it is a pleasure to also have the opportunity to thank and acknowledge the many others who have contributed to the Review. Thanks are certainly due to all the students and academics who have provided information, but all of us in the physics community owe a particular debt of gratitude to the hard working team at the Physical Sciences Subject Centre at the University of Hull, to the members of the Panel that guided and advised on the conduct of the Review, and most especially to Professor Mike Edmunds of the University of Cardiff who carried out much of the survey work and was mainly responsible for the detailed drafting of the final report.

Physics is an exciting subject that underpins much of modern technology and is vital to the economic well-being of the world and to our human appreciation of our true place in the physical universe. The teaching and learning of physics are also exciting concerns, and their effective prosecution is just as dependent on the provision of good data as is the development of physics itself. If, as its creators intend, this Review helps to guide, safeguard and sustain the future of physics teaching then the effort that went into it will certainly have been worthwhile.

Robert Lambourne
Advisory Panel Chair

3. Executive summary

1. This report is based on surveys of students and staff involved in 3-year BSc or 4-year MPhys/MSci physics or physics-related degrees at UK universities.

2. The student educational experience is not markedly different throughout the different types of the universities offering courses.

3. Students entering physics or physics-related degree courses are better qualified (judged by A-level scores) than the average university entrant, and the university entrance requirements have tracked the upward movement with time in awarded A-level grades.

4. 80% of students state that they did *not* chose a physics degree primarily for its employment prospects.
   (*section 6*)

5. Students view the university physics curriculum as well-balanced; neither too academic nor too applied, and including appropriate links to the results of modern research.
   (*section 7.1*)

6. There is considerable support available for the weaker student. Although a large majority of students feel challenged by at least parts of their courses, a significant proportion of staff think that the brightest students are not sufficiently stretched.
   (*section 7.1*)

7. In the transition from secondary to higher education, students and staff agree that lack of experience in practical work and problem solving, and a lack of mathematical skills, are the greatest cause of difficulty for incoming physics students.
   (*section 7.2*)

8. Students value the opportunity to study some modules outside physics and mathematics.
   (*section 7.4*)

9. Small-group tutorials are regarded by students as the most effective teaching method. Lectures also remain popular. The educational value and popularity of project work is clearly acknowledged by both students and staff. The student projects are often informed and supported by the research work of staff.
   (*section 7.5*)

10. Feedback from students to staff on the quality of teaching is almost universal, and is valued and used by staff.
    (*section 7.7*)

11. Students' perception of the value of laboratory work clearly increases during their courses, together with a preference for open-ended experiments.
    (*section 8.4*)

12. Staff and students agree that feedback to students on their academic work is valuable, and should ideally be individually targeted, timely and preferably in writing. Most students feel feedback is prompt enough for it to be effective, but its full potential may not be fully realised for all students.

(section 8.5)

13. Acquisition of transferable skills is now an intrinsic part of physics and physics-related degrees. There is some evidence that a proportion of students would welcome and benefit from greater access to training in study skills or "learning how to learn" at the beginning of their courses, although by their final year three-quarters of students believe they are well-equipped to continue life-long learning.

(section 9)

14. Relatively few physics and physics-related students undertake paid work during term, although a small minority work over ten hours.

(section 10)

15. During the teaching period, the average time spent by students on private academic work, outside formal teaching, is half of staff expectations for this activity. This mismatch is to some extent remedied by private study during vacations.

(section 10)

16. Although the combined proportion of first and upper-second class degrees awarded in physics is comparable to other degree subjects, the proportion of first class degrees is over twice that in most other subjects, an effect also seen (for example) in mathematics degrees.

(section 11)

17. A majority of students would like more weight to be given to continuous assessment in their degree classification.

(section 11)

18. By their final year, most physics or physics-related students are intending to use the physics they have learned in a career, and about 40% go on to obtain a physics-based postgraduate qualification.

(section 13)

19. There appears to be scope for greater interaction between physics departments and employers of physics graduates to make students more aware of career opportunities.

(section 13)

20. Three quarters of students think that work placement is a good way to prepare for employment, but only a few (possibly less than 15%) actually find or take up a placement.

(section 14)

21. The increased emphasis by universities on training staff in teaching in higher education is clearly evident in the staff profile. There is evidence of a significant rate of teaching innovation by staff, with the younger and female staff tending to be more involved in teaching development and educational research.

(section 15)

22. 84% of the undergraduates rate the majority of their teaching as "excellent" or "good".

(section 7)

4. Physics degrees in the UK

The nature of undergraduate physics degrees can be quickly gleaned from two sources:
(i) the 2008 version of the QAA Honours Degree Benchmarking Statement "Physics, astronomy and astrophysics":
<www.qaa.ac.uk/academicinfrastructure/benchmark/statements/Physics08.pdf>
(ii) the Institute of Physics (IOP) "The Physics Degree: Graduates Skills Base and the Core of Physics" (2006):
<www.iop.org/activity/policy/Degree_Accreditation/file_26578.pdf>

The following brief description is largely paraphrased from the above two sources.

Physics is a fundamental science, allowing understanding of complex physical systems by the application of basic principles. The fundamentals of physics, which all students need to cover to some extent, include electromagnetism, relativity, quantum and classical mechanics, statistical physics and thermodynamics, wave phenomena and the properties of matter. Students will also study the application of the fundamental principles to particular areas. Physics-related courses may include atomic physics, nuclear and particle physics, condensed matter physics, materials, plasmas and fluids. Astrophysics and astronomy courses will include the application of physical principles to cosmology, the structure, formation and evolution of stars and galaxies, planetary systems, and high-energy phenomena in the universe. More specialised courses, or modules, may involve subjects such as engineering or medical physics. Whatever the course, the student would be expected to develop some qualitative understanding of current developments at the frontiers of the subject. A good physics degree course should stretch and challenge students – giving a real insight into the physical Universe, encouraging clarity of thought and development of intellectual abilities. It should give a broad physics-based education which will make the graduate numerate, articulate and eminently employable, and also be a good preparation for research in industry or academia.

Mathematics is an essential part of a physics degree. Physics is a quantitative subject and the development of mathematical skills is necessary to describe and model the physical world and solve problems. The practical nature of physics requires developing the skills necessary to plan investigations and collect and analyse data (including estimation of inherent uncertainties). Proficiency is necessary in the planning, execution, and reporting of the results of experimental or theoretical investigations. Open-ended project work – which can be practical, theoretical or computational – is widely used to develop skills in research and planning (including use of data bases and published literature), and to develop the ability to assess critically the link between theoretical calculation and experimental observation.

Particularly important is the development of the ability to formulate and tackle problems in physics. This will involve the identification and application of the appropriate physical principles, using special and limiting cases and order-of-magnitude estimates to guide thinking about a problem, and presenting the solution -

making the assumptions and approximations explicit.

A physics degree will enhance transferable skills that can be used in many different careers: Problem-solving skills: developing the ability to formulate problems in precise terms and to identify key issues, and fostering confidence to try different approaches in order to make progress on challenging problems. Investigative skills: developing the ability to undertake independent investigations, including using all relevant sources of information. Communication skills: since physics and the mathematics used in physics deal with surprising ideas and difficult concepts, good communication is essential, and a physics-based degree should develop the ability to listen carefully, to read demanding texts, and to present complex information in a clear and concise manner. Analytical skills: study of physics should encourage the need to pay attention to detail and develop the ability to manipulate precise and intricate ideas, to construct logical arguments and to use technical language correctly. IT skills: developing computational and IT skills including the ability to use appropriate software such as programming languages and packages. Personal skills: developing an ability to work independently and ethically, to use initiative, to self-organise to meet deadlines, and to interact constructively with other people, both in groups and individually.

There are currently 45 UK universities offering degrees in "Physics", or closely related degrees such as Astrophysics. The degree title "Physics with……" normally indicates that physics will form at least two-thirds of the degree material, while in "Physics and…." it will probably be between two-thirds and a half.

4.1 Widening participation

There are numerous parallel and interlocking efforts being put into widening participation in physics in the light of which the increase in A-level and equivalent[1] requirements for students entering degree programmes may appear paradoxical (see Section 6 below). Two points need to be made. First, by its nature a physics degree requires students to achieve a high level of ability in two distinct areas, maths AND physics. To remove this requirement would remove the unique value of a physics education. The widening participation initiatives therefore attempt to seek out students with the relevant potential. Second, an increasing fraction of the A-level physics cohort attains grade A: the number of students applying to Universities with maths/physics at grade B/C (in either order) appears to be relatively small. Thus the upward drift of physics entry grades has tracked the physics A-level. As will be seen in Section 6, physics students as a group are a remarkably well-qualified cohort.

The most one can argue therefore is that the widening participation initiatives have been successful in preventing any potential decline in numbers of undergraduate physics students. Alternative strategies to widen participation are therefore worth pursuing. In particular, the Integrated Sciences programme funded by HEFCE as part of the Stimulating Physics Initiative has developed an alternative route to physics. It has two strands. First a new full degree programme that integrates the sciences of which physics is a recognised part; second, a pathway to enter a physics degree (or other discipline) at level 2 after two years of Integrated Sciences. The programme therefore provides a route to widen participation for students with an interest in science who have not had the opportunity at school to prepare adequately for entry to a physics degree.

1. In most places in this report the reader should interpret "A-level" as "A-level and similar qualifications". Physics departments across the UK accept from entrant students Scottish, Irish and IB qualifications, amongst others. The majority of students, however, enter with A-level qualifications.

5. About the surveys

In association with the HEA Physical Science Centre Review of the Student Learning Experience in Chemistry, two questionnaires were devised and distributed in the first half of 2008. Those for staff (Staff Questionnaire; questions numbers denoted[sta(n)]) and students (Student Questionnaire, questions denoted[stu(n)]) were made available in paper and on-line format, and the results combined. Another questionnaire was distributed to a small sample of Directors of Teaching (DoTs Questionnaire[dot(n)]) at university physics departments, followed up by (mainly telephone) interview (DoTs Interview[dotint]). A route for access to copies of the questionnaires is given at the end of this report (Section 16.)

In the following analysis, the departments are grouped into Russell and non-Russell groups. The Russell Group is an officially constituted group of large and research-intensive universities, eighteen of which have a physics department (Appendix 1: *UK Universities Offering Physics Degrees*). Further sub-grouping was not thought to be worthwhile, given that the total number of departments is only 45. What will become clear from the results of our survey is that the educational experience for students is really very similar in both groups of universities. In effect we have validated the "null hypothesis" of no major differences between the student experiences of physics degrees in Russell group and non-Russell group universities.

In reporting responses to the surveys, we occasionally use median values – i.e. where exactly half the replies are above, and half below, the reported value. The median can be more representative of the typical experience of an individual than the mean. Where 10% and 90% percentiles are give, these indicate a lower and higher value within which 80% of the sample's responses lie.

The survey of physics department teaching staff yielded responses from 273 staff in 42 institutions, 152 staff from the Russell group, and 121 from non-Russell universities[sta1]. Responses were received from across the

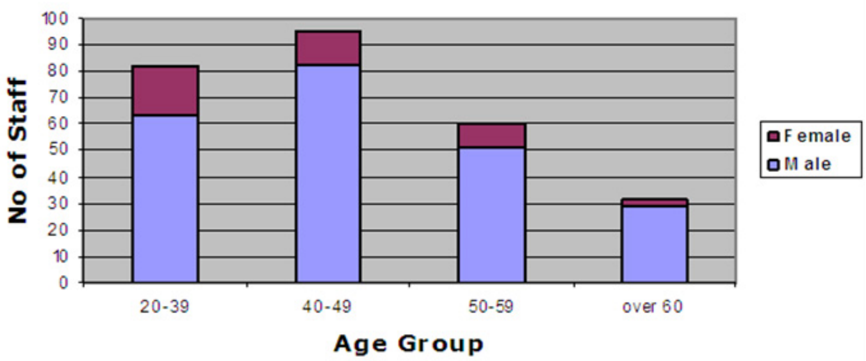


Figure 1 Age distribution of staff (showing gender) responding to the Staff Questionnaire.

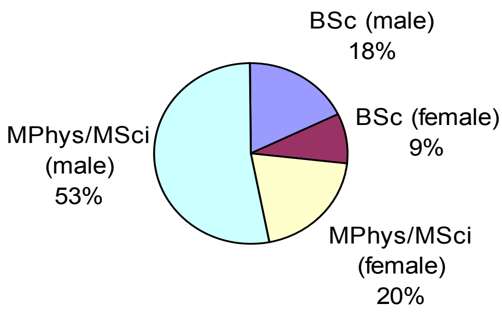


Figure 2 Gender and course distribution[stu4,stu6] of students responding to the Student Questionnaire.

whole range of teaching staff in departments – Professors (62), Readers (40), Senior Lecturers (29), Lecturers (56), and other teaching staff (27). Others identified themselves as Head of Department, or Director of Studies/ Teaching[sta3]. As might be expected, not all staff answered all questions. Figure 1 shows that there was reasonable representation of all age groups[sta4]. Only two female staff in the oldest age group responded to the survey. The distribution shows marked improvement (although still far from ideal) in the gender balance for the youngest group. Only three staff (1% of total) below the age of 29 responded to the survey. First appointments to departments appear to occur quite late

In the staff survey, 228 (85%) staff identified themselves as male, and 41 (15%) identified themselves as female[sta5]. IOP statistics from March 2004 across the university physics sector suggested an overall gender balance for lecturers, senior lecturers, readers and professors as 92% male to 8% female, and this balance is supported by replies by Directors of Teaching[dot] reporting a balance of around 89% male to 11% female. These staff gender ratios are rather different from the current distribution between male and female physics graduates 79%:21% (IOP statistics for 2005/6), and the male/female ratio of 71%:29% in our Student Survey[stu6]. The small number (in absolute terms) of female replies implies that gender imbalances in replies to questions should be treated with some caution. Of the staff, 88% were submitted in the 2008 RAE - the percentage is only slightly lower in the non-Russell group (84%) than in the Russell group (92%). Male staff are submitted more (90%) than female (78%)[sta6].

Returns to the *student* survey were received from 700 students, but the sample was refined by omitting those not specifying a year of study,

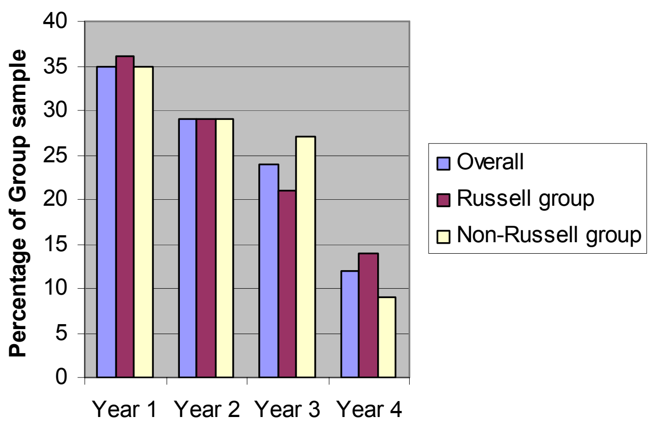


Figure 3 Distribution of students who responded to the questionnaire by year of course and university group.

or in Year 1 at a Scottish University (which roughly corresponds to the second year of A-level studies elsewhere in the UK). Where year numbers are used in this report, they refer to the standard year numbers as in use in universities in England, where a BSc honours degree is normally taken in three years and an MPhys/MSci in four. The sample used of 667 students represents 17 universities[stu1]; 427 students from 8 Russell group, 240 students from 9 non-Russell group. In 2005/6 (most recent figure readily available) there were approximately 10500 physics undergraduates in the UK, so the sample is about 6% of the relevant population. Figure 2 and Figure 3 show that of the students who responded to the questionnaire, those who are taking MPhys/MSci courses (73%) outnumber those taking BSc courses (27%), by about three to one, with a higher proportion taking MSci/MPhys in the Russell group (82%) than in the non-Russell group (57%)[stu4]. There is a satisfactory survey distribution across years for both university groups[stu5]. The overall ratio of MPhys/MSci to BSc students nationally is not easily available – this data is not, for example, tabulated by HESA. From Director of Teaching[dot] replies on degrees awarded we find ratios varying between departments of 34%:66% to 79%:21%, with an approximate student-number-weighted mean of 62%:38%. Our student sample is therefore rather richer in MPhys/MSci students (73%) than the overall physics student population (~62%).

In Figure 4 the overall student gender ratio in the sample[stu6] (male 71%, female 29%) is compared with gender statistics of UK home university students in 2005/6, and A-level entries in 2007 *(data from <www.iop.org/activity/policy/Statistics/Education%20Statistics/page_2656.html> and <www.jcq.org.uk>).*

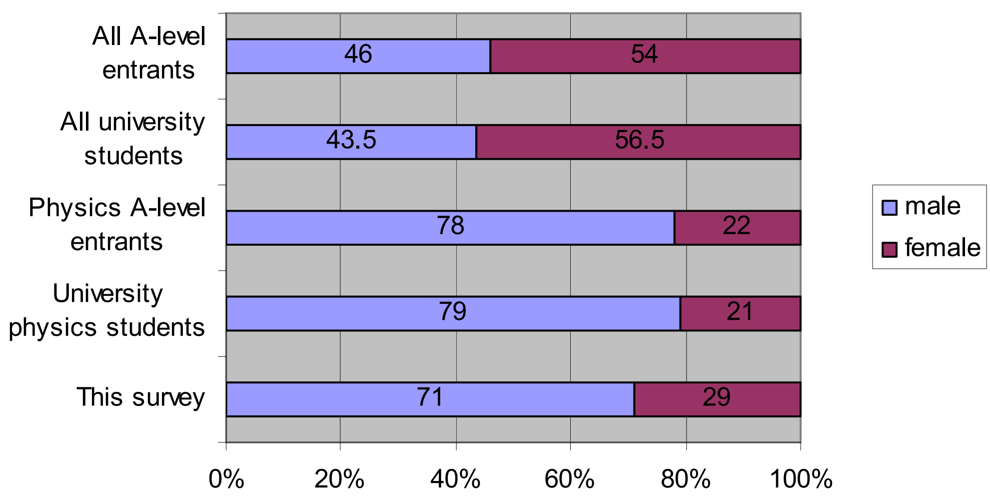


Figure 4 Student gender ratios

6. The student entry

Numbers: The number of students accepted on physics degrees was 3349 in 2007 (0.8% of entry to all degrees), and has remained fairly constant over the past five years (see Figure 5), decreasing very slightly by 0.7% from 2003 to 2006, but with a sudden increase of 9% from 2006 to 2007.
(Source <www.iop.org/activity/policy/Statistics/Education%20Statistics/page_2656.html> The numbers of accepted applicants are close, but not necessarily identical, to the numbers who actually enrol).

Entry qualifications: Students usually enter a physics degree course with A-Levels, Scottish Highers, or equivalent in both physics and mathematics, and frequently with an additional subject. A tariff points system (see Glossary of Terms) is used here to assess student overall attainment. The requirement for both a physics and a mathematics qualification obviously restricts the pool of applicants, but nearly all departments regard it as necessary. The number of applications in 2007(2006) was 3700 (3333), with acceptance of 3349(3080), giving a success rate for students finding a place (although not necessarily at their first choice of university) of 91%(92%), compared to a success rate of 76%(75%) for application to all degree schemes. It should be noted, though, that the cohort of physics applicants is rather unusual in its qualifications. Data from UCAS (statistics_online/annual_datasets; excluding cases where tariff is not known) in Figure 6 and Figure 7 show that, despite a general upwards drift in entry qualifications over the past five years (which is matched by an increase in A-level scores, see below), physics entrants are remarkably well qualified compared to the average for degree programmes. In 2007 over 55% had 420 points or over, and less than 4% had less than 180 points. (For comparison, the percentages of the same upper and lower qualifications in all degrees combined are

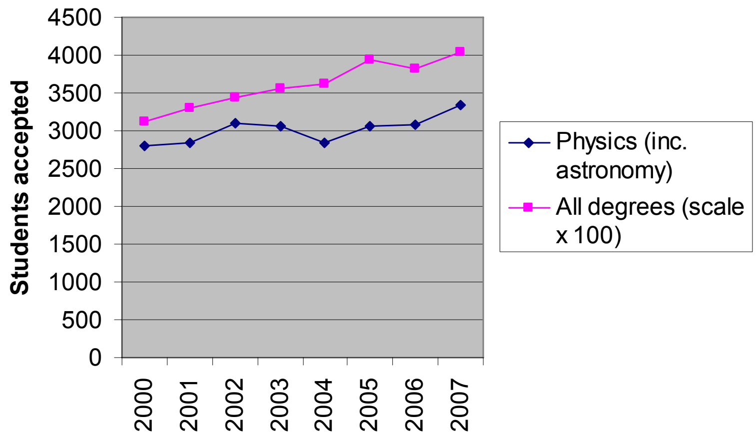


Figure 5 Number of acceptances for undergraduate entry to physics degrees

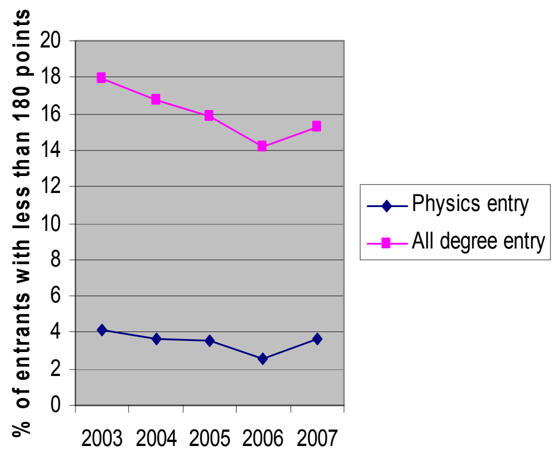


Figure 6 High end of qualifications on entry to degree course

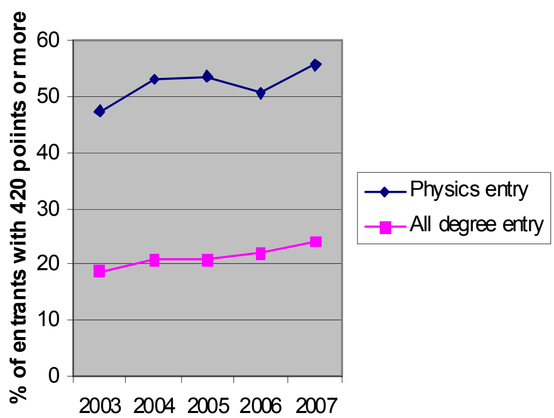


Figure 7 Low end of qualifications on entry to degree course

24%,15%; in chemistry 38%,5%; in mathematics 55%, 3%; in pre-clinical medicine 82%,3%). Based on the UCAS 2007 acceptance numbers, 94% of physics undergraduates enter at age 20 or less, and only 3% are aged 25 or over.

The change in A-level success has been mirrored in the entry qualifications. Based on analysis of the IOP Publication "Physics on Course" from 2001-2008, in England, Wales and NI, comparable data exists for entry to BSc Physics in 35 universities and MPhys/MSci Physics at 31 universities. Over the period 2001-2008, the "typical" A level offer for a place on a physics degree increased by 16% for BSc (typically BCC to ABC or BBB), and by 17% for MPhys (to ABB). By 2008, the published offers for MPhys/MSci ranged from AAA to ABC (universities in the Russell group), and AAA/AAB to BC (non-Russell group), while offers for BSc ranged from AAA to BCC (Russell), and AAA/AAB to CC (non-Russell). Ref for 2008 data: <www.physics.org/UploadDocs/contents/Documents/pdf/physics_on_course_2008.pdf>

[For Scottish Universities, based on Scottish Higher grades, (data from 8 universities for BSc, 4 for MPhys), the average offers increased between 2001 and 2008 by significantly less – 6% and 7% respectively. A rough comparison suggests the current offers are similar to the rest of the UK in terms of A-level grades – averaging BBC and ABB/AAB respectively.]

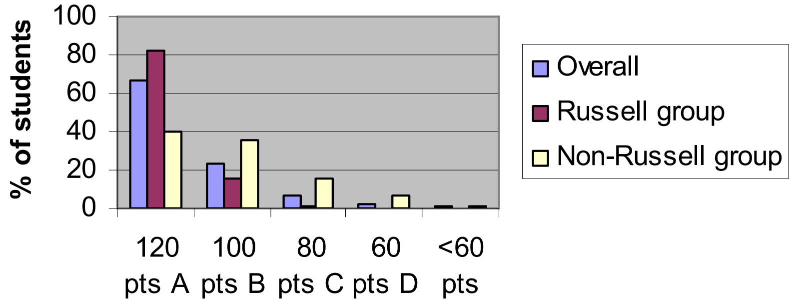


Figure 8 Student survey: highest Physics qualification on entry to course

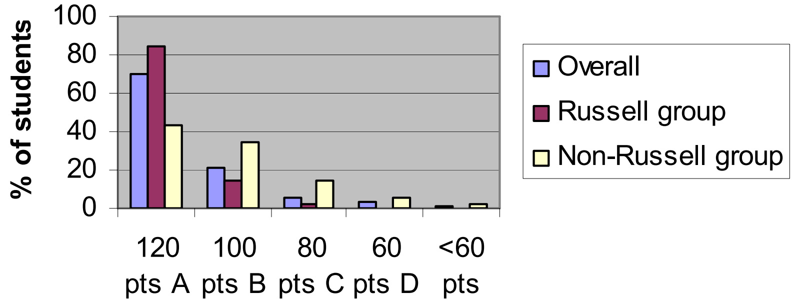


Figure 9 Student survey: highest Maths qualification on entry to course

The maintenance of entrant numbers over the period 2001-2008 (see Figure 5) despite an increase in published entry requirements and *despite an 8.5% decrease in the number of students sitting A-level Physics*, probably reflects an increase in the number of A and B grades awarded at A-level. Based on A-level data from Joint Council for Qualifications <www.jcq.org.uk> the proportion of A grades increased from 24.9% in 2001 to 31.8% in 2008, resulting in a 16.9% increase in the *number* of students with A grades (8% in those with A or B), despite the decrease in examination candidates. Importantly for course entry, there was also a particularly strong increase in the proportion of A grades in Mathematics from 29.3% to 44.0 % – completely overwhelming a slight decrease (2.5%) in numbers of candidates. Over *all* subjects, the number of A-levels sat increased by 10.5% and the proportion of A grades rose from 18.6% to 25.9%.

The average A-level points scores actually obtained by entering students in 2007 (National Student Survey <www.unistats.com>) range from 540 (equivalent to grades AAAA) to 330 (AAB/ABB) for the Russell group, and from 500 (AAAA) to 210 (AB or CCD/CDD) for non-Russell group.

In our student survey, at A-level (or its equivalent) more than *90% had an A or B in Physics, and 91% an A or B in Maths*. The distribution of their physics[stu6] and mathematics[stu7] entry grades are shown in Figure 8 and Figure 9, indicating that on average the Russell group students were better qualified on entry.

Most departments have the option of transferring students from the BSc course to the MPhys/MSci course (or *vice versa*) at the end of the first or second year. To transfer into the MPhys/MSci students will generally be required by the end of Year 2 to achieve a minimum assessment score falling between 50 and 60% - varying between departments, but typically 55% with some discretion for special circumstances.

7. Undergraduate physics courses

Most physics departments offer both MPhys/MSci and BSc degrees, with only four (from non-Russell group universities) offering only BSc (See Appendix 1). Nearly all students (> 93%) are offered a choice, at some stage of their course, as to whether they take a BSc or MPhys/MSci degree[stu82], although acceptance onto MPhys/MSci is typically dependent on a performance in end-of-year assessment as mentioned at the end of the last section. A minority of students (29%) were given the option of taking a BSc or MPhys/MSci with an industrial placement scheme[stu84]. Of those that were not, 70% in the Russell group commented that it would not have been attractive to them, while 50% of those in the non-Russell group said that it would[stu84a].

A large majority of staff[sta61] and students[stu83] think that there is a clear advantage in taking an MPhys/MSci course rather than a BSc, as shown in Figure 10.

The main reasons students[stu83ab] and staff[sta61ab] give, for and against, are shown in Figures 11-14 (multiple choices were allowed).

The value of the MPhys/MSci depends to some extent on students' career aspirations. It is recognized that the extra year prepares students better for their future careers, especially if they plan to do a research degree. The principal disadvantage is the extra cost entailed, which may not be felt to be justified (despite an enhanced educational experience) if the student is not intending to follow a physics-based career.

One finding from the student survey is that *over 80%* of the responding students did NOT

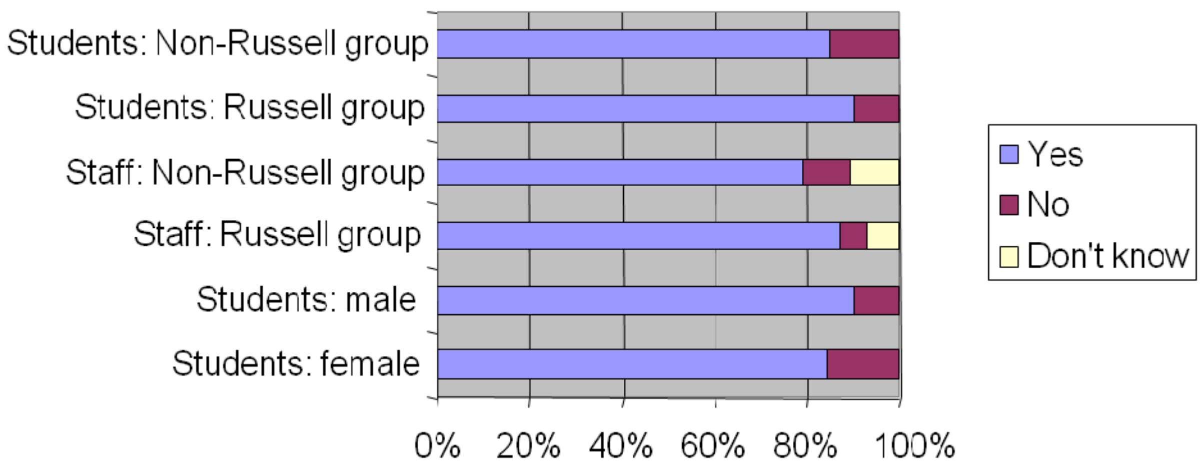


Figure 10 Response to the question of whether there is an advantage in taking a four-year 'M' course rather than a BSc

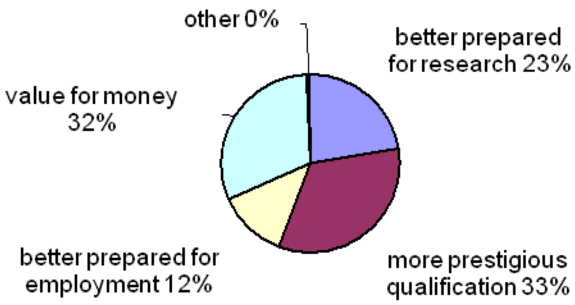


Figure 11 Student reasons for preferring MPhys/ MSci (593 respondents)

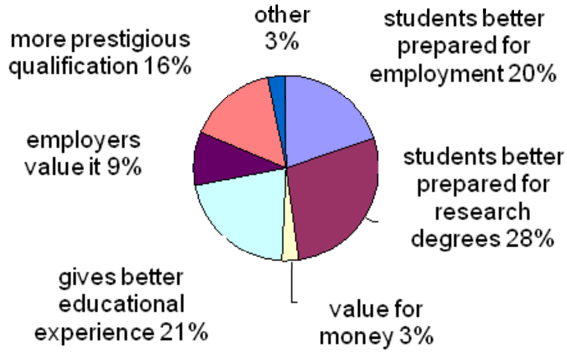


Figure 12 Staff reasons for preferring MPhys/MSci

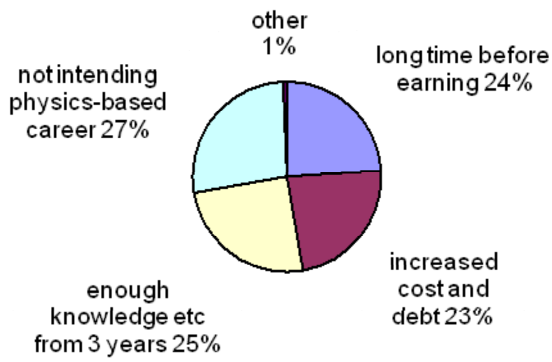


Figure 13 Student reasons for not preferring MPhys/MSci (78 respondents)

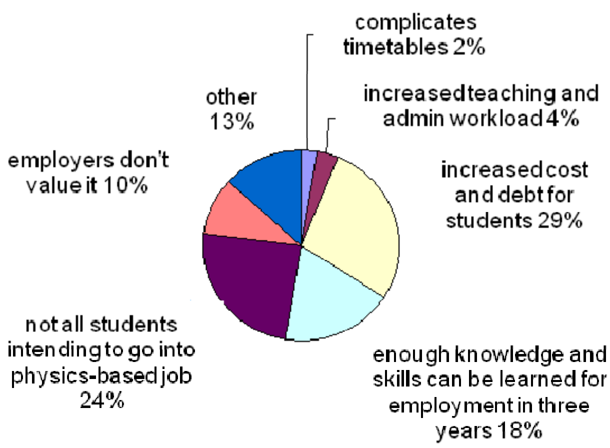


Figure 14 Staff reasons for not preferring MPhys/ MSci

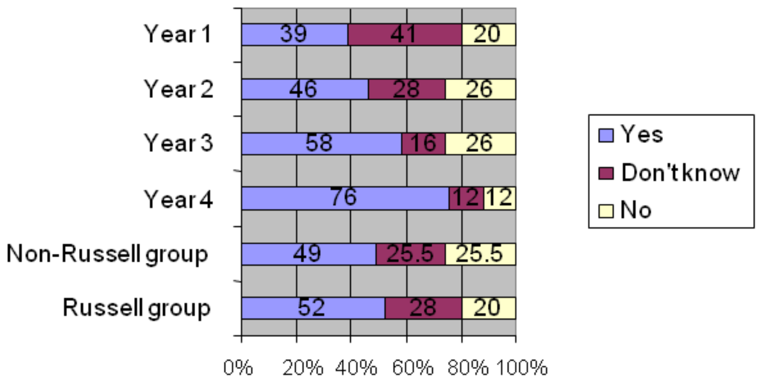


Figure 15 Student response to question[stu89] "Do you think that your course covers enough areas of modern research?

choose[stu103] a physics degree mainly for its employment prospects, a result that is marginally stronger in the Russell group students, but independent of gender. This result echoes a study of the attitudes of Scottish school and university physics students (Research in Science & Technological Education, Vol. 20, No. 1, 2002). N. Reid & E. A. Skryabina report that although the likely career opportunity was a significant factor, by the time university subject choice of physics was made the students' enjoyment of the subject and good grades at school were more important influences.

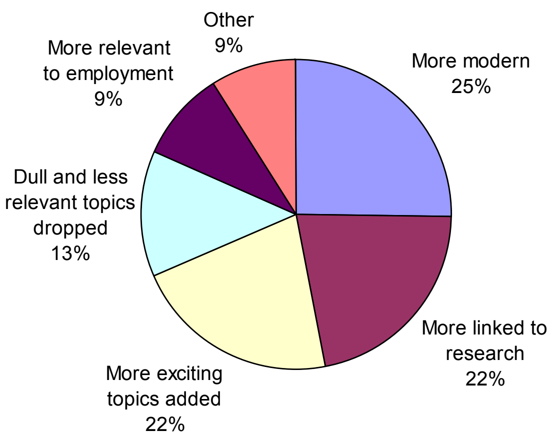


Figure 16 Positive staff views on how curriculum has changed with time

7.1 Curriculum content and review

A large majority of students (82%) find the curriculum/syllabus[stu85] well balanced, with only a few (4%) thinking that it is too applied (4%) or too academic (14%). Around 70% found the mathematics content[stu86,88] of the course "about right", with about 20% finding it "too challenging" – results that are fairly uniform across year and university group. A tenth or less found the mathematics "very straightforward", and about 20% would like more mathematics modules[stu88]. A large majority (93%) of students found[stu87] the mathematics content "useful" or "very useful", the percentage (10%) of those wanting *fewer* mathematics modules[stu88] corresponds well with 7% finding them "not very useful".

Students see more of modern research[stu89] as they progress through their degrees, to a reasonably high level of satisfaction by Year 4 (See Figure 15). It is interesting, though, that 26% of Year 3 students would like to see more. Although a small majority (55%) of staff in the non-Russell group would like more specialist modules[sta70], a larger majority (63%) in the Russell group would not. This could reflect a greater current availability of such modules in the Russell group (perhaps through MPhys/ MSci), or a greater feeling[sta69] of over-specialisation there.

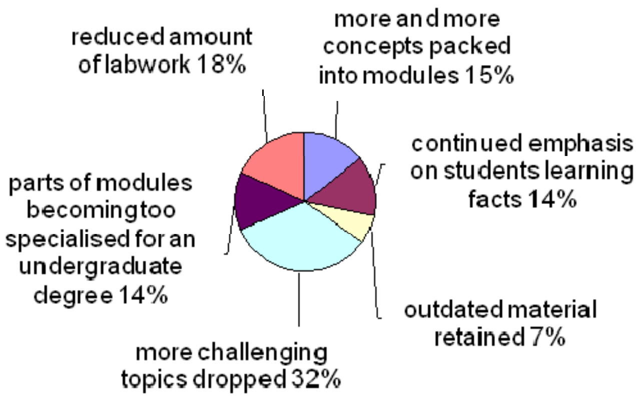


Figure 17 Negative staff views on how curriculum has changed with time

Areas of modern physics which have recently been, or may soon be, introduced into courses include[dotint] nanotechnology; biophysics; quantum information and measurement; with reintroduction of advanced quantum mechanics and fluid dynamics. In some cases electronics and some aspects of semiconductor physics have been reduced or dropped. Around 70% of staff in both university groups who expressed an opinion[sta67] suggested that more modules in advanced mathematics ought to be available, while about 60% also suggested advanced computing.

A very high proportion of staff (~80%) from both university groups have introduced new topics[sta66] into their teaching programme from their own research, while about half have introduced new material from their own scholarship or other workers' research. Staff impressions on improvement[sta68] (Figure 16) and deterioration[sta69] (Figure 17) in the curriculum over the time they had been teaching also gave some indication that the curriculum has been refreshed to include more modern, research-linked and exciting topics. At least half of staff believe that some of the more challenging topics have been dropped, and nearly a third suspect overspecialisation and overcrowding of the courses. The overspecialisation is not seen as such a problem in the non-Russell group. Less than 10% of staff think that the teaching programme has become more relevant to employment.

A few departments involve students (normally through representation) in course or module development[dot2.6.6]. A third of students knew[stu92] that they were involved and nearly a half did not know whether they were or not.

There was an interesting student response to the question[stu90] of whether their course gave enough emphasis to applying basic physics to

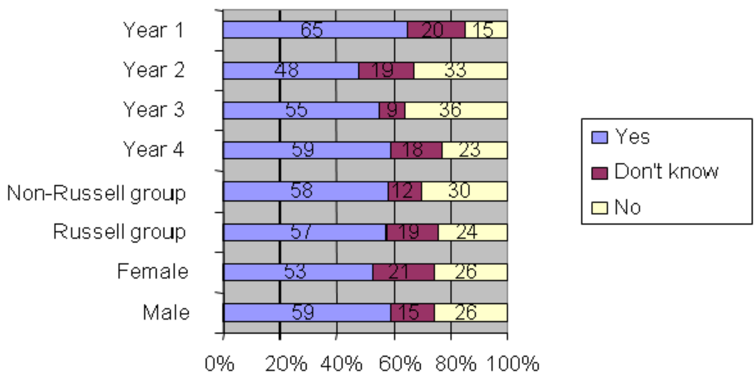


Figure 18 Student response[stu90] on whether their course gave enough emphasis to applying basic physics to more general areas and problems

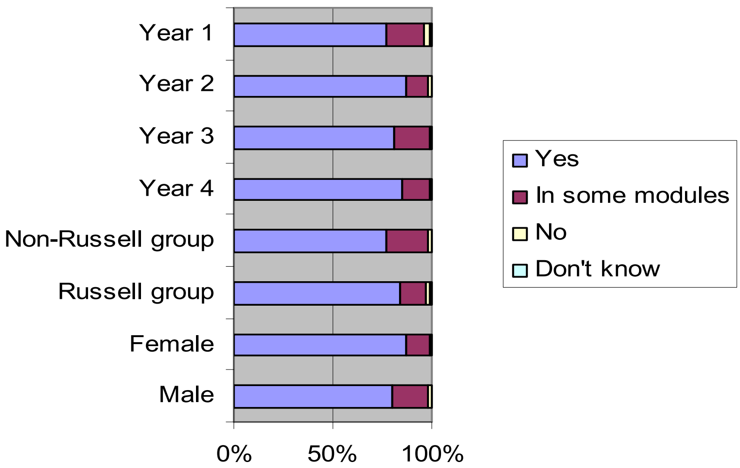


Figure 19 Student response[stu66] to "THIS YEAR, do you believe that you are being sufficiently challenged in your course?"

more general areas and problems. The progression with year of study (see Figure 18) shows that general applications of physics are visible in the first year courses, but perhaps are rather less covered in later years as the courses become more specialised.

Only 3% or less of students thought that they were not being sufficiently challenged in at least some modules in their current year of study[stu66] (see Figure 19), although with the benefit of hindsight[stu67] a higher proportion (8%) felt they could have been challenged more (see Figure 20). BUT among the staff[sta52], as many as one third think that the brightest students are not being sufficiently challenged (see Figure 21). Staff are confident[sta53], especially in the non-Russell group, that the weaker students are being sufficiently supported. (See Figure 22). The student experience of support in their first year[stu71] was not far away from the staff belief – with over 70% feeling adequately supported, although (reversing the staff perceptions) the Russell group students felt more supported than the non-Russell group.

The accreditation of degrees by the Institute of Physics was generally regarded as helpful by staff[sta71] in the non-Russell group (58% yes, 12% no, 30% don't know), with a slightly less positive response from Russell group staff (52% yes, 18% no, 30% don't know). Across both groups[sta72] only 16% of staff definitely felt that the IOP "Core of Physics" for accreditation is

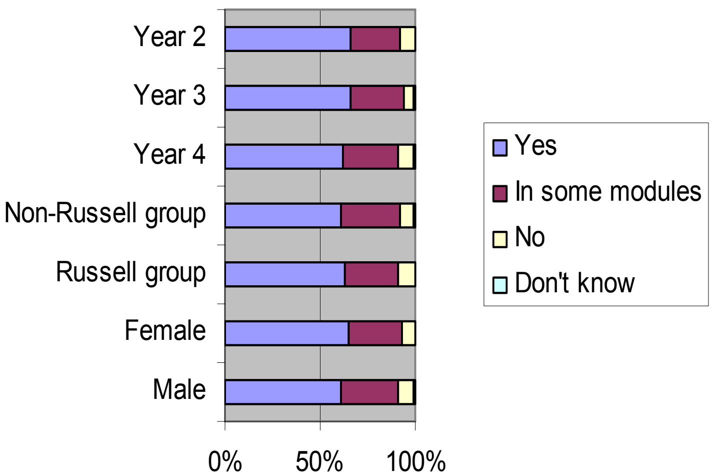


Figure 20 Student response[stu67] to "In previous years do you feel you have been sufficiently challenged"

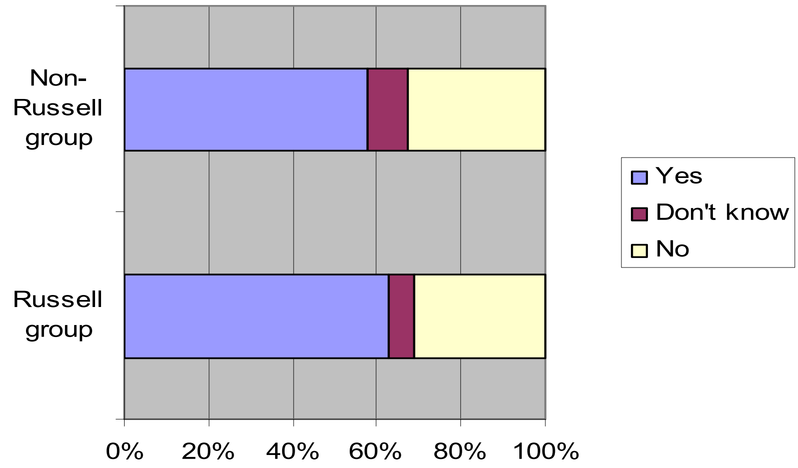


Figure 21 Staff response[sta52] to "Do you believe that the brightest students are being sufficiently challenged in your courses?"

too prescriptive, and stifles development of courses. A significant minority (46% of staff in non-Russell group, 39% in Russell group) regarded accreditation as necessary for maintaining standards[sta73].

7.2 Transition to university

On entry to university 51% of the Russell group students and 21% of the non-Russell group students recall[stu63] taking a test. Of these students, 62% received feedback[stu64], which about half found helpful[stu65] in subsequent studies, and half did not. The testing may have informed the department's teaching style even if it was not of direct benefit to the student.

Nearly 70% of non-Russell group students felt that the *physics syllabus*[stu64] they had studied at school/college had prepared them very well for university physics, but Russell group students were considerably less impressed (see Figure 23). In the case of the *mathematics syllabus*[stu65] 62-63% of students in both groups felt well prepared. Perhaps surprisingly, there was no obvious correlation with physics A-level grade – i.e. the students with higher A-level grade did not feel themselves to be better prepared for the university course. Again, for mathematics there was no major correlation of feelings about preparation with A-level grade, but a larger proportion of those with the lowest grades felt not sufficiently well prepared. Giving their assessment of what would have helped them to perform better on entry to

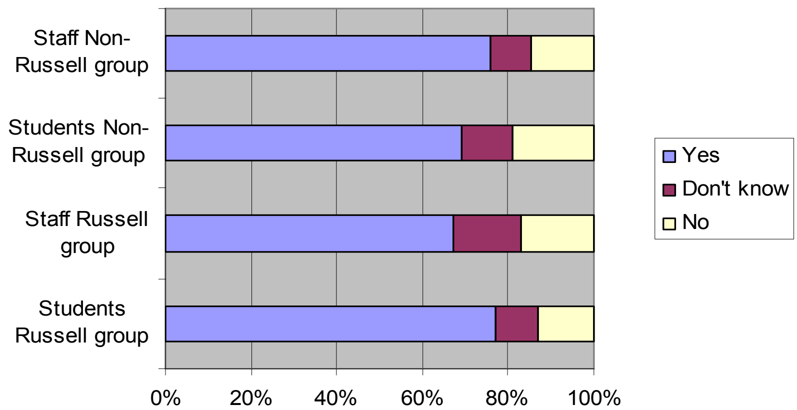


Figure 22 Staff belief[sta53] on whether the weaker students are being sufficiently supported in their courses, together with general student experience during their first year[stu71].

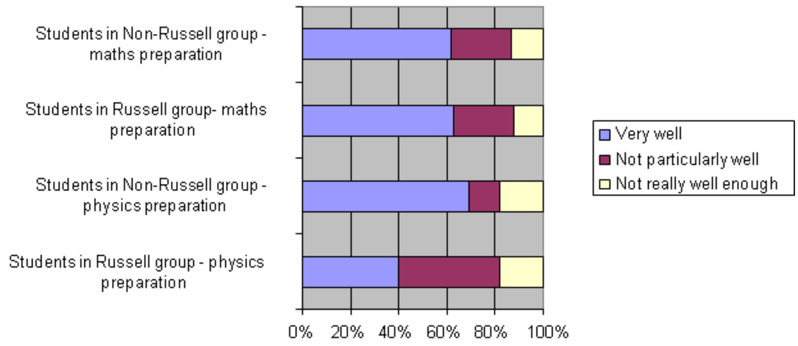


Figure 23 Students' assessment of their preparation[stu64,65] for university physics by syllabus at school/college.

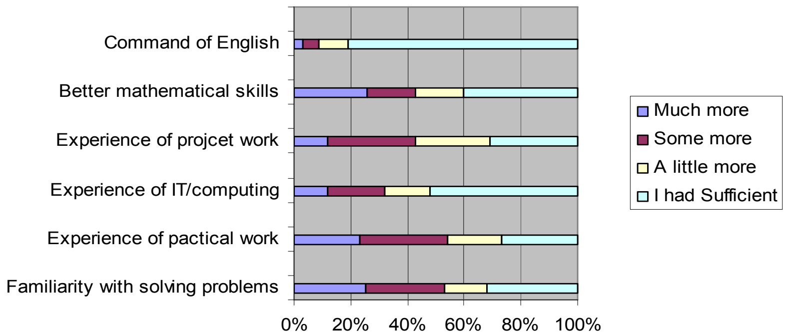


Figure 24 Russell group student response to question[stu68] "When you entered university do you think you would have performed better if you had…"

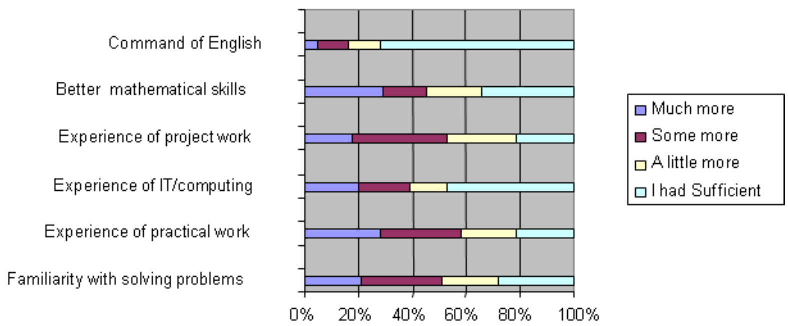


Figure 25 Non-Russell group student response to question[stu68] "When you entered university do you think you would have performed better if you had…"

university[stu68] (see Figures 24 and 25), students acknowledged problem solving, practical work and mathematical skills as necessary, and as areas of weakness. It is interesting that experience of practical work is the main perceived lack, with over half the students wanting more. The non-Russell group students felt slightly less prepared in all these areas except problem solving.

The range of knowledge and experience of students on entry is recognised by staff[sta51] as causing learning difficulties for some students, or problems for teaching. As shown in Figure 26, these concerns echo those of students (see Figures 24 and 25).

In Figure 26 only the staff who have identified problems are included. The student learning

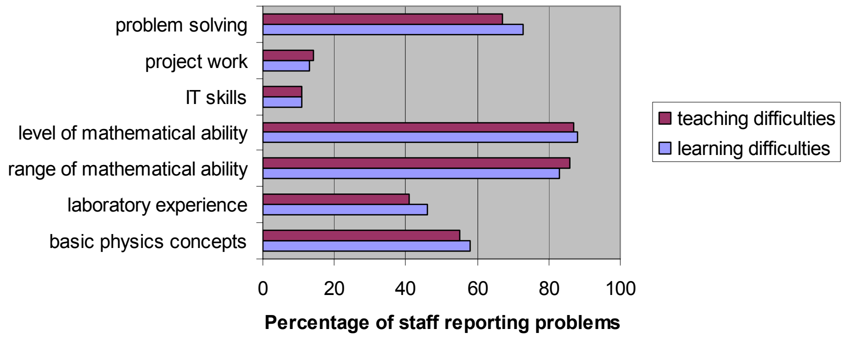


Figure 26 Problem areas identified by staff[sta51]

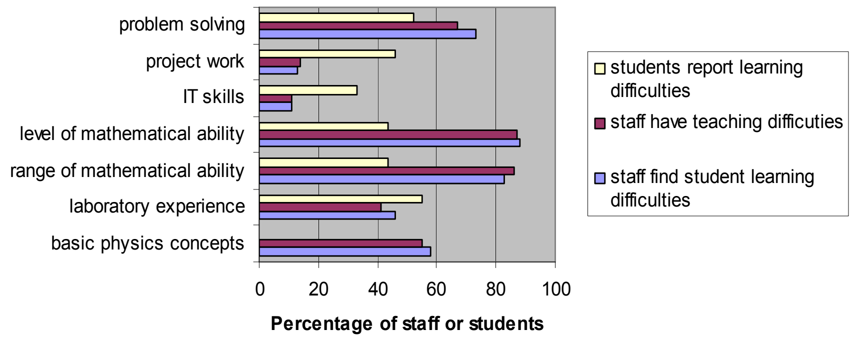


Figure 27 Comparison of student and staff perception of problems at the secondary/tertiary transition

and staff teaching difficulties correspond closely. The most serious problem (reported by over 80% of staff) is the level and range of their mathematical ability. Difficulties with problem solving are reported by nearly 70% of staff. Perhaps unexpected are the problems with basic physical concepts. The lack of laboratory experience re-enforces the widespread view that not enough hands-on practical work takes place in school laboratories. Students do, however, seem to be well prepared in the areas of project work and IT skills. The difficulties identified by staff are much the same across both groups of universities. A comparison with the expressed students' needs (Figure 27) is interesting.

Staff feel the *mathematical* difficulties more strongly than the students, while lack of laboratory experience is more keenly felt by the students. A minority of students (particularly in the non-Russell group) feel a lack of project work and IT skills, although staff do not recognize these as areas of particular weakness.

7.3 Personal tutor and mentor support

Only 8% of students[stu69] did not have a particular member of staff as a personal tutor in their department, and three-quarters of the students[stu69] with experience found the system helpful. A quarter of students said that they did not find the system helpful. This could be the fault of the department, or of the student not making good use of the system, or of the system being inappropriate for some students.

Almost half (49%) of the Russell group students[stu70] had been assigned a student mentor from a later year of the course, a significant minority of these (40%) found this helpful. A much smaller fraction (~10%) of students in the non-Russell group reported being mentored, but they were more positive, with 16 out of 22 finding it helpful – a group that is perhaps too small for real statistical significance.

Asked to indicate which of the following they would consult first if they were having a problem understanding a particular topic, students[stu100] show (see Figure 28) an increase in use of the internet, and a decrease in the use of textbooks from Year 1 to Year 3/4. Student friends are a useful resource for a significant fraction (~1/3) of students. A lecturer or tutor would only rarely be the first port-of-call.

Although a majority of staff (64% Russell group, 55% non-Russell group) said that they were aware[sta48] of the content of the current A-level syllabuses, some 40% of staff are not aware. The claimed awareness is poorest in the youngest age group (45% aware in 20-39 year group; 62% in 40-49; 71% in 50-59; 73% in 60+), with no obvious gender bias. Of staff directly involved in first-year teaching[sta49], 70% of them are indeed influenced in their teaching by the A-level syllabuses. The variation between what students of different Boards and combinations of papers have experienced (resulting in a need for some repetition and duplication) may explain why the influence is not closer to 100%. Only 19% of staff make use[sta50] of students' A-level *scores* when thinking about their particular teaching to first year students. This does not imply that students with low A-level scores are not supported. Many departments do provide support classes (particularly in mathematics) for students with poor A-level scores, or poor performance in diagnostic tests on entry.

7.4 Non-physics modules

Many courses offer the possibility of studying subject modules outside physics and mathematics. We exclude here students on Natural Sciences degrees and first and second year in Scotland where choice is particularly wide. On average 22% of physics students[stu80] do take at least one non-physics/mathematics module in their first year, declining to around 13-15% in their third or fourth year. Russell group students (25%) are considerably more likely to take such modules[stu80] than non-Russell group students (12%). Popular subjects[stu80ai] include chemistry, geological sciences, computing, economics/management/business, European and Oriental languages, and philosophy. At least some choice[stu80a] of which non-physics modules to take was reported by three-quarters of the rather small relevant sample of under 150 students (see Figure 29) and 90% felt[stu80b] that studying a non-physics subject had been useful or very valuable (see Figure 30). Although 71% of staff agreed[sta60] in thinking such modules useful or essential (see Figure 31), the view of 29% that they were unnecessary or a waste of time contrasts with

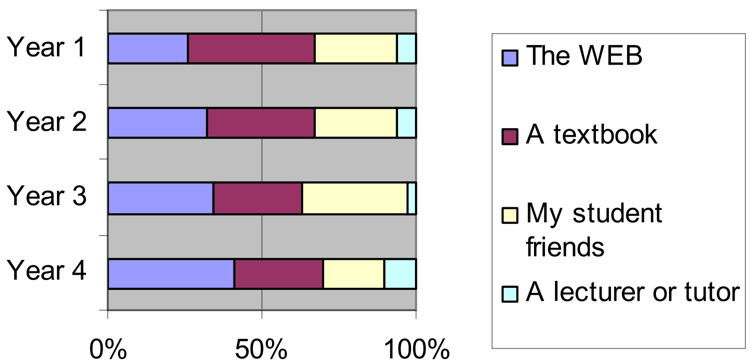


Figure 28 Student response[stu100] to question "If you are having a problem understanding a particular topic, indicate which of the following you would consult first?" ***(Responses comparable in both university groups)***

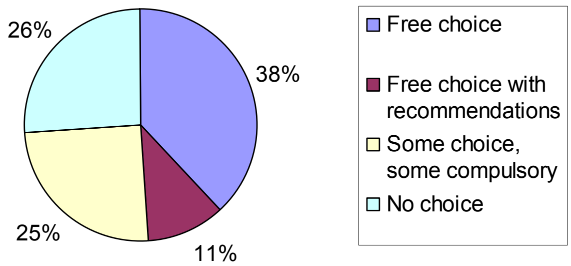


Figure 29: Reported availability of student choice[stu80a] in non-physics modules

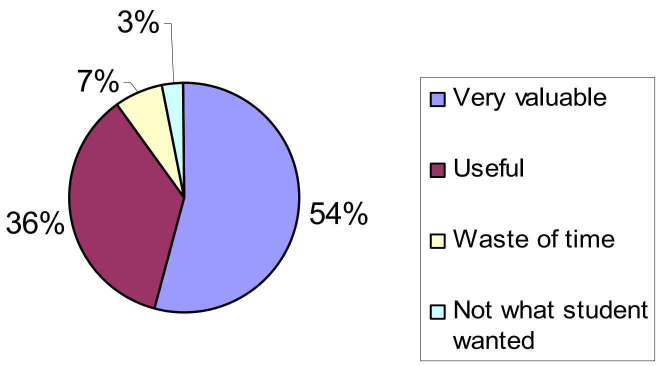


Figure 30: Student views[stu80b] on value of non-physics modules

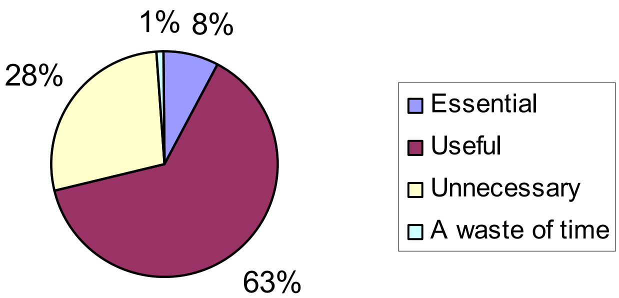


Figure 31: Staff views[sta60] on value of non-physics modules

their popularity with students. Just over half (52%) of the whole student sample would have liked the opportunity to study[stu81] more modules outside physics and mathematics.

7.5 Types of teaching

In considering students' views on teaching it is probably necessary to bear in mind that many will not have experienced a wide variety of teaching methods, and therefore reports of satisfaction, although welcome, may be made in the absence of any true comparison.

Lectures, tutorials and projects are all regarded positively by nearly 90% of students[stu19] (see Figure 32), with tutorials being particularly effective. Not so effective (although still regarded positively by a majority of the smaller group who had actual experience) are group projects and e-learning.

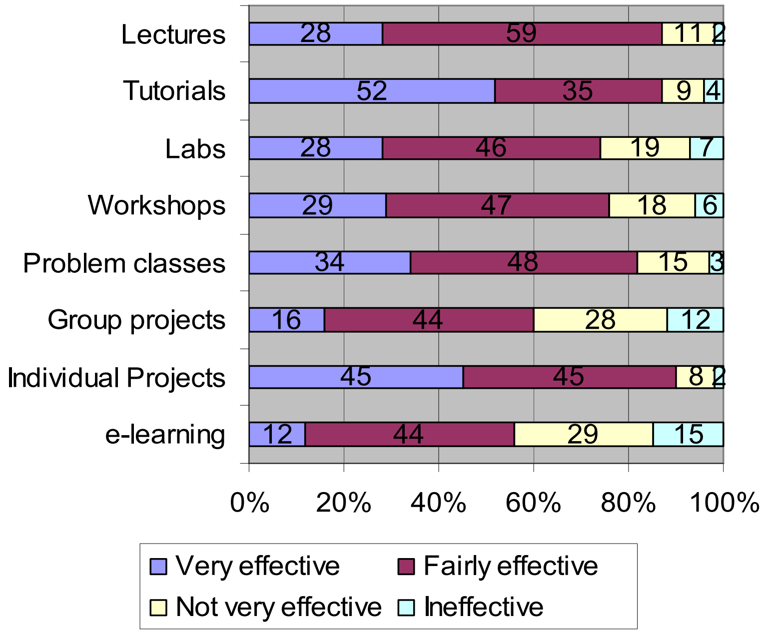


Figure 32 Students' views[stu19] on the effectiveness of teaching methods. (Individual projects refers to the extended projects of Year 3 and 4)

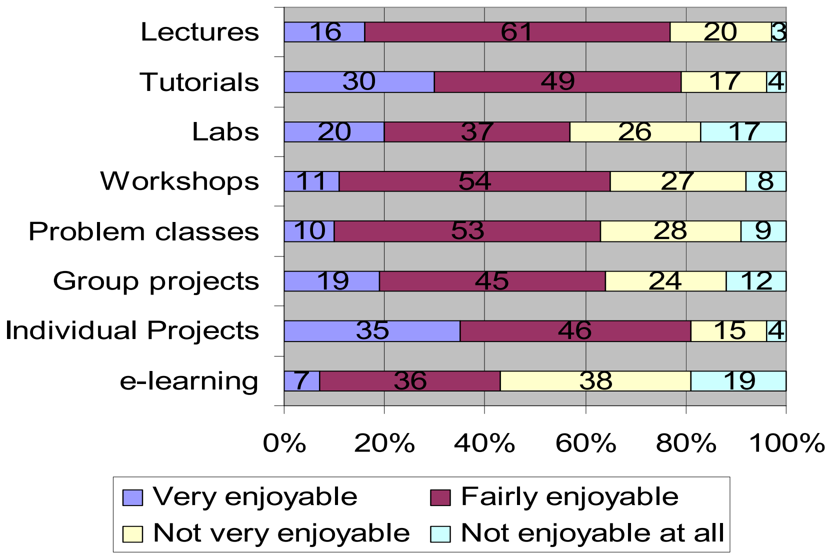


Figure 33 Students' views[stu20] on their enjoyment of teaching methods. (Individual projects refers to the extended projects of Year 3 and 4; replies have been eliminated where there was no experience of a particular method)

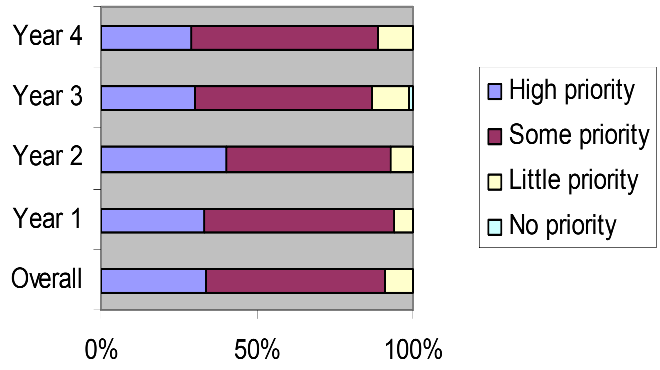


Figure 34 Student opinion[stu97] on the priority that most of their lecturers/professors give to teaching

There is a slight indication that tutorials and e-learning are more effective in Russell group (90%,60% positive students compared to 85%,49% in non-Russell group) while lectures are seen as more effective in the non-Russell group (91% positive compared to 84%). The reaction to laboratories is comparable in both groups.

When asked how enjoyable[stu20] they found the different teaching methods (see Figure 33), lectures, tutorials and projects were popular, e-learning less so. The similarity of responses on "Workshops" and "Problem Classes" may mean students are not distinguishing between the two.

It is encouraging that 90% of students think[stu97] that staff give at least some or high priority to teaching (see Figure 34). It may be that teaching is not the highest priority for all staff, but only 10% percent or less are thought to give it low or no priority. The increasing (but still small) "little priority" result from Year 1 to Year 3 may reflect more "research oriented" staff giving the specialist lectures in later years, or departmental policy to target good lecturers to Year 1 courses. There were no significant differences between the student views in both university groups. Most students are aware[stu98] which of their lecturers/professors are active researchers. The awareness increase from 68% and 73% in Years 1 and 2 up to 86% and 91% in Years 3 and 4, as progressing students evidently get to know staff better by later years. A similar increase in awareness is clearly seen in student opinion[stu99] (Figure 35) on whether the research work in their department had directly enhanced the teaching and learning they experienced as undergraduates. The responses are very similar (to within 2%) for both university groups, and it is clear that at least 60% of students are aware that research has enriched their education of by the time they graduate.

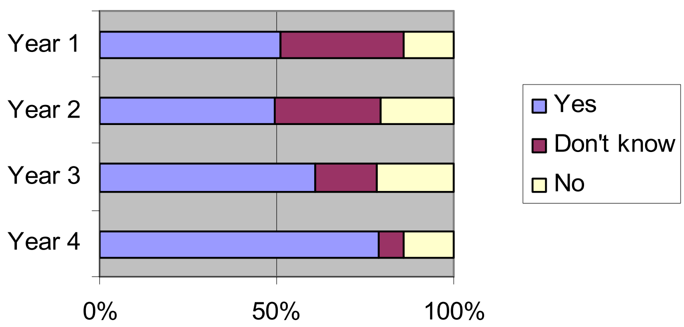


Figure 35 Student response[stu99] to the question "Do you think that research work in your department has directly enhanced the teaching and learning you have experienced?"

Table 1: Student summary[stu101] of their experience of the majority of teaching on their physics degree course

	Excellent	Good	Satisfactory	Poor
Overall	**30%**	**54%**	**13%**	**3%**
Year 1	31	58	10	1
Year 2	27	55	15	3
Year 3	27	50	16	7
Year 4	38	51	10	1
Russell group	33	53	12	2
Non-Russell group	24	56	15	5

When asked to summarise their experience[stu101] (Table 1), only a very small number of students (~3%) rate the majority of teaching on their course as less than satisfactory. The proportion of "Excellent" and "Good" combined is similar in both Russell group (86%) and non-Russell group (82%). It may be significant that "Excellent" and "Good" ratings both decrease from Year1 to Year 3, but revive in Year 4.

7.6 Organisation of teaching

Independent of university group, a large majority of staff[sta12a] (78%) felt that they were consulted on the *amount* of teaching they were committed to, and[sta12b] (87%) on the *topics* they preferred to teach. A rather lower percentage[sta12c] (52%) felt they were consulted on the teaching methods to be used, although this may simply mean that half the time the teaching methods are left for the member of staff to decide for themselves. Younger members of staff felt they have slightly less influence on their 'teaching load' and 'topics taught'. The oldest (and by implication most experienced) staff were the most likely to be left alone to choose their own methods. The level of consultation reported by female staff was significantly higher (by a few percentage points) than that acknowledged by male staff.

7.7 Feedback on teaching and teaching quality

The collection of feedback from students about the quality of teaching is almost universal, with only 5% of staff[sta44] not seeking feedback on a frequent basis, and less than 1% never doing so (see Figure 36). Essentially all departments have formal feedback schemes[dot2.6.1]. Similarly, there is almost always a student representative for each year on a departmental staff/student or

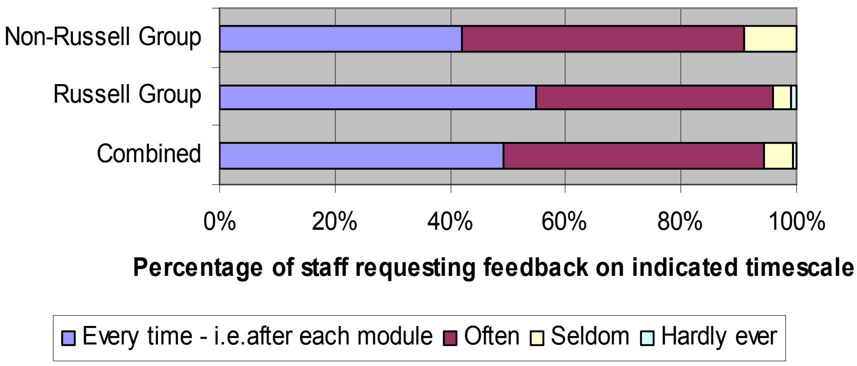


Figure 36 Frequency with which staff[sta44] request feedback from students on their teaching. The frequency may in some cases be fixed by departmental or university regulations

teaching committee, and 90% of student[sstu91] are aware of this representation. For staff[sta44a], 63% still use paper forms as the most popular way of obtaining student feedback, probably because this is cheap, easily administered, and offers a better means of control for their completion. There is some suggestion[dotint] that response rates can plummet when electronic systems (used by 27%) are introduced, unless they are direct (e.g. by "clickers" in a lecture). Questionnaire "fatigue" can also be a problem[dotint]. A number of staff (8%) prefer the more personal direct verbal approach, but this does not maintain the anonymity of replies, and may therefore dissuade some students from commenting.

About half of students (see Figure 37) believe that notice is taken of their comments[stu93] and Russell group students feel they are listened to more than non-Russell group students do. It is perhaps of concern that by the third and fourth years about a quarter still feel that they have little influence. Despite this residual student scepticism, over 90% of staff[sta45] across both groups find student feedback helpful in improving their teaching, at least sometimes (see Figure 38), endorsing the value of student feedback on teaching.

Over half of staff[sta46a] (56%) discuss the feedback they obtain with their students, but a fifth rarely do. Cross-correlation (with[sta45]) shows that staff who rarely or never discuss the feedback with students still find the feedback helpful in improving their teaching. The youngest age group of staff are considerably more likely (70%) to discuss the feedback with students than their mid-career colleagues, but female staff (46%) less likely than male (58%). Discussion between staff[sta46b] is more common, with over 80% of staff saying that they generally discuss student feedback on their teaching with colleagues. The fraction declines slightly with age, but there is none of the mild gender bias shown over discussion with students.

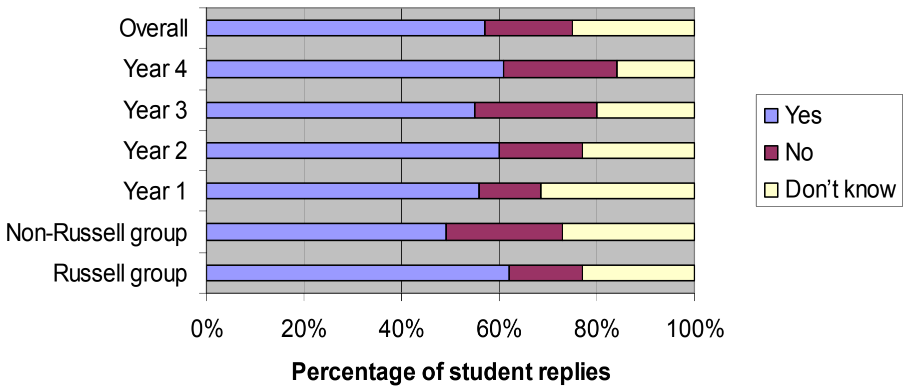


Figure 37 Student views[stu93] on whether the department/school/university takes notice of the comments they make on teachers and teaching methods via questionnaires, staff/student panels etc.

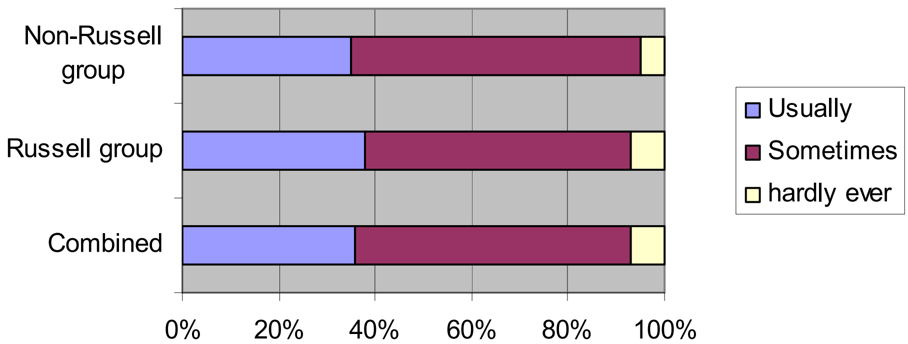


Figure 38 Staff views on whether they find student feedback useful in improving their teaching

8. Teaching and learning methods

8.1 Lectures

Lectures continue to be a major teaching method in physics. They appear to be reasonably effective, with students regarding them[stu26] as usually (70%) or sometimes (24%) time well spent. A half of physics students claim[stu21] to attend all lectures, and 44% claim to attend most. Only 6% of students find lectures unhelpful or rarely attend them.

Although 79% of staff provide[sta18] prepared notes always or sometimes, nearly 90% of staff expect students to be making some kind of notes[sta17] of their own (46% expecting full and 42% partial notes), and not to just rely on the material provided. In the Russell group, 52% of staff say that they always provide notes, but the percentage falls to 39% in the non-Russell group. Although full notes are popular with students (see Figure 39), the majority of students (58%) actually prefer[stu22] to make their own, or to have only skeleton notes provided. Preference for making own notes increases slightly from Year 1 (29%) to Years 3 and 4 (37%).

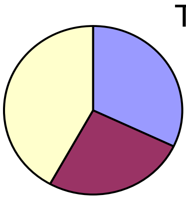


Figure 39 Student preferences[stu22] on lecture notes

Where notes are provided, 51% of staff hand them out[sta18a] before, 32% during and 17% after lectures, which matches rather well the student preferences[stu23] of 48%, 39% and 13% respectively. The majority of students (72%) would like[stu24] any notes to be provided both in hard copy and on the internet or a VLE, rather than just as hard copy (17%) or just electronically (11%). Most staff (84%) are now using electronic posting[sta19] either always or for at least some notes.

Workshops or tutorials are often[sta20] (but not always) used to back up lecture material, and only a very small percentage of staff[sta21] (less than10%) do not allocate additional supporting work or study material. The recommendation of particular papers/sections of books for student reading (i.e. other than a book list) is slightly less common, but 80% of staff are providing[sta22] student support this way, at least 'sometimes'. The additional study material is usually (11%) or sometimes (52%) followed up by the students[stu25], but around a third never or only rarely do so.

The physical estate of formal teaching facilities is good, with Directors of Teaching[dot2.4.1] rating 66% of lecture rooms and classrooms as "excellent, modern teaching space with all facilities available", 26% as "reasonable accommodation with most facilities available" and only 9% as "teaching rooms in need of refurbishment and additional facilities"

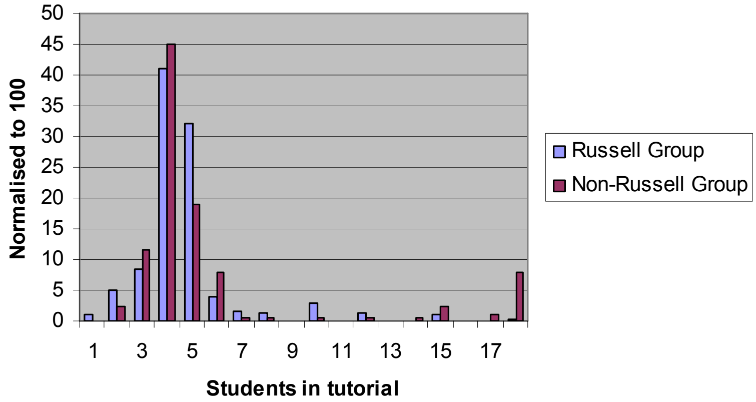


Figure 40 Tutorial group size, as experienced by students[stu27a] (excluding Oxbridge). No attempt is made to account for the slight numeric effects of responding students in the sample who may share tutorials. The furthest right hand bin is 18 or more students

8.2 Tutorials, workshops and problem-solving classes

A large majority of staff (86% in the Russell group, 80% in the non-Russell group, and irrespective of gender) believe[sta23] that it is essential for students to experience small group teaching. It is perhaps surprising that 20% of staff in non-Russell group universities are unconvinced, given that students (see Section 5.5 above) regard small group tutorials as particularly effective.

8.2.1 Tutorials

We define a tutorial as the interactive teaching of a small group of students by an academic. They are less formally structured than a lecture and may involve academic discussions, professional and personal development activities, or skills development. Students experience[stu27]a a median tutorial group size of 4 in Russell group departments, with 10 and 90 percentiles at 3 and 6. This excludes Oxbridge students, where the median size is 2. For the non-Russell group the median is 4, the same as for the Russell group, with the same lower 10 percentile of 3 but an upper 90 percentile of 15 (see Figure 40).

The student medians of four correspond very well to staff opinions on the optimum size[sta24] for small group teaching (see Figure 41). The plot shows a preference for smaller groups in the Russell sample, although both groups clearly peak at 4 students. The median for the

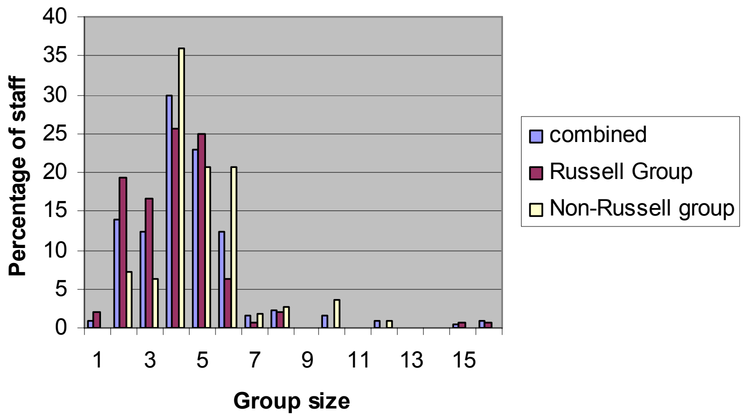


Figure 41 Staff opinion[sta24] on the optimum number of students for small group teaching

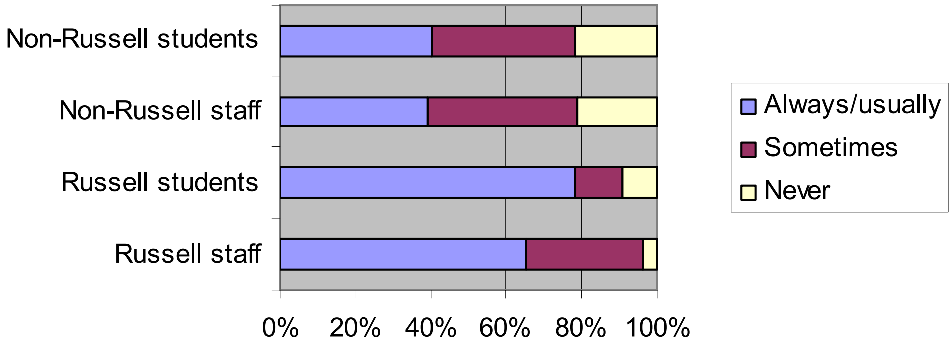


Figure 42 Frequency of setting work prior to tutorials: staff practice[sta25] and student perception[stu29]

combined and Russell groups is 4 students, with 10 and 90 percentiles at 2 and 6. The non-Russell group's staff median is slightly higher, falling exactly between 4 and 5, with 10 and 90 percentiles at 3 and 6.

Students are often set work to do in preparation for tutorials, the practice being a little more common in Russell group departments (see Figure 42). Student perception follows the staff practice fairly well. To understand the kind of work set, we define "exercise based" as looking up material, algorithmic solving of standard problems, while "problem-based" involves more open-ended investigations requiring deeper thinking, and that may not lead to definite answers. There is remarkable consistency of student views[stu30] across years and institution group that the set work is about 63% exercise-based and 37% problem-based. Staff[sta25a] suggest the split is actually rather more even at 54%:46%, again consistent across institution groups. Essays are only set by 6% of staff. Tutorials also provide an important opportunity to answer student questions based on coursework and lectures.

8.2.2 Problem solving classes (other than tutorials)

Most physics departments arrange problems classes at which students work at solving problems, supported by advice from staff, postdocs or research students. Only 4% of staff[sta26] in non-Russell group universities and 9% in Russell group reported that such classes were not provided in their department, in reasonable agreement with the 8% of students who had not experienced[stu19e] problems classes by Year 3. Their effectiveness, if not their enjoyment, is fairly highly rated by students (see Figures 32 and 33 above). This view is echoed by staff[sta28] across both university groups, of whom 59% think that they are effective in developing problem-solving ability for all or most students, 37% think them effective for some, and only 4% think that they help few students. Half of the students[stu29] report that work is usually set prior to problem classes, with a further quarter having work set sometimes, and a quarter never. There is a wide variety in the number of students[stu27a(ii)] in problem classes (see Figure 43), with a median of 25.

8.2.3 Workshops

Workshops are usually interactive student classes aimed at developing skills, typically involving less preliminary student work[stu29] than tutorials or problems classes. Staff report[sta30] their use particularly for problem solving, IT and technical (e.g. mathematical) skills, and as such there is certainly overlap in student experience with problem classes. The size of group[stu27a(i)] is variable, with a median of 25 (see Figure 44). Overall about two-thirds of students have experienced[stu19d] workshops, with laboratory classes evoking rather similar response on their effectiveness (see Figure 32 above).

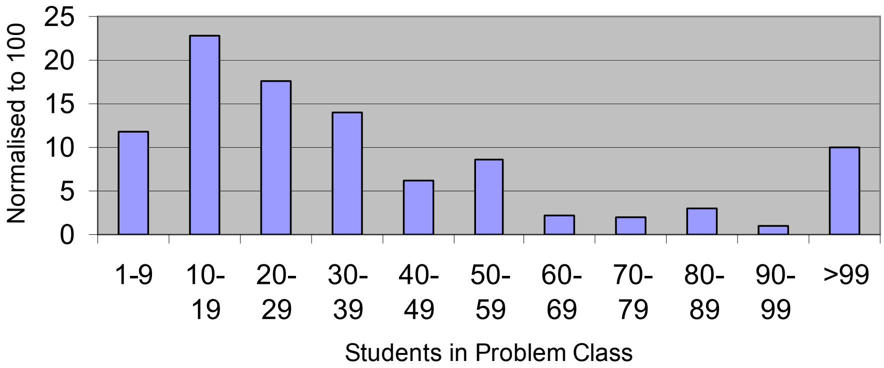


Figure 43 Student experience of the group size[stu27a(ii)] for problem classes. The largest groups here probably represent sessions where an entire module cohort has a problems class instead of a lecture.

8.3 Group work

About three-quarters of students have found working in groups[stu46] to be good for learning, interesting and stimulating, but there is considerable dissatisfaction with the assessment of group work – with about one-half (54% of those with experience) considering it not fairly assessed. Group assessment will be considered further in Section 9 below. Asked how much time students would like[stu47] to spend working in groups, there was no clear mandate for change, with 25% wanting more, 20% wanting less, and 55% content with current allocations.

8.4 Laboratory Work

Nearly all physics students undertake at least some laboratory work in their first two years. The percentage of students with no allocated labs[stu31] (e.g. pursuing only theoretical options) rises through the four years as 4%;6%;26%;45%. For those with labs, the average hours allocated each week vary between institutions and in general increase steadily from Year 1 to Year 4. The distributions are shown in Figure 45, and the medians and percentiles are given in Table 2.

During the first two years students find[su36] they typically spend an extra two hours outside the laboratory completing associated tasks, such as writing up experimental reports. Ten percent

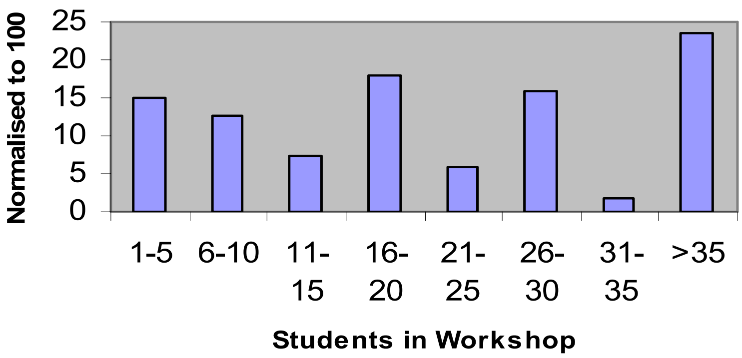


Figure 44 Student experience of the group size[stu27a(i)] for workshops. Only one student reported a class size of larger than 40 students.

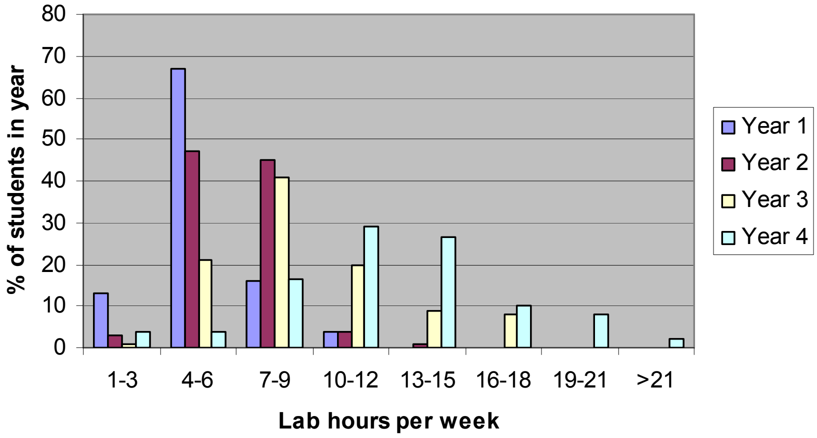


Figure 45 Average hours[stu31] of student laboratory time allocated each week

of students will spend an hour or less, and ten percent more than 5 (Year 1) or 6 (year 2) hours. In Year 3 and 4 expended laboratory time will become confused with work on individual projects.

A remarkably high 99% of students claim[stu32] to attend all (89.3%) or most (9.3%) scheduled labs. There is a very interesting increase in students' perception[stu33] of the importance in lab work in their study of physics as their course progresses (see Figure 46), with over half recognising it as essential and nearly 90% recognising it as either essential or important by the last two years. Around 70% of students (increasing to 80% in Year 4) find labwork helps[stu34] in understanding theoretical concepts.

Guidance on learning in the laboratory is given[stu37] about equally by a textbook (or manual) and direct instruction/demonstration, with occasional use of IT demonstrations. During their first three years, about 63% of students find queries always or usually answered to their satisfaction[stu41], rising to 85% in Year 4 – i.e. during advanced project work. But at least a third of students in the earlier years find queries are only sometimes dealt with adequately.

Student experience[stu39] is that freedom of choice in selection of experiments increases through the course (see Figure 47). The non-Russell group is slightly more prescriptive. The majority (60%) of students are happy[stu38] with laboratories being held at fixed times, although 21% would prefer a choice of times, and 19% would like freedom over an extended period of opening.

The type of labwork preferred[stu42] by students shows a development towards "open-ended" investigations as their confidence in their practical ability increases over the course (see Figure 48). This is particularly marked in the progression to Year 4 of an MPhys/MSci.
A mixture of methods of assessment[stu51] of laboratory work is used throughout physics

Table 2 Statistics of average hours of student laboratory time[stu31] allocated each week.

	Median allocated hours	10% percentile	90% percentile
Year 1	5 hours	3 hours	8 hours
Year 2	6	4	8
Year 3	8	6	14
Year 4	12	7	16

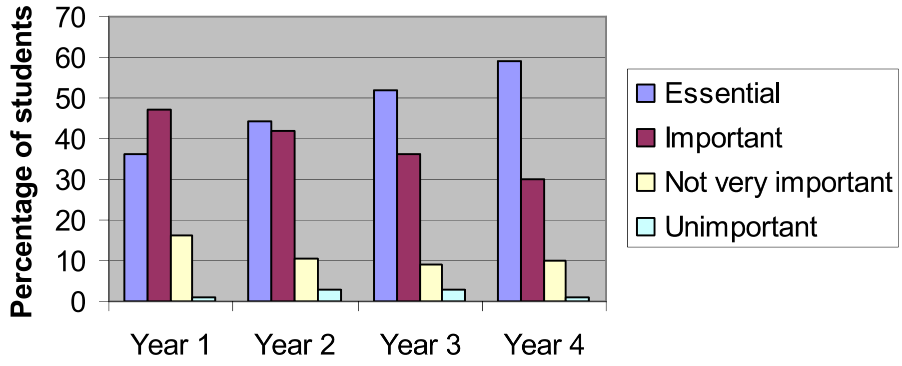


Figure 46 Student views[stu33] on the role of lab work in their study of physics

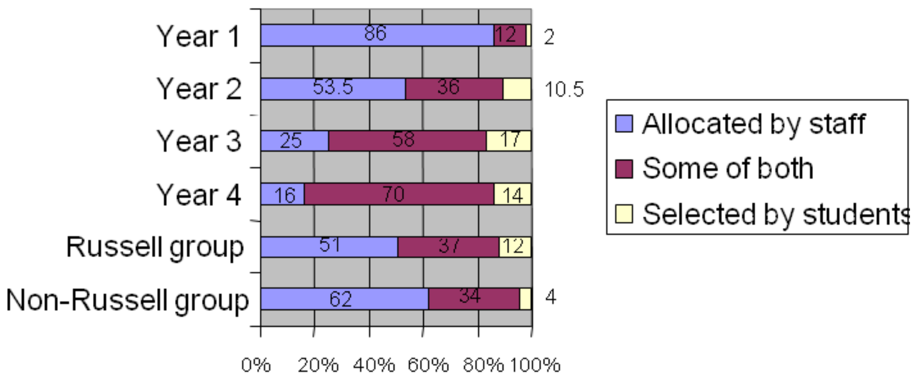


Figure 47 Student experience[stu39] of allocation of experiments

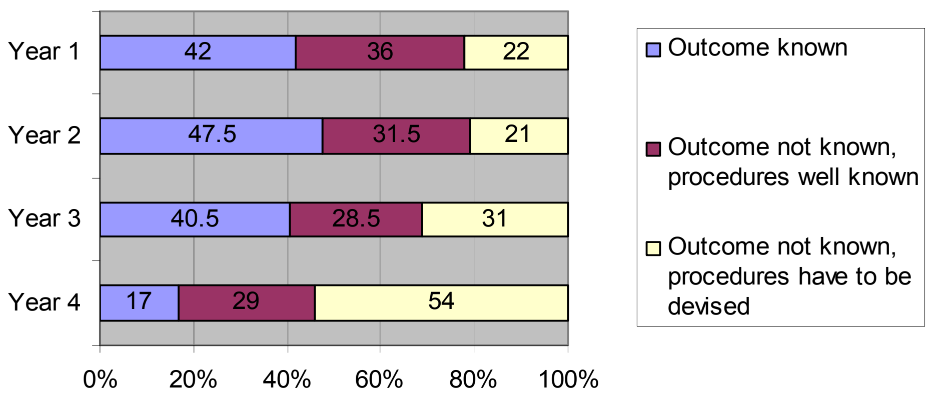


Figure 48 Student preference[stu42] for type of laboratory work.

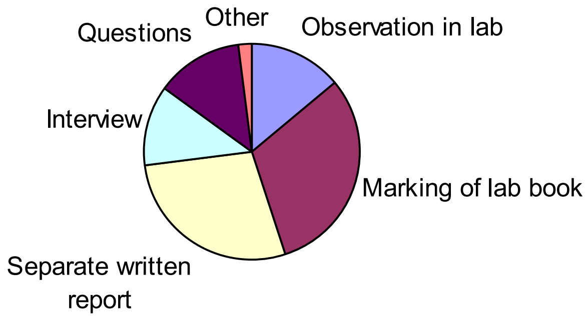


Figure 49 Methods of marking of laboratory work. This overall mixture of methods reported by students[stu43] does not vary by more than a few percent between years, although the particular mix may vary between and within individual departments.

degree courses (see Figure 49). Student confidence[stu44] in whether the scores achieved in the lab accurately reflect their skill as a laboratory worker increases during their course (see Figure 50). This may contribute, (along with realisation of the importance of practical work, Figure 46, and increased confidence in practical skills, Figure 50), to the trend increasing with year of student views[stu45] on how much lab work assessment should count towards a degree (see Figure 51). Further consideration is given to assessment in Section 9.

Students' attitude[stu40] to the time spent on laboratory work changes through their course, with a clear increase in satisfaction in later years, probably the impact of individual project work (see Figure 52). Over half of students believe their time in the laboratory to be well spent. There is obviously a range of views since a small but significant percentage (~10%) think that not enough time is spent to fully develop their practical skills, and others – around a third by Year 3 - think labs take up too much time. A significantly smaller proportion of staff (~9%) than students feel that too long is spent in the laboratory. (Staff opinions[sta29] on practical work are also shown in Figure 52). Proficiency is the lab[stu35] is thought of as being important or essential in getting a job by 75% of students, not-very important by 22%, and unimportant by only 4%. These percentages change very little with progression through the course, or with university group.

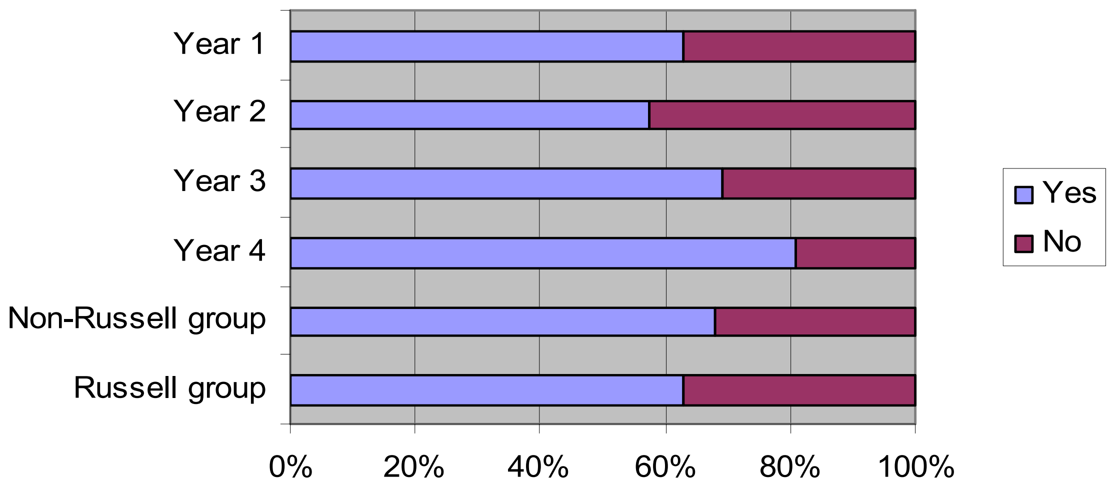


Figure 50 Student views[stu44] on whether the scores achieved in the lab accurately reflect their skill as a laboratory worker

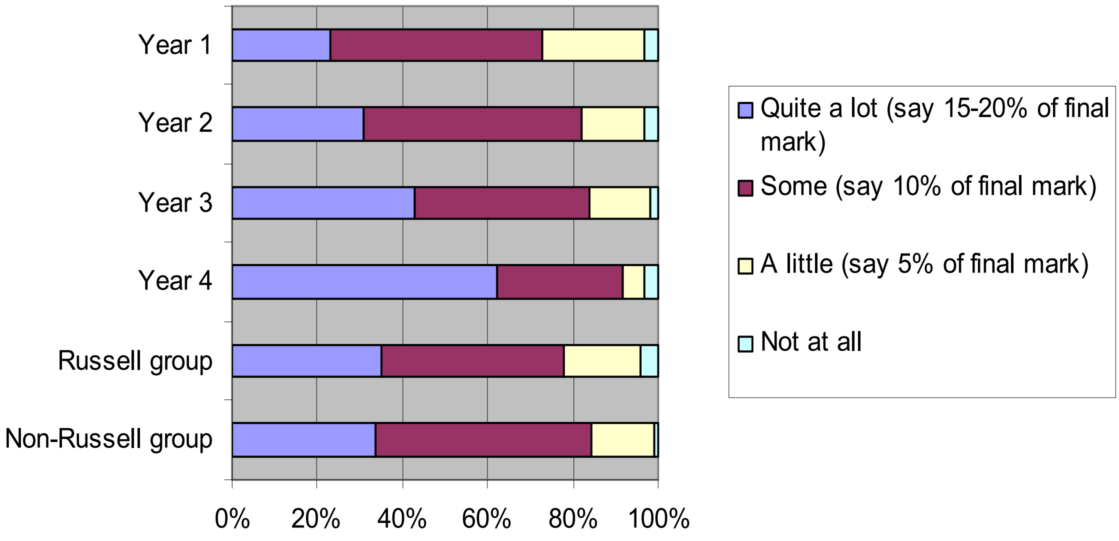


Figure 51 Student views[stu45] on how much lab work assessment should count towards a degree. (Year 4 lab work is likely to be project work.)

8.5 Feedback to students

There is remarkably close agreement between staff[sta47] and students[stu59] that feedback on student work should be individual, during the module and preferably written, although oral feedback is also appreciated, particularly in the Russell group (see Table 3).
The value of feedback is endorsed by 70% of students feeling[stu61] that the feedback they received does help them to learn better, while only 10% believe that it does not, and 20% are unsure.

The regularity of feedback decreases slightly from Year 1 to Year 4, as might be expected if students are to develop as independent learners. In Year 1 24% of students[stu60] were receiving feedback on all modules, but 39% reported having feedback on either only a few or no modules (other than overall assessment marks). By Year 4 this has grown to 57%. Some feedback, such as discussion of project or

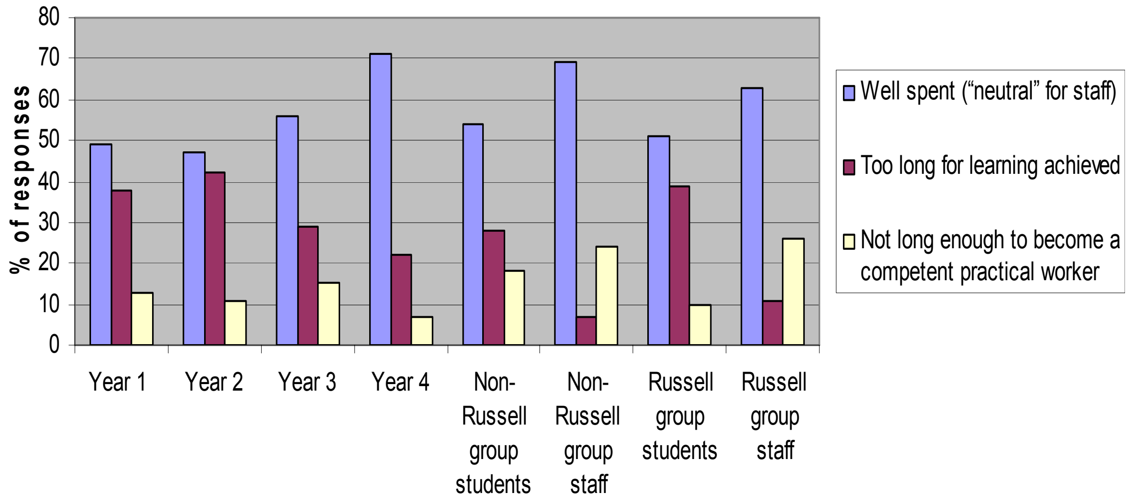


Figure 52 Student[stu40] and staff[sta29] attitudes to student time spent in the laboratory. The staff answer choice was "neutral" rather than "well spent".

Table 3 Student[stu59] and staff[sta47] views on what kind of feedback is most appreciated by students

	Type of feedback	Detailed individual feedback or general group performance?	When in module/ course?
Students, Non-Russell group	Written: 66% Oral: 34%	To Individual: 98% To group: 2%	During: 92% At end: 8%
Staff, Non-Russell group	Written: 66% Oral: 34%	To individual: 93% To group: 7%	During: 88% At end: 12%
Students, Russell group	Written: 59% Oral: 41%	To individual: 97% To group: 3%	During: 89% At end: 11%
Staff, Russell group	Written: 56% Oral: 44%	To individual: 90% To group: 10%	During: 80% At end: 20%

laboratory work, may simply not be recognised as feedback by the students. Overall, 23% of students in the Russell group and 21% in the non-Russell group claimed they had no regular feedback. The return of marked student work was felt to be either always or usually prompt enough to be useful by 64% of students[stu62], only sometimes promptly enough by 26%, and almost never by 10%. It is clear that the majority of students are benefiting from feedback, but its full potential is not being realised for a minority that may be as large as a third.

Most staff (60%) in both university groups provide[sta36] (at an appropriate time) written model answers to the coursework that they set. A further 23% provide them sometimes, and less than one-fifth (17%) never.

8.6 Learning outcomes

A learning outcome is the specification of what a student should be able to do as the result of a period of specified and supported study. Learning outcomes should not simply use terms such as ‘understand’ or ‘appreciate’, but should indicate how students can demonstrate their understanding or appreciation. Learning outcomes are now very widely used in tertiary education to specify what should be achieved by students on a module, and obligatory for most university programmes.
(A guide to writing learning outcomes may be found at: <www.heacademy.ac.uk/assets/ps/documents/primers/primers/ps0091_writing_learning_outcomes_mar_2005.pdf>)

Directors of Teaching confirm[dotint] that physics staff are required to provide learning outcomes for all course components, and staff do provide them[sta15] for most modules. Awareness of the provision of learning outcomes (see Table 4), is not universal, although over three-quarters of students and over four-fifths of staff are aware that they are provided for all or a majority of modules.

Substantial numbers of students (71%) do use[stu15] learning outcomes at least sometimes to find out what they are expected to know and understand from each component of the teaching programme, but a fraction do not – one third in Russell group, and one fifth in the non-Russell group. Male students are more likely NOT to use them (32%) than female students (23%). When students were asked[stu16] if they thought it worthwhile providing learning outcomes for every module of the teaching programme, 86% in the non-Russell group and 75% in the Russell group answered yes, again implying that they are valued, if not always used. About 30% of students were not aware[stu18] which learning outcomes were being assessed, perhaps echoed by the 37% of staff[sta35] who do not find leaning outcomes even “sometimes” helpful in setting assessments. It is interesting

Table 4: Staff[sta15] and student[stu14] awareness of the provision of learning outcomes for their courses.

	Provided for all modules	Provided for the majority of modules	Provided for a few modules	Not provided	Don't know
Students: Russell group	49%	25%	10%	9%	7%
Staff: Russell group	66%	13%	1%	7%	13%
Students: Non-Russell group	49%	31%	10%	4%	6%
Staff: Non-Russell group	82%	11%	2.5%	2%	2.5%

that nearly 80% of the youngest staff age group do find the learning outcomes helpful for setting assessments at least some of the time, while over 40% of all three older groups do not. It may be that increased experience and familiarity with courses leads to less reliance on formal criteria. It certainly seems that many staff are not universally convinced of the value of learning outcomes to the extent that they routinely link them to their teaching[sta16], with only 50% in the Russell group and 56% in the non-Russell group regularly drawing students' attention to learning outcomes, and emphasizing their value.

8.7 Educational technology

A summary of the opinions of those students who had experience of modern presentation methods can be made by grouping "very helpful" and "helpful" responses into "positive" and "not particularly helpful" and "definitely not helpful" into "negative". The views over the four undergraduate years are indicated in Figure 53. The categories are as follows: "PowerPoint" refers to presentational software in lectures[stu102a]. There is a clear decrease in effectiveness from Year 1 to Year 4. It may be that this kind of presentation is less suited to

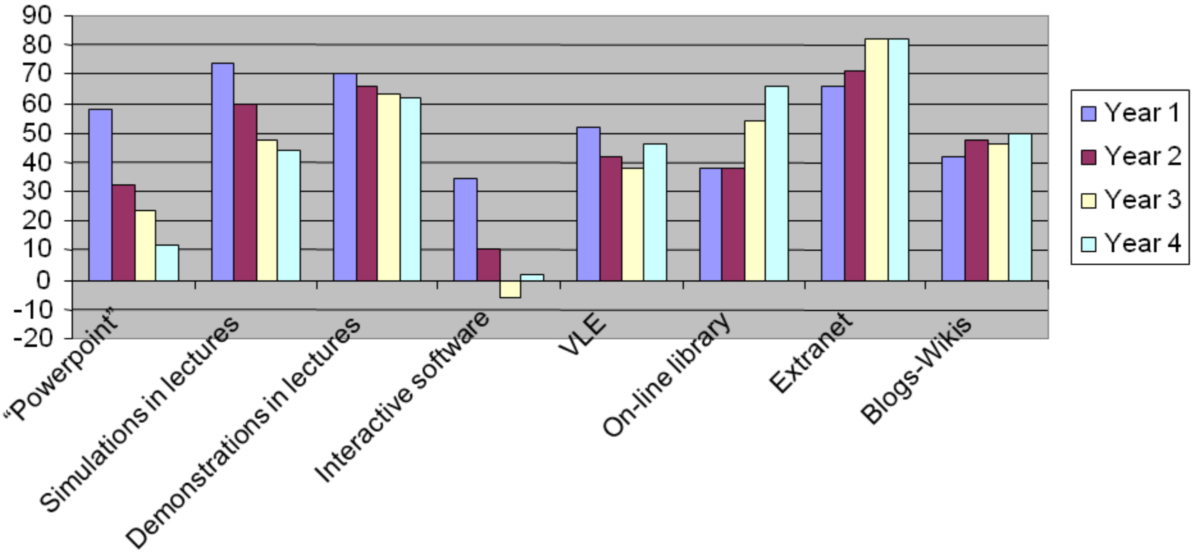


Figure 53 Student views[stu102] on modern presentation methods. What is shown is the percentage of positive responses minus the percentage of negative responses, from students with experience of the method. More details of the methods are given in the text.

advanced material, or is not being used appropriately. Very few students (<4% in Year 1, and none by Year 4) had no experience.

"Simulations in lectures" refers to computer simulations or videos in lectures[stu102b]. In general found quite helpful, particularly in early years. Experience increased from 87% of students in Year 1 to 97.5% in Year 4.

"Demonstrations in lectures" refers to experimental demonstrations[stu102c], traditionally acknowledged as a valuable method, but resource-intensive. They are much appreciated by students, although some 10% of students in Russell group universities, and a significantly larger 20% in non-Russell, claim never to have seen one.

"Interactive software" refers to interactive educational software or computer simulations on the internet[stu102d]. These are regarded as only moderately successful, and one third of students have no experience.

"VLE" refers to teaching material on a Virtual Learning Environment or university intranets[stu102e]. Fairly helpful, but one quarter of students have no experience.

"On-line library" refers to on-line student access[stu102f] to the university library, and hence to journals. It is evident that this becomes more useful as students use it more in later years, particularly in project work. Usage increases from 62% of students in Year 1 to 87% in Year 4.

"Extranet" refers to use of external internet resources[stu102g]. Valuable, particularly in later years – again probably as project work increases. By Year 3, 95% of students have experience, 99% by Year 4.

"Blogs-Wikis" refers to interactive web-based discussion forums[stu102h], from the department or outside. One-third of students have no experience, but the majority (~70%) of students who have tried find them helpful.

The declining student enthusiasm for presentational software (e.g. PowerPoint) is echoed by staff views[sta82a], where 54% do not think it has improved their teaching and only 24% think it has, with 22% not sure. Staff views[sta82b] on whether it has enhanced student learning are even more lukewarm, with 55% thinking it has not, 17% that it has, and 28% not sure. It must be concluded that there are disadvantages as well as advantages in this type of educational technology.

Less than one-fifth of staff definitely feel that the introduction of other educational software[sta83] has significantly improved their teaching or enhanced their students' learning, and around half definitely feel that it has not. It may be that educational software in physics is not being widely used, is intrinsically rather ineffective, or is not being used properly. Staff response[sta84] to the introduction of VLEs is not as positive as the students' view, with only 8% in the Russell group and 30% in the non-Russell group feeling that VLEs had significantly enhanced student learning. The lack of a really positive response may reflect a genuine uncertainty among staff rather than lack of experience, since almost every higher education institution has invested heavily in this type of system to provide additional learning resources for students. Some 58% of staff in the Russell group and 39% in the non-Russell group remain unsure of the educational benefits, but this may well change with more experience over the next few years.

9. Independent learning, transferable and study skills

The balance between teaching and independent learning in physics courses is found[stu72] to be about right by over three-quarters of students, particularly by Year 4. The remaining quarter of students split about equally in wanting more and less formal teaching. There is no strong student gender bias (see Figure 54). Although a clear majority of staff[sta59] feel the current balance is about correct, there is (particularly in the non-Russell group) a significant view that there should be *less* formal teaching and more independent study – and very few staff (< 4%) feel there should be more formal teaching (while 13% of students might like this). There are probably two reasons for the slight differences of staff and student viewpoint here. The first is that (as will be shown in Section 8 below) students are not currently fulfilling *staff* expectations on the amount of independent study that *staff* believe is necessary for a good understanding of the subject. A second factor may be the pressures on staff time.

For coursework (e.g. examples sheets) there is an almost equal (58%:42% in the Russell group, reversed to 48%:52% in non-Russell group) split in students[stu73] who would prefer to work on their own, and those who would prefer to work together. The overall (combined) nearly equal split of 54%:46% does not change significantly through the course, or with gender (52%:48% for females, 55%:45% for males). Project work is popular. Across years and institutions a majority of students[stu74] (~62%) think that the amount of project work in their course is about right, with 23% wanting more, and 15% wanting less. By Years 3 and 4, when they have substantial experience, only 11-12% want less. Staff certainly perceive project work as very valuable educationally. In reasonable accord with student views, 84% of staff[sta54] think there is about the right amount, with 13% wanting more, but only 3% wanting less.

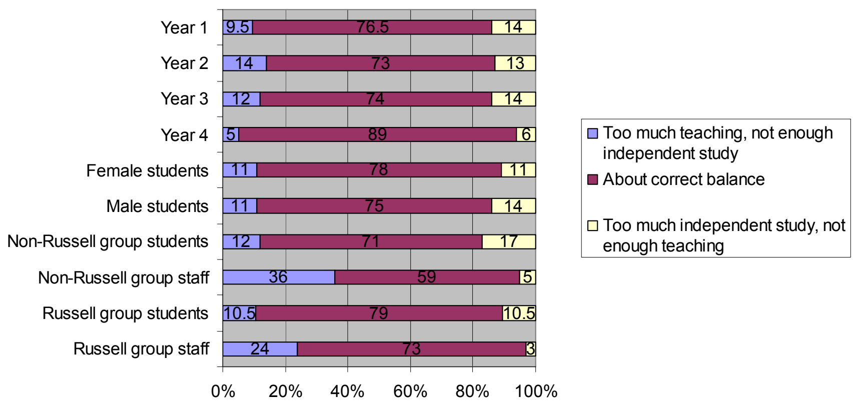


Figure 54 Student[stu73] and staff[sta59] views on the balance of teaching and independent study

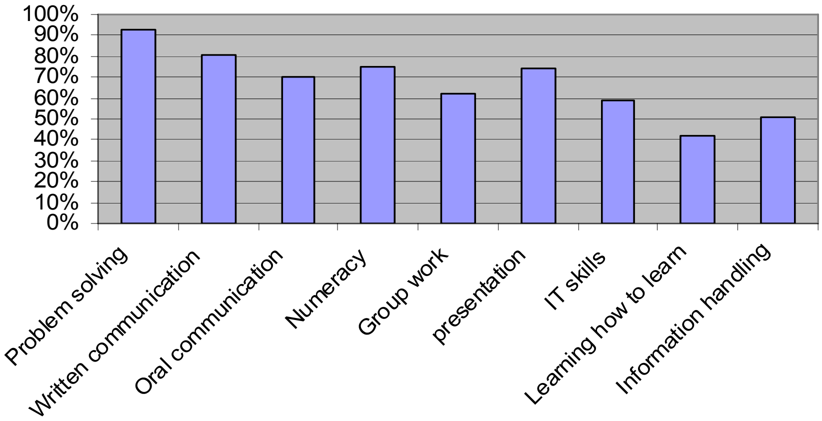


Figure 55 Percentage of staff[sta62] that report deliberately including particular transferable skills into their teaching

Staff rely heavily on their own research work[sta55] for devising and running student projects, with only 3% of staff in the Russell group and 7% in the non-Russell group never doing so. Overall 74% of staff always use their own research, and 21% sometimes. This is a strong argument for retaining staff interest in research, even in less research-intensive departments

Only 32% of university staff think[sta58] students understand what is meant by an "independent learner", while more (39%) think they do not and 29% are not sure. It may be significant that by Year 3, only a half of students feel[stu76d] they have been sufficiently developed in "learning how to learn". Although a majority of students (66% by Year 3) report[stu75], that they have been provided with advice or training on how to develop their study skills, a third say they have not. In spite of this, 71% of students felt[stu79] by Year 3 that they *had* developed their study skills enough to do well in their degree course, and 73% felt they had developed their study skills enough to continue[stu79a] learning as necessary during their future professional lives. (The latter percentage had reached 76% by Year 4). This does, however, leave around a quarter of students who do not develop, or do not have confidence that they have developed, sufficient independent study skills to help them both during and after their degree course. It will be seen in the next paragraph (Figure 57) that 'learning how to learn' seems to be given the lowest priority by staff in embedded skills teaching. Consideration should be given to provision of some simple additional (and perhaps optional) help in developing student study skills from the very beginning of courses.

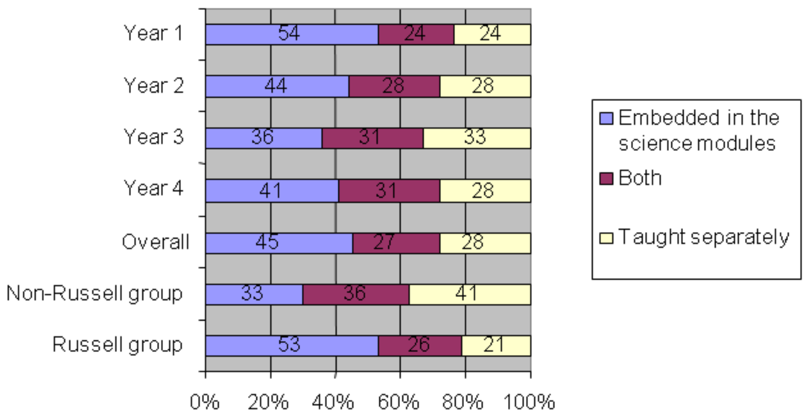


Figure 56 Student recognition[stu77] of where transferable skills are taught

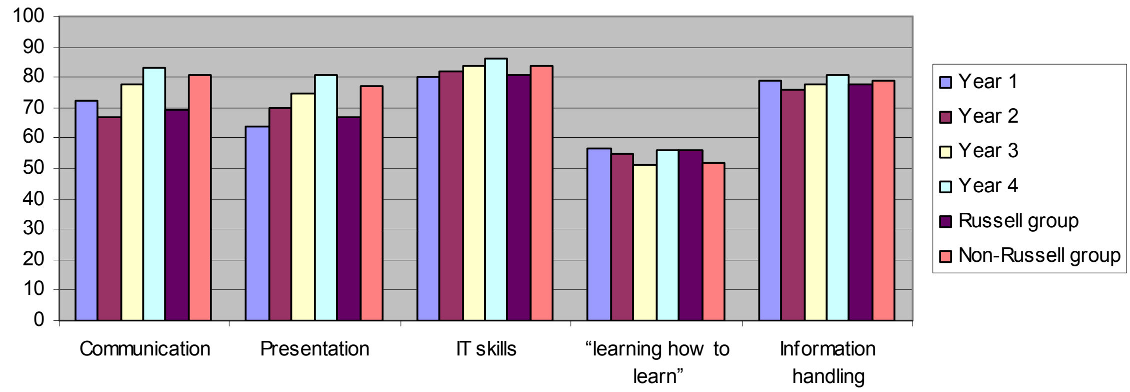


Figure 57 Percentage of students who feel[stu76] they have been given sufficient exposure to particular transferable skills during their course.

There is a strong belief among staff[sta65] that transferable skills should not be taught completely separately from physics (only 2% would disagree), but should be embedded within physics modules (23% of staff agree), taught through project work (18%) or through both of these, with some separate teaching where necessary (57%). In both university groups, just over half (52%) of the staff think[sta64] that transferable skills are better taught within the department, with 42% supporting a joint approach from both within and outside the department. Only very few (~6%) would opt for outside teaching only. The support for a joint approach may lie in the fact that most physics staff (62% in the Russell group, 55% in the non-Russell group) believe[sta63] they themselves have acquired the ability to facilitate student learning of transferable skills, without training; while nearly a third have had training. Only a tenth of staff felt that they had not been given training that they felt necessary. A very high proportion of staff is including[sta62] the development of transferable skills alongside physics teaching (see Figure 55). The embedded teaching is recognized by students[stu77] (see Figure 56), with specific skills-development sessions increasing in later years. It appears that non-Russell group students experience more of their skills teaching separately.

A large majority of students[stu76] feel that they have been sufficiently exposed to transferable skills development in their course, and the percentage increases with year (see Figure 57). The comparatively lower satisfaction on study skills "learning how to learn" has been mentioned above.

By the final years of their course, 21% of students in both university groups believe[stu78] that the inclusion of skills teaching has enhanced their educational experience, with a further 48% percent believing it has enhanced their experience to some extent. About 30% remain unconvinced throughout their course.

10. Student workload

Students were asked[stu8,stu9] to estimate how much time they would spend each week during term on formal teaching (including labwork), on other coursework (e.g. assignments), on private study (reading, extra examples etc), paid work, and other activity which might enhance their CV (e.g. voluntary work). The medians and percentiles are given in Table 5, and the distributions shown in Figures 58-62. It is clear that there is a large variation between individual students.

The combined total of the medians for "Formal Teaching", "Coursework" and "Private Study" in years 1, 2, 3 and 4 is remarkably constant at 26½, 26½, 25½ 26 hours per week. There is a shift in later years away from formal teaching to private study (work outside of formal teaching increasing as 7, 8, 9, 11 hours per week). Since no separate question was asked about project work, some students may have omitted to declare this in Years 3 and 4, while others may have included it in coursework or private study – therefore the overall hours of work, particularly in the last two years, should be treated with caution. The figures also make no allowance for (often considerable) time overheads in moving between classes, laboratories, tutorials etc.

Most physics students, at least in this sample, apparently do not undertake paid work during the term (see below), and the amount of CV-enhancing activity is also small on average. Table 6 gives details with a slightly different binning than Figure 61. Some 80% of physics students are not in paid employment during term, while around 4% work more than 15 hours per week. There is no strong trend with year of study, except a marginal trend for a slight increase (~6%) in undertaking paid work during Year 3. There is a slight indication that physics students in non-Russell group universities undertake more paid work than Russell Group physics students.

For the surveyed physics students the paid work take-up of 20% is much less than the average of 42% for all students (based on a 2600 student survey reported in

Table 5 Student estimates[stu9,stu9] of the time spent in various learning and other activities during a typical week of term. The upper figure in each entry is the median in hours, and the brackets give the lower 10 percentile and the upper percentile (e.g. 80% of Year 1 students spend between 14 and 25 hours in formal teaching.)

	Formal teaching	Coursework	Private study	Paid work	Other (voluntary)
Year 1	19.5 (14 – 25)	5 (2 – 14.5)	2 (0.5 – 9.5)	0 (0 – 9)	0 (0 – 4.5)
Year 2	18.5 (14 – 24)	5.5 (1.5 – 15)	2.5 (0.5 – 10)	0 (0 – 6)	0.5 (0 – 6)
Year 3	16.5 (10 – 25)	5.5 (1.5 – 16)	3.5 (0 – 10)	0 (0 – 11)	0.5 (0 – 7.5)
Year 4	15 (6.5 – 24.5)	6 (1 - 20)	5 (0.5 – 15)	0 (0 – 6.5)	0.5 (0 – 10)

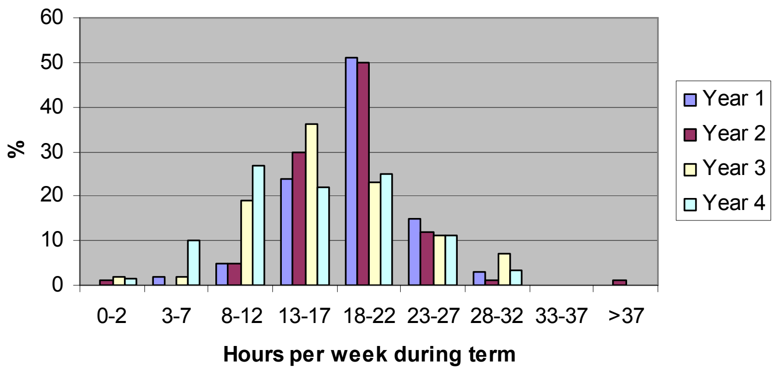


Figure 58 Student estimate[stu8] of formal teaching (including labwork) workload.

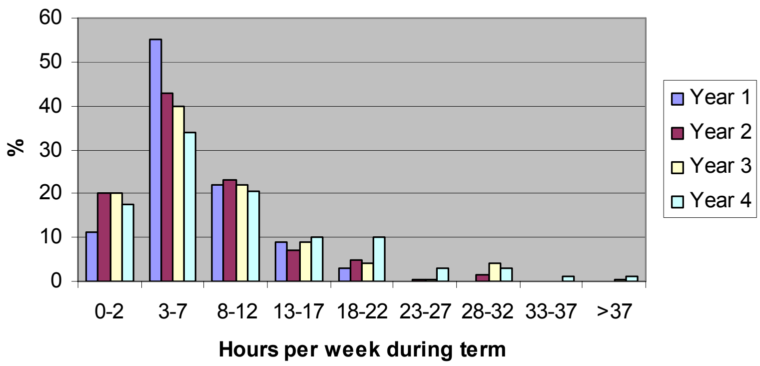


Figure 59 Student estimate[stu9] of study time spent on coursework (assignments etc.)

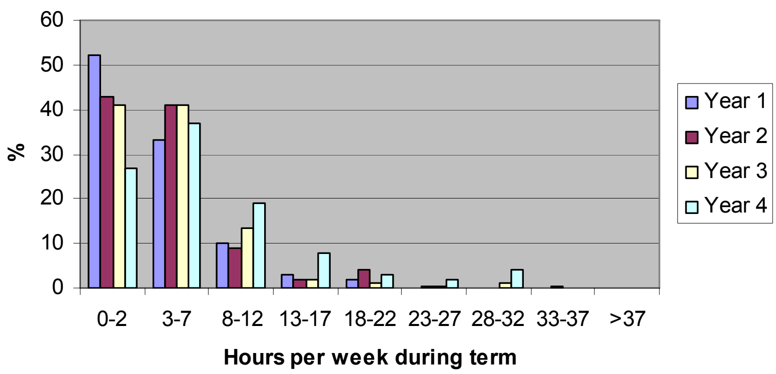


Figure 60 Student estimate[stu9] of time spent on private study (reading, extra problems etc., not formally assigned)

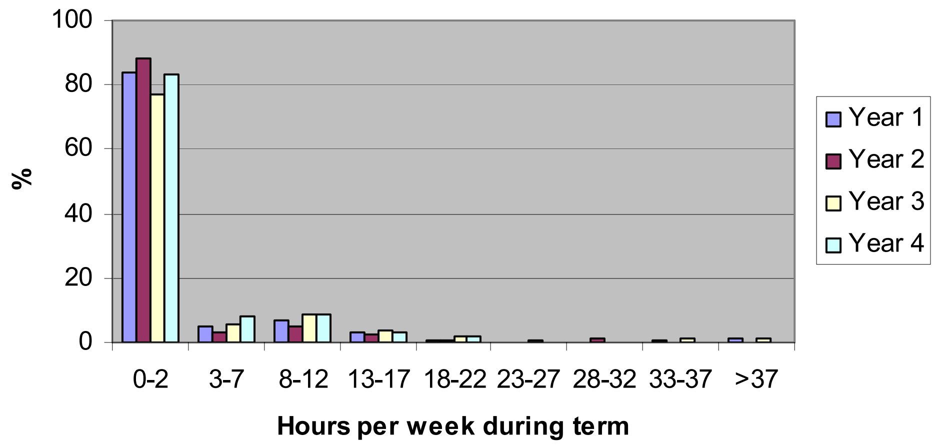


Figure 61 Student estimate[stu9] of time spent in paid work during term.

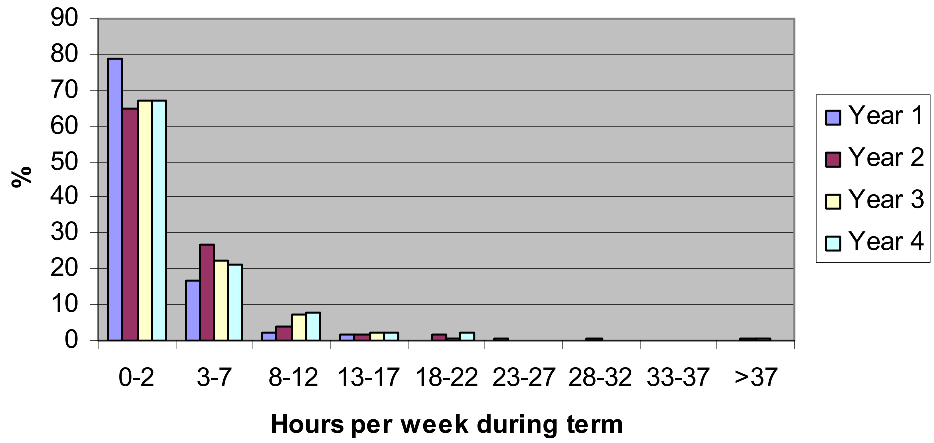


Figure 62 Student estimate[stu9] of time spent in activities likely to improve their experience and CV, such as voluntary work.

<news.bbc.co.uk/1/hi/education/7540137.stm>) This may reflect the time demands of a physics course, or the average level of economic support available from the family background of this particular student sample. A study of student degree choice between 1981-1991, before self-financing of students became a major issue, did not find any correlation of degree choice and social class (ref: Bratti, Massimiliano, Social Class and Undergraduate Degree Subject in the UK (February 2006), IZA Discussion Paper No. 1979. Available at SSRN: <ssrn.com/abstract=885348>).

The percentage of physics students who chose not to undertake paid work seemed so anomalous that a check was undertaken by carrying out a small supplementary survey in November 2008. In this supplementary survey whole lecture classes were briefly surveyed at the beginning or end of a lecture – ensuring that all attendees were included. The sample was 844 students from one Russell group and four non-Russell group universities, with 435 in Year 1, 178 in Year 2, 161 in Year 3 and 70 in Year 4. The combined sample had a median of 0 hours and 10, 90 percentiles of 0, 5 hours, i.e.

Table 6 Detail of the students' estimates[stu9] of time spent in paid work during term (hours per week).

	Number of replies	0 hours	1-5 hours	6-10 hours	11-15 hours	More than 15 hours
All Years com-bined	**676**	**80%**	**6%**	**6%**	**4%**	**4%**
Year 1	225	82%	5%	7%	3%	3%
Year 2	182	84%	5%	3%	4%	4%
Year 3	164	74%	8%	6%	7%	5%
Year 4	100	79%	9%	6%	3%	3%
Russell group	433	82%	7%	5%	3%	3%
Non-Russell group	204	78%	5%	7%	5%	5%

very comparable with and validating the results of the questionnaire samples given in Tables 5 and 6.

It should be noted that a few percent of students (8% in the original and 5% in the supplementary survey) are spending more than 10 hours per week in paid work, and some in excess of 20 hours. The impact of this on their performance in degree studies should perhaps be investigated further.

Nearly all (95%) students in the sample claim[stu12] that they never miss classes because of paid work, only 5% do so occasionally and a tiny percentage (less than 0.2%) do so often. Students do, of course, miss classes for a variety of other reasons, including finding a particular type of class unhelpful in their learning. Although 32% of students[stu11] believe they attend all classes, where they chose to miss it is much more likely to be lectures (half will do this on occasion), than tutorials or labs. Their estimates of their typical attendance at different types of class are given in Table 7.

There is a major mismatch between the amount of time which staff expect students to spend on study work outside formal teaching, and what most students actually achieve. Staff expect[sta57] students to do roughly twice as much private study in term time than they actually do. The staff expectations are shown in Figure 63. Russell and non-Russell group staff share a common median expectation of 20 hours per week, with lower 10 percentile at 10 hours (already larger than Year 1-3 students medians) and upper 90 percentile at 30 hours (Russell group) and 25 hours (non-Russell group). We recall that the medians from the Student Survey for Years 1-4 are respectively 7, 8, 9, 11 hours per week, which is the sum of

Table 7 Student estimate[stu21,stu28,stu32] of their percentage attendance at timetabled classes

	All	Most	Some	Few	None
Lectures	50%	44%	5%	1%	<1%
Tutorials	75.5%	17.5%	3%	2%	2%
Labs	89.3%	9.3%	0.9%	0.3%	0.2%
Workshops	55%	20%	6%	3%	16%
Problem-solving classes	56%	23%	7%	5%	9%

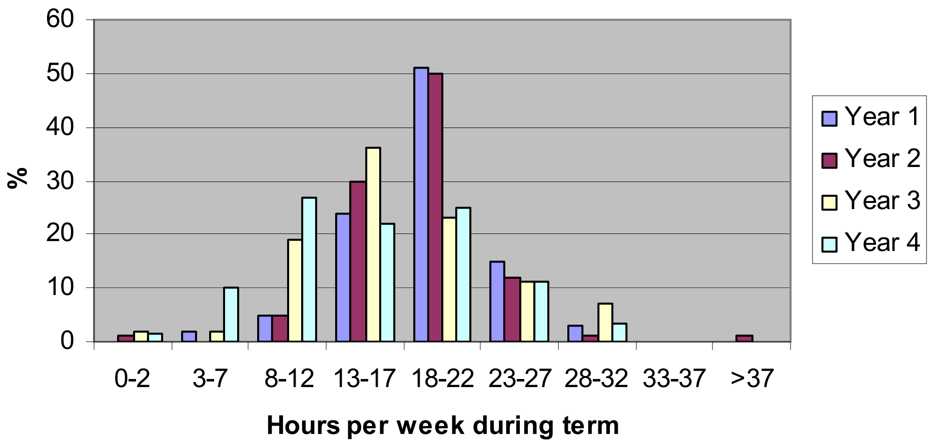


Figure 63 Staff expectations[sta57] of number of hours a student is expected to spend on academic work outside timetabled sessions (i.e. total per week over all modules)

coursework and private study from Table 5 above. For current QAA norms*, a typical undergraduate year giving 120 credits would represent 1200 hours' work. If we include assessment weeks etc for an academic year of 30 weeks, this is a nominal 40 hours per week. From Q9 of the Student Survey, the formal load per week is around 16-20 hours, so the staff expectation for private study on top of this corresponds to QAA norms. But it should be remembered that the constraints of time-tabling often mean that the actual way in which formal teaching is scheduled may make it difficult for students to utilise time effectively for private study.
(*for QAA norms see <www.qaa.ac.uk/academicinfrastructure/FHEQ/academicCredit/AcademicCredit.pdf>)

In considering the amount of academic work that students carry out, it is important to take account of study during university vacations, particularly in preparation for the examination and assessment periods that typically follow the Christmas and Easter breaks. The medians and percentiles of student estimates[stu10] are given in Table 8, and the distributions shown in Figures 64. These estimates may be rather optimistic (indeed, at the high end, the estimated days may exceed the length of the vacation!)
To put in context, if we accept median figures, and take a day to represent 7 hours' work, then this student effort, spread over 26 weeks of term would be equivalent to 4, 6, 6½, 7 hours of private study per week, in Years 1 to 4 respectively. Although almost certainly optimistic, these figures go some way towards

Table 8 Student estimates[stu10] of the time spent in academic work during the university vacations. The upper figure in each entry is the median days, and the brackets give the lower 10 percentile and the upper 90 percentile (e.g. 80% of Year 1 students spend between 1 and 18 days on academic work during the Christmas vacation).

Estimated days spent in academic work	Previous Summer Vacation	Christmas Vacation	Easter Vacation
Year 1		7 (1 – 18)	8 (3 – 21)
Year 2	2 (0 – 20)	10 (1 – 20)	10 (2 – 28)
Year 3	1 (0 – 14)	10 (1 – 20)	14 (3 – 28)
Year 4	2 (0 – 15)	10 (2 – 21)	15 (4 – 30)

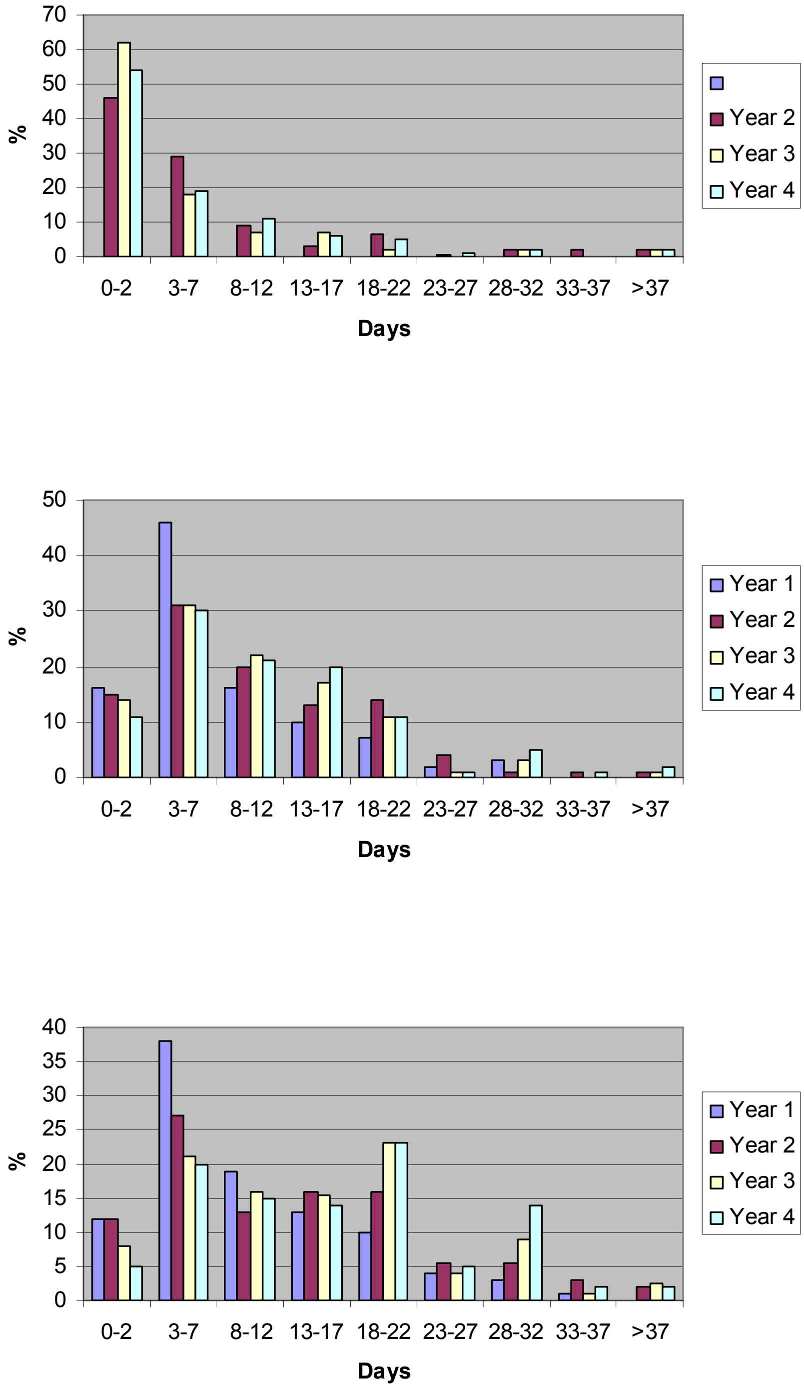


Figure 64 Student estimates[stu10] of the time spent in academic study during the university vacations. The histograms (from the top) represent the previous summer, the Christmas and the Easter vacations of each year.

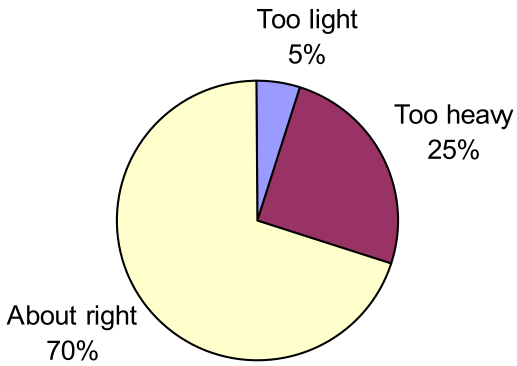


Figure 65 Overall physics students' view[stu13] on their workload

bridging the gap between staff and student expectations on private study. The variation between individual students, as can be seen, is very high. The planning of academic programmes should perhaps take more account of the actual study pattern of students. Overall, the student view[stu13] is that the workload is about right (70% agree), while 25% think it is too heavy and 5% think it is too light (Figure 65). There is no obvious difference (within about 2% of the overall percentages) of this view between the two university groups, or between years – except that in Year 2 29% students (i.e. 4% higher than the overall percentage) think the workload too heavy.

11. Assessment

A majority of students (58% in Russell group, and a slightly but significantly higher 66% in non -Russell group) say[stu57] they find that assessment at university is quite different from the types of assessment they experienced at school. But even more (74%) feel that the *amount* of *formal* assessment[stu48] on their course (examinations, tests, marked lab reports, marked assignments etc) is about right. Only 6% feel that there is not enough, and 20% that there is too much – although that proportion increases from 16% in Year 1 to 24% in Year 3, before falling back to 18% Year 4 – the latter probably because of the large component of project work. Most students (71%) also feel that their assessment has been appropriate[stu49] to the teaching they have received, the remainder being split equally between those who do not know and those who do not think it has been appropriate. Although about a half of students are content with the *balance* between formal examinations and continuous assessment[stu51], there is a clear trend of a desire to weight more towards continuous assessment with length of student experience. Those in favour of such a shift increases from 34% in Year 1 to 52% in Year 4. The feeling is stronger in non-Russell group students, and slightly stronger in females than males (See Figure 66).

Students experience[stu52] both formative and summative assessment, although the amount of formative assessment decreases from Year 1 to Year 4, presumably in line with transfer of

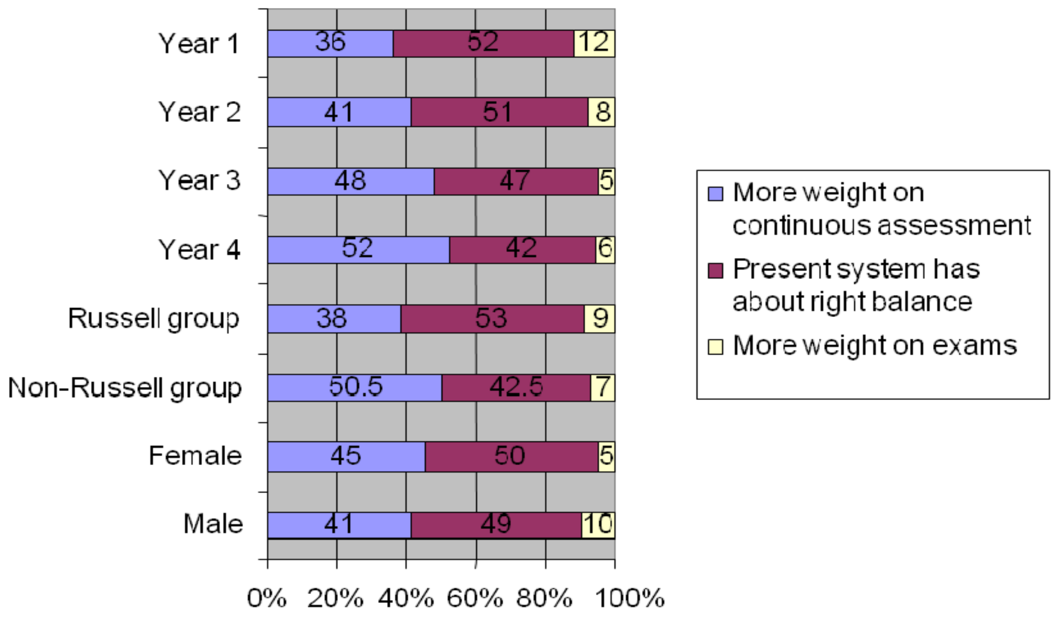


Figure 66 Student preferences on the balance[stu51] between formal examinations and continuous assessment in their overall assessment.

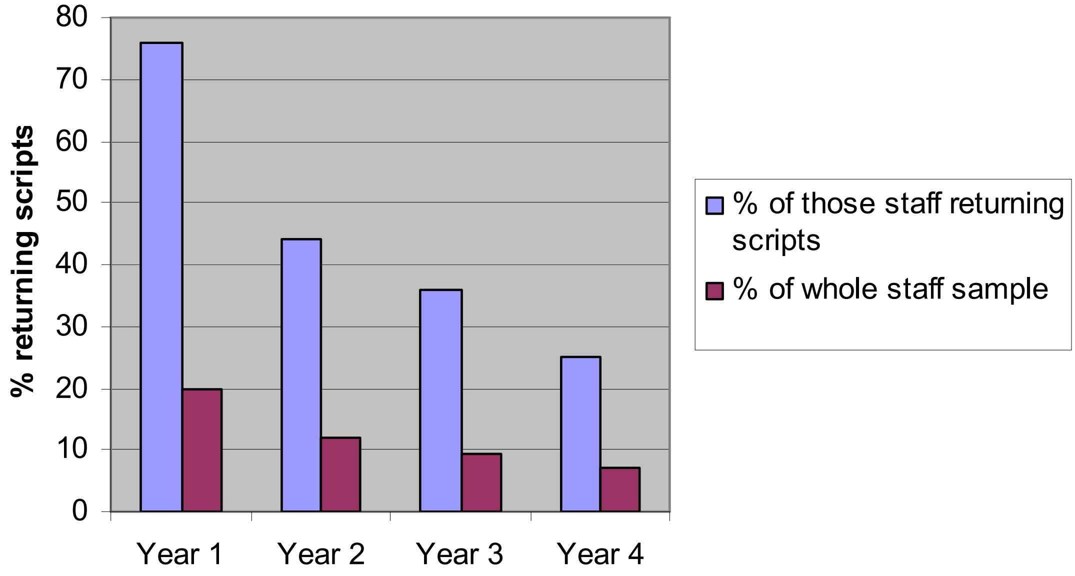


Figure 67 Staff returning[sta37a] marked examination scripts to students. For those staff who do return scripts, the figure shows the distribution over years – e.g. 75% return them to Year 1 students, 44% to Year 2 students. For the whole staff sample only 20% return scripts in Year 1, etc. Return or non-return of scripts is often fixed by departmental or university regulations.

responsibility for independent learning to the student. About a half of students[stu53] recognise formative assessments that are in the same style as summative assessments (e.g. dummy examination papers), allowing them to practice. Overall, 51% of students report[stu54] that *all* of their coursework (formative and summative) is marked, and another 31% that most of it is. Only 10% in the Russell group and 3% in the non-Russell group say that little or none is marked. The amount marked does decrease in Year 4 (little or none marked increasing to 20%), which may reflect relying on the student to use formative assessments as a tool in independent learning by giving out solutions rather than direct marking.

The practice of return of marked examination scripts to students varies between individual institutions. As shown in Figure 67 scripts are returned most frequently to first year students, and decreasingly in the later years of the course. Detailed replies here were only given by a quarter of staff[sta37a], and this suggests that the regular return of examination scripts does not occur frequently, although just under half of staff (46% Russell, 49% non-Russell) reported[sta37] that they returned scripts at least sometimes.

As might be expected, there is some element of "strategic learning" in student behaviour – i.e. concentrating only on those topics or activities which are thought to be essential. Where coursework is set but not assessed, a quarter of students[stu55] admit that they would probably not do it, while 39% would usually do it, and 36% do it sometimes. Three quarters of students agree[stu56] that they tend to ignore some subjects that are covered in lectures but are unlikely to come up in examinations, a trend that increases to 85% by Year 4.

The perception[sta39] of almost three-quarters of the university teaching staff is that student participation is assessment driven. In the Russell group this is 68% of staff, in the non-Russell group 77%. Only 14.5% and 9% of staff in the respective groups disagree. Presumably staff would prefer students to be predominantly motivated by their interest in the subject. There are no really marked systematic trends with staff age or gender, except that the 40-49 age group (82%) is strongest in the belief that it is the assessment which drives participation. Three quarters of staff[sta41] (70% in Russell group, 83% in non-Russell group) regard assessment as the main mechanism for determining the extent to which students have

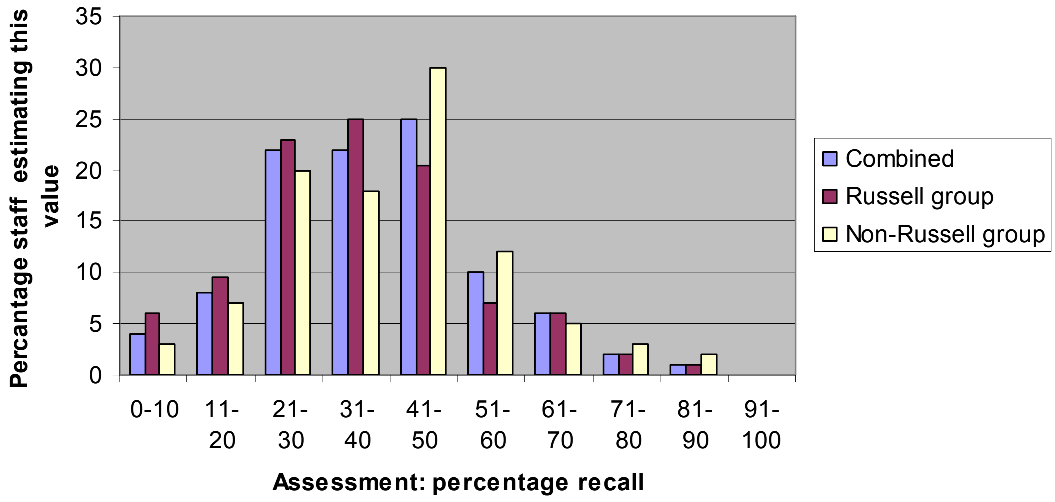


Figure 68 Staff estimate[sta38] of the percentage that recall plays in their current degree assessment scheme

become independent learners, although only half[sta42] think assessment is actually a useful tool in *developing* independent learning.

Peer assessment – involving students in marking each others' work – had been experienced by about 80% of the student sample[stu58] surveyed, but only just under half of staff[sta43] (42% in the Russell group, 52% in the non-Russell group). Many students (~40%) were unsure of their reaction, but of those who declared a firm opinion, 52% overall felt that it was *fair*[stu58a], and a substantial 48% thought that it was not. The reaction in the non-Russell group (where there was a little more experience) was more positive (66% thinking it fair) compared to the Russell group (only 45%). The staff with experience were more positive[sta43a] – 82% (Russell) and 78% (non-Russell) thinking it fair. A similar split is seen in student views of whether peer assessment is *helpful*[stu58b] (68% positive in non-Russell, 53% in Russell), but there was a marked trend for this positive attitude to decrease from Year 1 (68% overall)

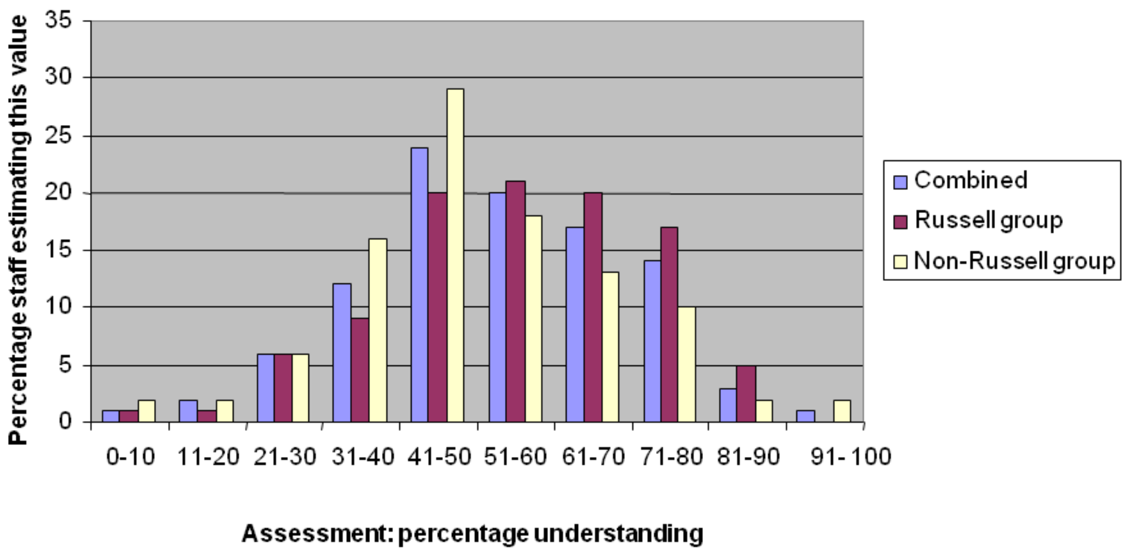


Figure 69 Staff estimate[sta38] of the percentage that understanding plays in their current degree assessment scheme

to Year 4 (51%), implying some growing doubts. Again staff were much more positive – 92% in non-Russell group and 83% in the Russell group thinking it helpful. Not surprisingly, nearly half of students did not feel they could comment on how *accurate*[stu57c] it is as a method of assessment, but unease is shown by those who did express a view – with 72% (Russell group) and 60% (non-Russell group) believing that it is not accurate. It is interesting that the staff views are rather closer to the students' here – with 49% in the Russell group and 36% in the non-Russell group doubting accuracy. There is a slight paradox here, since 82% of Russell staff had already declared the assessment fair. But at face value, while a majority (64%) of non-Russell staff do support its accuracy as a method, half of Russell group staff and three-quarters of their students do not.

Project work represents a very important component of student learning in the final two years. Typically it will contribute 15-30% of Year 3 and 40-50% of Year 4. Departments devote considerable effort[dotint] to multi-aspect procedures for project assessment. Three-quarters of staff (82% non-Russell, 69% Russell) believe that the quality of project work is reliably assessed[sta56], while only 10% (9% non-Russell, 12% Russell) believe that it is not.

Degree assessment schemes test both recall and understanding, and staff think[sta38] that current assessment is based on about 40% recall, 60% understanding – with the non-Russell group closer to 45%:55%, although the distribution of individual staff beliefs is rather broad. Staff opinions on the relative proportions that are currently involved are shown in Figures 68 and 69. For *recall* the median value for the combined sample and the Russell group is around 40%, with the non-Russell group only marginally higher around 45%. The 10 and 90 percentiles for both groups are about 20% and 60%. For *understanding* the median value for the combined sample and the Russell group is about 60%, with the non-Russell group marginally lower at around 50%. The 10 percentile is about 35% of the combined and Russell groups, about 30% for the non-Russell group. The 90 percentiles are around 80% and 75% respectively.

The relative contribution of the assessments of each year to the overall degree class is usually

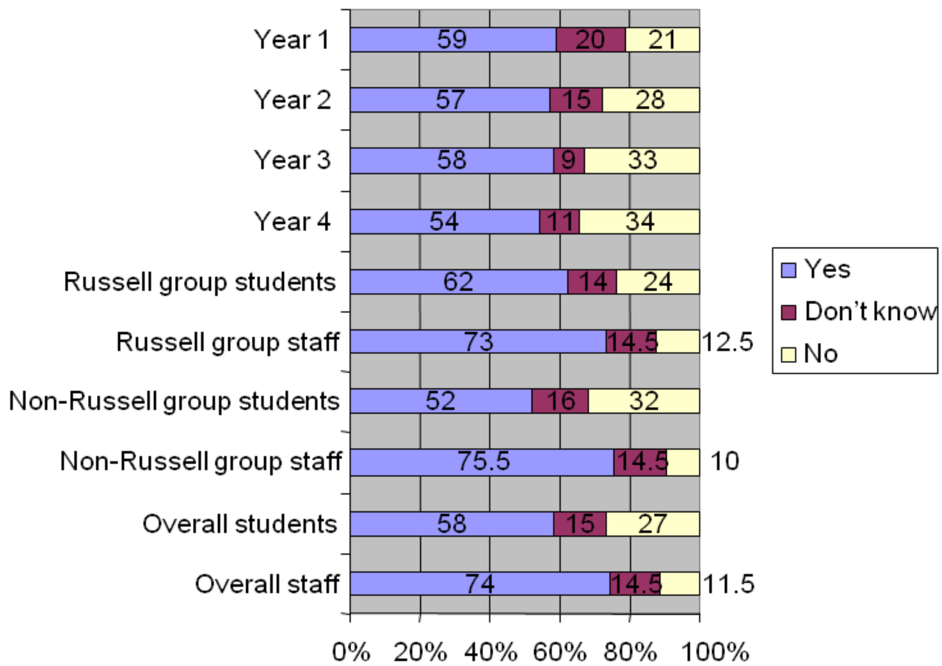


Figure 70 Student[stu50] and staff[sta40] opinion on whether overall the methods of assessment used reflect genuine student ability accurately.

determined by the university rather than the physics department, and there are some variations between institutions. A typical weighting for BSc would be 1/3 from Year 2 and 2/3 from 3, and for MPhys/MSci 1/5 from Year 2, 2/5 from Year 3 and 2/5 from Year 4. Other schemes for BSc vary from equal weighting for Years 2 and 3 to 1:3. Few institutions appear to vary from weightings of 1:2:2 for years 2, 3 and 4 of MPhys/MSci, but 1:1:2 is an example. Only a few universities use a weighted component of Year 1 marks in the degree classification, and at a 15% or less level. All students will, however, usually have to at least pass all or most of their Year 1 modules to satisfy degree credit point requirements.

Overall, most staff and students agree that the current methods of assessment do accurately reflect a student's level of ability (See Figure 70). It may be significant that student confidence in the validity of assessment decreases with progress through the course, although this could simply reflect over-confidence or disappointment. Non-Russell group students express less confidence (around 5% less) than their Russell group counterparts. Staff confidence in assessment is higher than the students'. Just over 10% of university staff (12.5% Russell, 10% non-Russell) felt that the assessment regime does not reveal genuine student ability. There is no trend of this view with gender of staff, but slight career progression in that the oldest staff group (60+) show the greatest confidence (6% negative) in the assessment regime, the youngest the least (18% negative).

12. Degree classification (data from HESA)

Physics students perform unusually well in their degrees. Over the five years 2002/3 to 2006/7 the relative percentages of 1:2.1:2.2:3 or Pass degrees awarded was 28.5%:34%:25.5%:12% compared to (2005/6 results) for all degree subjects of 12.6%:48.8%:31.4%:7.0%, although it should be noted that some other subjects such as mathematics also produce outstanding performance. There is little apparent change with time (see Figure 71), except an increase in higher classes awarded in non-Russell group. By 2006/7 the distribution is remarkably similar in Russell and non-Russell groups, with overall ratios as 30% first class, 33% upper second, 25% lower second and 12% third or pass. But as Figures 72 and 73 show, the distribution is quite variable between universities.

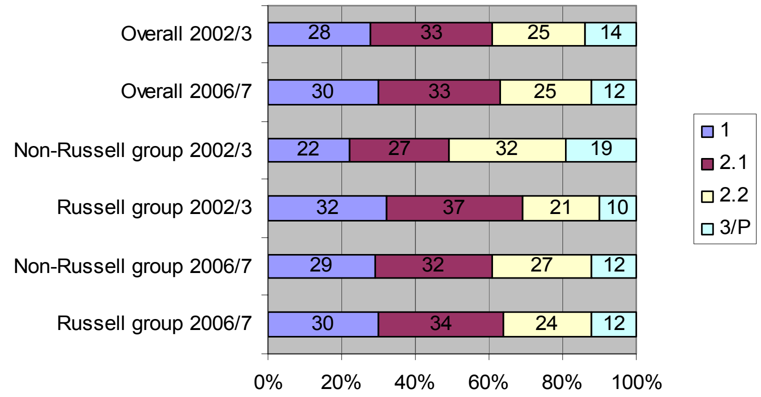


Figure 71 Physics degree classifications 2002/3 and 2006/7

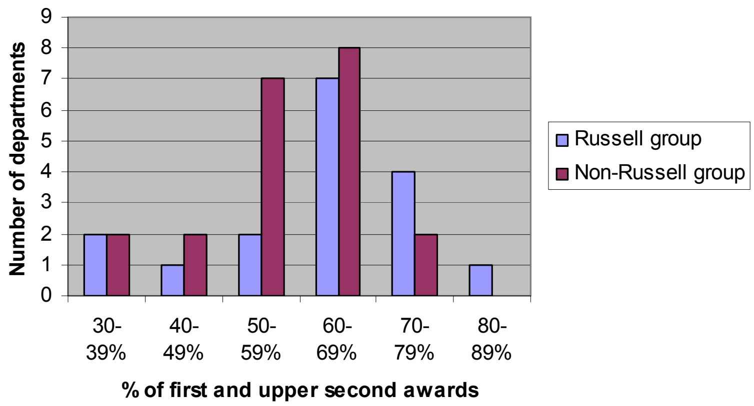


Figure 72 First-class degree awards 2006/7, as percentage of classified degrees.

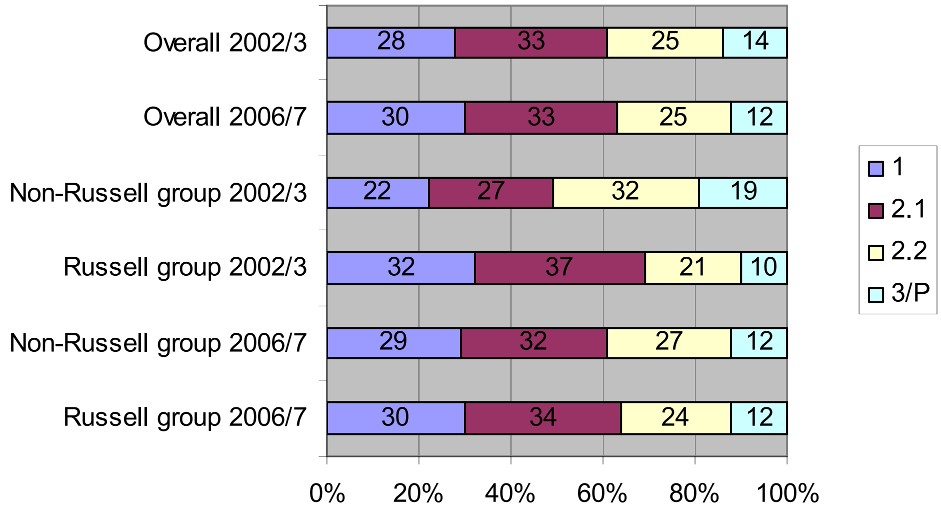


Figure 73 Physics degree classifications 2002/3 and 2006/7

The degree distribution also varies significantly from year-to-year, as shown for two example universities in the Figure 74. A simple explanation of the variations both between years and universities would be that indeed an *absolute* standard (based on experience and criteria referencing) is working.

Using raw statistics from HESA and without distinction between Russell and non-Russell groups, we can compare the degrees awarded in astronomy as well as physics (although noting again that the degree nomenclature is rather arbitrary, and that many physics degrees will contain astronomy/astrophysics modules). This is shown in Figure 75, where it will be seen that although there is some evidence of a drift upward with time in the award of astronomy qualifications, the astronomy degrees represent only some 11% of the total physics and astronomy degrees awarded and the overall degree classifications are remarkably consistent, corresponding in 2006/7 (as above) to 30% first class, 33% upper second, 25% lower second and 12% third or pass, with the first class only slightly higher than the 5-year average of 28%.

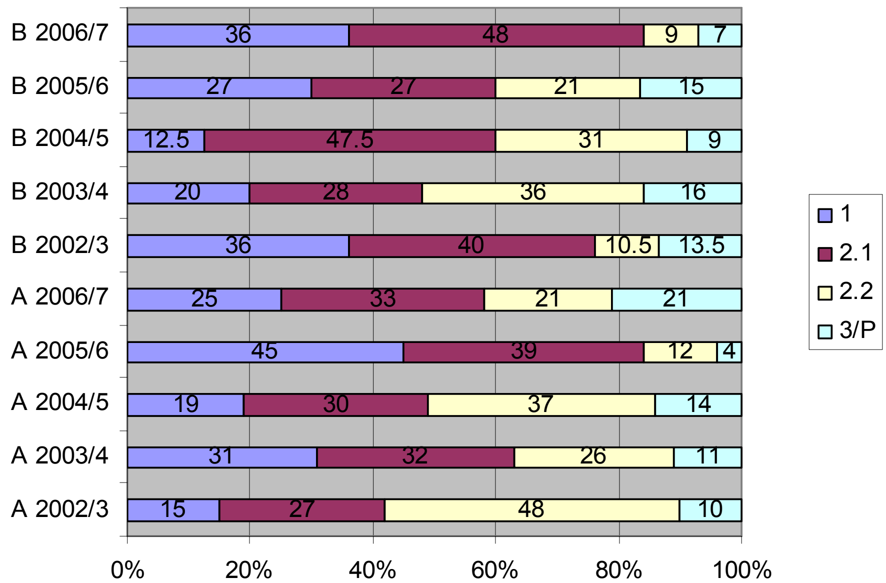


Figure 74 Variation of awarded degree classes between years for two sample departments. University A is in the non-Russell group, B is in the Russell group.

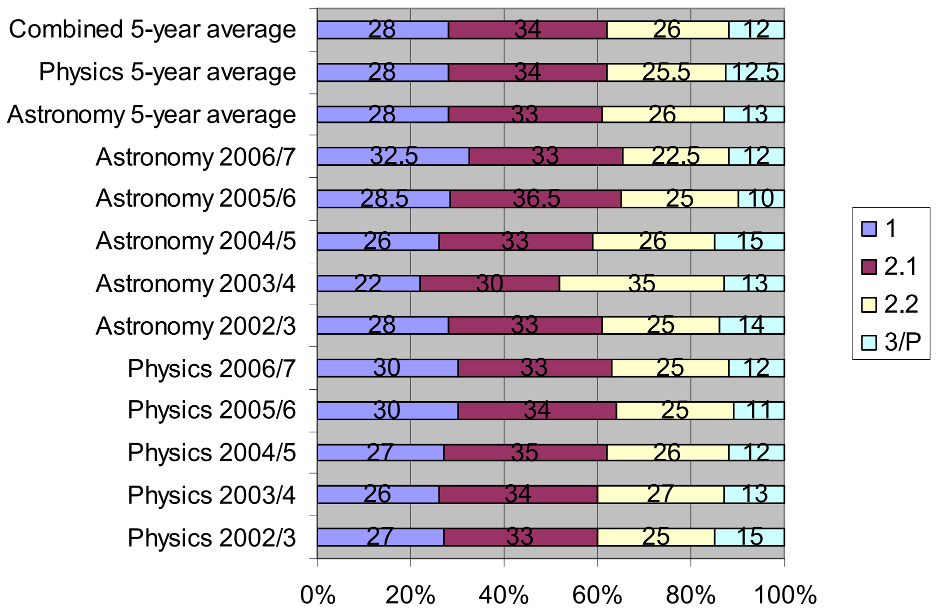


Figure 75 Degree classification in Physics and in Astronomy over a five-year period.

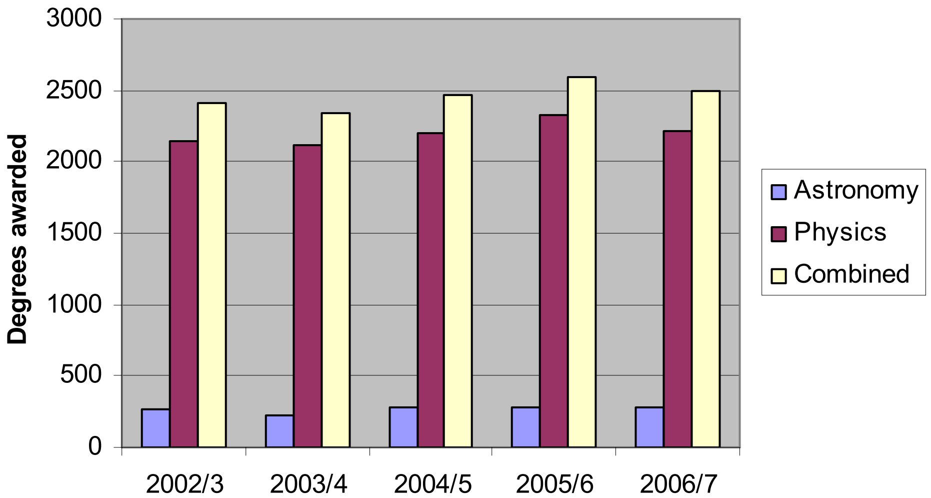


Figure 76 Number of degrees (first degree, i.e. BSc/MPhys/MSci) awarded in Physics and Astronomy over a five-year period *(HESA statistics for Great Britain and Northern Ireland, with a few minor additions to the list of universities listed in Appendix A)*. Not all physics or physics related degrees may have been captured here.

The actual *number* of first degrees awarded (from the HESA statistics) is shown in Figure 76, with the 2006/7 figures being approximately 2500 combined (2210 physics and 290 astronomy/astrophysics).

13. Career intentions and preparation for employment

Student career aspirations[stu95] firm up during their course, and Year 3 students indicate that over half are intending to enter a career which directly uses their skills and knowledge of physics (see Figure 77), with no significant male/female difference. Many of the rest are still unsure of their career direction, but for at least 20% of current students it will not be physics-based. Most of the students who continue to Year 4 in an MPhys/MSci are clearly more committed to a physics-based career. In planning further qualifications, in their first year About 9% of students in both Year I and Year 3 hoped for an MSc/PhD outside Physics. The commitment to physics in Year 4 shows again in that the percentage of those intending a further physics or physics-based degree rises to 79%, while for other subjects it drops to 3% (the percentages here are somewhat unreliable because of small numbers of replies). The actual proportion that do go on to postgraduate studies in physics can be estimated from the numbers awarded postgraduate degrees (see Figure 78), although there will be some uncertainties since some students may have entered postgraduate studies with other first degrees (e.g. mathematics) and due to the delay between

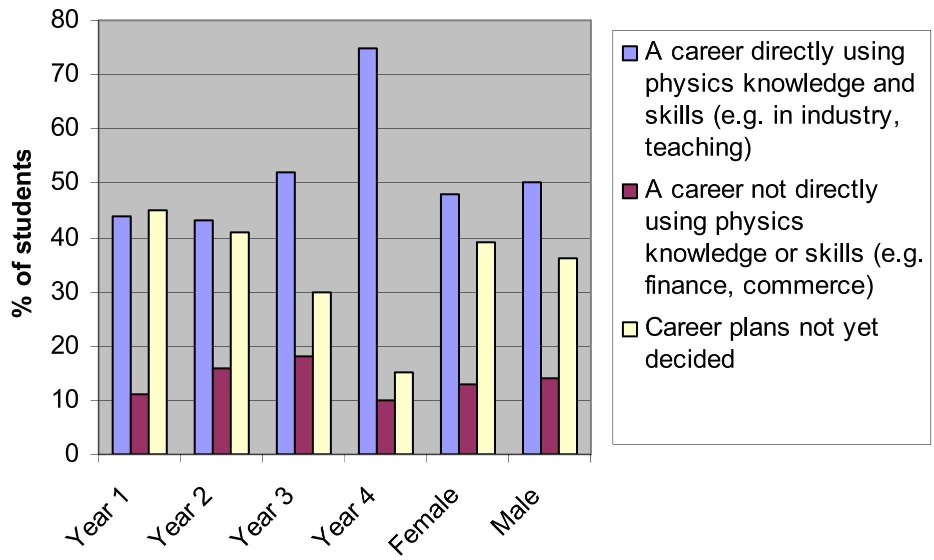


Figure 77 Student[stu95] career intentions

63% of students[stu94] were hoping that they would move on from a first degree to an MSc and/or PhD in physics (or a physics related subject), but this fell slightly to 54% by Year 3.

entry onto postgraduate studies and completion of postgraduate degree. But since numbers (from HESA) are remarkably stable over the five-year period 2002/3 to 2006/7, we estimate (to within no more than a 2% variation between years) that 41% of physics undergraduates go on to obtain a physics-based postgraduate qualification – 26% a PhD, 2% an MSc by research, and 13% an MSc not mainly by research or other postgraduate qualification. These proportions are based on the undergraduate degree statistics of Figure 76 above.

All universities have central careers advice services for students, and hence giving careers advice is not routine for many physics staff. Nevertheless, 93.5% of Russell group staff and 76% of non-Russell group staff report[sta88] personally providing careers advice for undergraduate students (e.g. within tutorials) either routinely or sometimes, and the fraction that do so increases with age. It is perhaps surprising in view of the previous paragraph that 24% of non-Russell group staff claim never to give careers advice (this is only 6.5% in the Russell group). By later years, 40% of

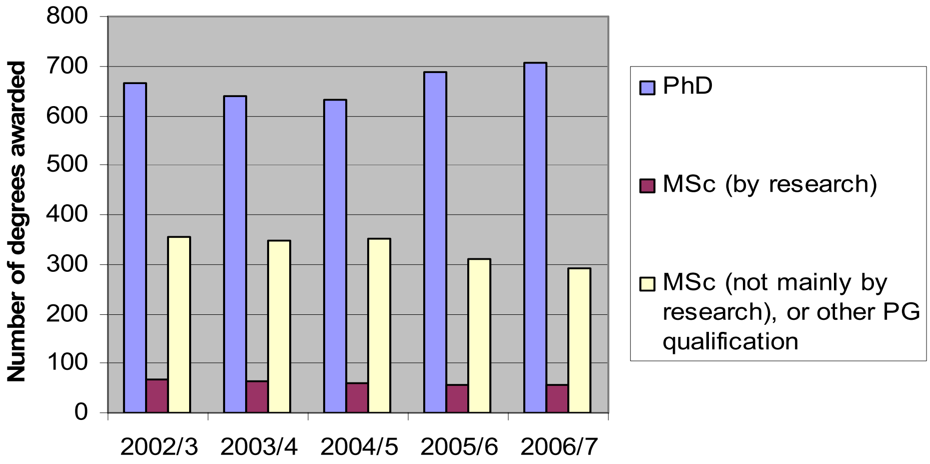


Figure 78 Postgraduate degrees awarded in physics, astronomy and related subjects (statistics from HESA)

By Years 3 and 4, over 80% of physics students[stu96] think that their course is providing the knowledge and skills that will be useful in their expected careers, and less than 10% believe it does not. Of students in Russell group, 62% did not feel[stu104] that there is a particular effort within their course to prepare them for employment, while around 56% of the students in the non-Russell group feel that there is. A majority of staff[sta74] think that they should take account of the different future employment of students in their teaching, but this attitude is marginally stronger in non-Russell (66%) than Russell group (58.5%). A significant minority (36.5% Russell, 27% non-Russell) do not regard it as necessary, which may simply reflect a belief that the skills learned on a physics degree course fit graduates sufficiently for employment without further consideration.

undergraduates[stu115] have had the opportunity to hear recent graduates who have returned to their department to talk about the jobs they are doing.

In preparation for employment, a fairly recent innovation has been to encourage or require students to keep a personal development plan, academic portfolio or personal log. Although 33% of staff in the Russell group and 52% of staff in the non-Russell group report[sta91] that they have started supporting students in this, only about 10% of students[stu105] in the Russell group and 45% in the non-Russell group say they are doing so.

All students are given safety briefings when they start laboratories in Year 1, and nearly[stu107] 85% of them recall being briefed. By Year 4, some 20% of students are aware of wider applications of health and safety regulations, and 23% of staff think[sta67] that this wider appreciation of health and safety should definitely be part of a physics degree course. The direct inclusion of the topic "employability" is a considerably higher priority for non-Russell group staff (33%) than Russell group (18%), but very few in either group (~1%) think European legislation should be included. Entrepreneurship only excites some 4% of staff, although 23% of students[stu67] have been offered the topic by Year 3, and 27% by Year 4. Other topics offered included taught elements of business study (38% of students), aspects of industrial physics (20%), patents and intellectual property rights (10%). Students report[Stu108a] that these courses were typically provided within the university either with (40%) or without (48%) physics department staff. For only 12% of students were the courses purely internal to physics. Most students (69%) did not know[stu108ai] whether the staff providing the courses were expert in these fields, but only 3% considered that they were not.

The majority of students are not aware of links between their physics department and employers of physics graduates, possibly because not all departments do have significant links. By Year 3 only 36% of students recognised[stu114] that there were links, but over 50% did not know, with the rest believing that there were no links. By later years, 40% are aware[stu116] that employers visit their department to give guest lectures or provide information directly about their companies. By Year 3, some 21% of students know[stu117] they have had an opportunity to meet (other than at careers fairs) employers connected with departmental research, but about half have not. Less than 5% (even in later years) feel[stu109] they have been given the opportunity to visit local physics-based companies, or those linked to departmental research, although nearly 40% will visit their departmental research labs.

Although it is not clear upon what evidence, most students are confident[stu118a] that employers are satisfied with graduates from their department. This confidence increases from 60% of students in Year 1 to 69% in Year 4, with a tiny 1% expressing a negative view. There is a touching loyalty to their own departments apparent in the fact that their view[stu118b] of employer satisfaction with physics graduates *in general* is about 10% lower.

14. Work placement and student exchange (e.g. ERASMUS) schemes

14.1 Work placement

Three-quarters of students[stu113] think that work placement is a good way to prepare for employment, with only 2% thinking that it is not. A minority of 29% of students felt they had been initially offered[stu84] a choice of BSc or MSci/MPhys with an industrial placement scheme. For those who had not[stu84a] it would have been attractive to 50% of non-Russell group and 39% of Russell group students.

Once on a degree course, around one-half of them (50% Russell group, 42% non-Russell group) do not know[stu110a] if an optional work placement scheme is running in their department, and for at least 15% no scheme seems to be available (the actual percentage may be higher). Only 20% feel[stu110c] that they had been provided with all the necessary information – although, of course, they may not have searched for it.

Where available, placements can be arranged by either departments or individual students. The student impression[stu111] is that both options are available in about half the departments, with others relying about equally on just the student or just the department. The geographical locations[stu112] offered were in the ratios 1:1:2 for (only UK):(UK+Europe):Worldwide

A small majority of students make a firm decision[stu110b] not to take up a work placement (58% Russell, non-Russell 51%). By Years 3 and 4 some 14-15% have either actually undertaken a placement, or still intend to. The percentage of non-Russell group students actually seriously pursuing a placement (25%, combining all years) is double that in the Russell group (12%). The percentage saying they want[stu110e] the opportunity is considerably higher (50% for students in the non-Russell group, 37% in the Russell group) than those taking it. Apparently[dotint] the prospect of the resulting removal from a student's peer group tends to discourage actual take-up. By later years, about 2/3 of those expressing an opinion[stu110d] (but these are quite small numbers, 70 students – most do not express a view) believe adequate course credit is given for work completed away from the university, but one third do not.

14.2 Student exchange (e.g. ERASMUS) schemes

Exchange schemes offer students the opportunity to study at a university abroad as a substitute for a year, or part of a year, at their home university. The choice of university abroad is normally determined by the department, based on bilateral university agreements. Over half of students (60% Russell group, 50% non-Russell group) are aware[stu110a] that a scheme exits in their own department. Only a minority (33% Russell group and 15% non-Russell group) feel they have been given all the necessary information – although, as for work placements, students may not have sought this out.

Nearly half of students (46%) in their first year have already decided[stu110bi] not to take up an exchange, growing to 80% by Year 3. Although overall 27% of students (28% Russell, 23% non-Russell) would like[110e] to have the opportunity to take part (even if their department does not currently have a scheme) in the event only 10% of Russell group and 6% of non-Russell group students actually[stu110bi] or intend to do so. As in the case of work placement, it appears[dotint] that the prospect of the resulting removal from a student's peer group tends to discourage participation. Also similar to work placement experience and based on even smaller numbers (59), roughly two thirds of students who express an opinion[stu110d] believe adequate course credit is given for work completed away from the university, but one third do not.

15. Developing teaching skills of staff

Nowadays staff appointed in higher education will find attendance at a course in teachings skills either compulsory or highly recommended. As shown in Figure 79, the universities' attitude to such course has changed over the years.

The staff reaction[sta7a] to such courses is split, with almost equal positive and negative reactions (see Figure 80), with rather more polarized views in the Russell group. Few staff thought of them as being very valuable (7%), or of being no value at all (9%). Some of the lack of enthusiasm may arise because the courses

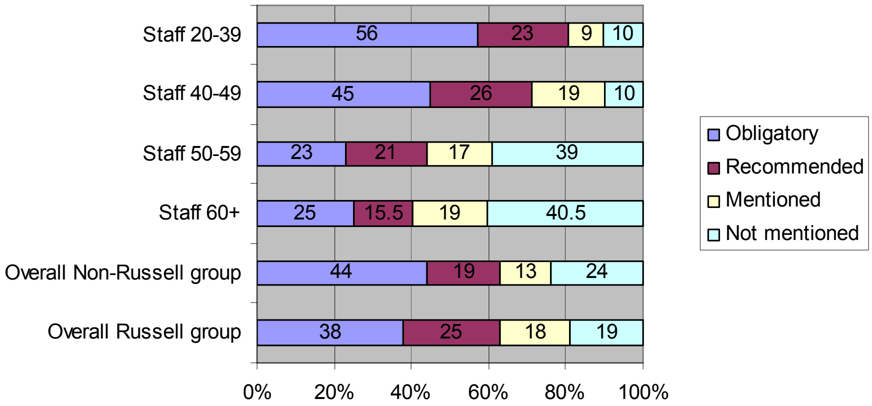


Figure 79 The priority given by the universities to attendance at teaching skills courses, as experienced[sta7] by physics staff of different ages.

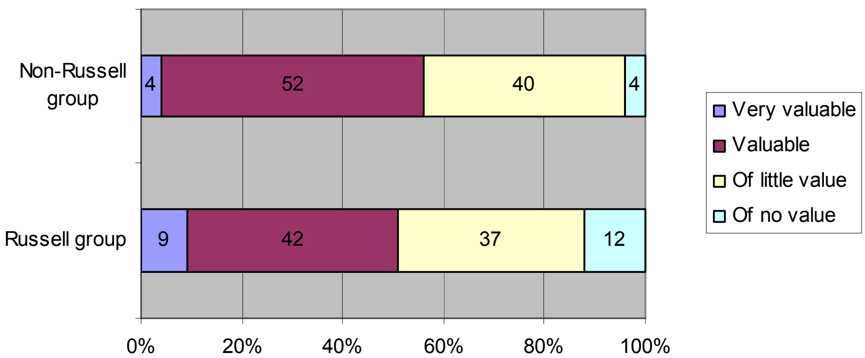


Figure 80 Staff description[sta7a] of teaching skills courses they attended at the start of their teaching careers.

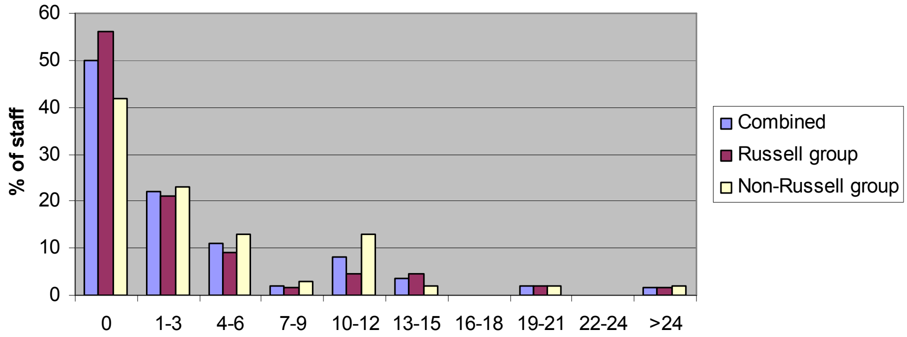


Figure 81 Number of days spent[sta75] by physics staff on a teaching development course/conference/activity in the academic year 2006/7.

were felt[sta7b] to be very much "general" (the reaction of 88% of staff in non-Russell departments and 79% in Russell group) rather than subject-specific (experienced by only 3% of staff, all in the Russell group). Elements of both general and subject specific approaches were seen by 18% of Russell staff and 12% non-Russell. In the future, a more subject-specific approach might be beneficial, although this could restrict useful cross-discipline interaction.

15.1 CPD and development of teaching

A large majority of staff (91%) have discussed[sta10] their personal style of teaching with other members of their department. This percentage decreases slightly from 95% in the 40-49 age band to 81% among staff over 60, but there is no significant variation with gender. The formal provision of teaching mentors among staff is becoming common, with 69% of staff under 40 having been provided[sta8] with one at some time. A little under half (44%) of staff have acted[sta9] as a mentor, varying from 11% of those under 40 to 65% in the (more experienced) 50-59 age band.

Directors of Teaching[dotint] consider that promotion is always based on some mix of factors, including teaching and other (particularly research) performance. Nevertheless it is encouraging that a third of staff (31% Russell group, 33% non-Russell group) believe[sta11] that at least one member in their department *was* promoted on the basis of good teaching. Most staff do not know whether such promotion has occurred, but 22% in the Russell group and 30% in the non-Russell group believe it has not. Evidence of a definite contribution to teaching is usually expected for promotion, but it is still unusual for good teaching performance to be the *determining* factor.

There is increasing availability of teaching development courses, conferences or activities organized by universities, departments, or professional bodies, (e.g. HEA, IOP). Figure 81 shows the number of days that individual staff members report[sta75] spending on these in the academic year 2006/7. Of Russell group staff, less than half attended any development course within the last year. The median for non-Russell group is one day, and the 10 and 90 percentiles for both groups are 0 and 10 days. 50% of the staff who replied spent no time at all at a teaching development event, but 50% of staff did so. The sample may be slightly biased in that staff who replied to the survey may be those more likely to be those taking an interest in teaching matters.

Nearly three-quarters of the staff responding[sta76] (which was 95% of the total sample) knew that their university has a policy of encouraging attendance at teaching development activities, with only 9% believing they did not. Although generally supportive, Heads of Department or School were not seen as having quite as positive an attitude to teaching development as their universities,

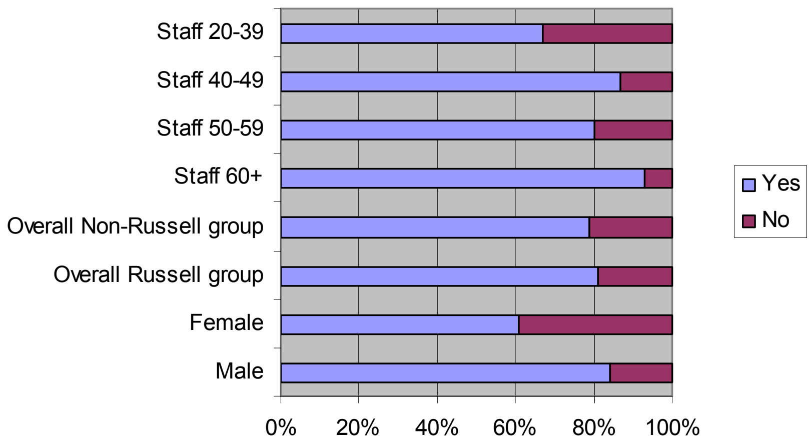


Figure 82 Staff response[sta79] to "Is your teaching style mostly in line with traditional methods of teaching?"

probably reflecting departmental priorities and resource constraints. 50% of staff in the Russell group (and 63% in the non-Russell) felt[sta77] that their attendance at teaching development activities was actively encouraged by their Head. Most of the remainder found their interest was at least accepted, and it is good that less than 5% of staff felt discouraged or ignored.

There is a rather mixed reaction[sta78] by staff to teaching development activities. Around 30% (25% Russell, 35% non-Russell) find them useful, while a further 45% or so in both groups find them somewhat variable. The remaining quarter (29% Russell, 22% non-Russell) do not find them particularly useful. This may suggest that teaching development activities need some improvement or tailoring for particular staff needs. Nevertheless where staff had undertaken a course in 2006/7, a reasonable majority (78% in the non-Russell group, 58% in the Russell group) are using[sta75a] (or intending to use) something of what they learned to improve their teaching in 2007/8. But a fair number of staff (29% in the Russell group and 14% non-Russell group) did not learn anything of immediate use. It seems[sta75b] that around 80% of those who are finding the courses useful are likely to pass what they have learned on to colleagues in their departments.

Staff across both university groups believe[sta79] that their teaching style is mostly in line with traditional methods of teaching (See Figure 82). The youngest group view themselves as the least traditional and the oldest group the most. It may be significant, though, that female staff view themselves as considerably less traditional than the males.

It is interesting that the fraction of staff (31%) who think[sta80] that new teaching methods are necessary for the current student cohort is even larger than those who do not currently use mostly traditional methods (20% in Figure 82). The need for new methods is recognized slightly more strongly by the non-Russell group staff (34% compared to 29%). Correlating response with staff age and gender does not show any obvious systematic trend, except a slightly greater enthusiasm (around 40%) for new methods among the youngest group, and by female staff (50% cf 28% for males, although responding numbers here are relatively small), re-enforcing the perception of gender difference in Figure 82, although this is obviously compounded by the age profile – see Figure 1).

Teaching does undoubtedly evolve, as demonstrated[sta81] by Figure 83 which shows that well over half of staff have, within the last five years, produced teaching material quite unlike the teaching that they had received in their university education, or quite unlike teaching they had delivered previously. There is some evidence here of more change in the non

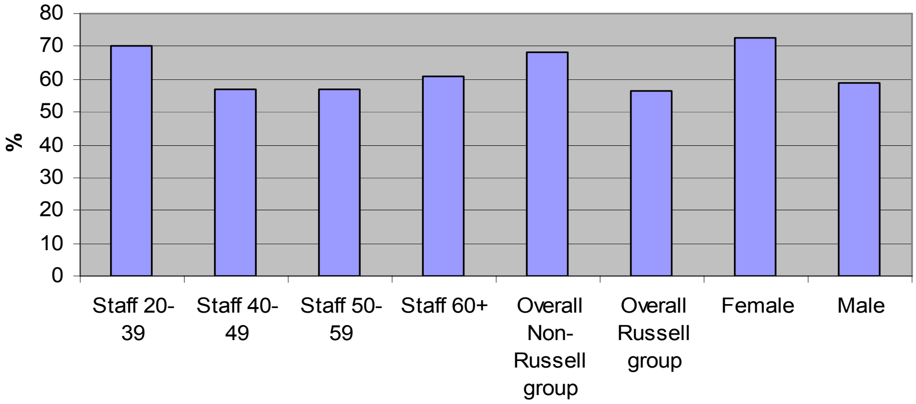


Figure 83 Percentage of staff[sta81] who, within the last five years, have produced any teaching material quite unlike the teaching they received, or quite unlike teaching they had delivered previously.

-Russell group, and again by the youngest age group and female staff. The reasons why staff say[sta85a] they have made changes are illustrated in Figure 84, and it is encouraging to see response to student feedback as a major component.

Innovative teaching materials (particularly in the area of enquiry/context/problem-based learning) tend to be created[sta34a] by the individual teacher (70%), and certainly internally (99%), with apparently little sharing between universities. An implication is that there is an opportunity for greater inter-University collaboration in production of such materials.

Only 17% of Russell group staff feel[sta34c] that these pedagogies have impacted on the way students are assessed in their department, although this increases to 28% in the non-Russell group, where the methods are more extensively used.

15.2 Subject based educational research

It is encouraging that 70% of staff have read[sta85] at least a few education research papers (see Figure 85), even if only about a tenth (perhaps less) of teaching staff seriously attempt to keep up with current research in physics education.

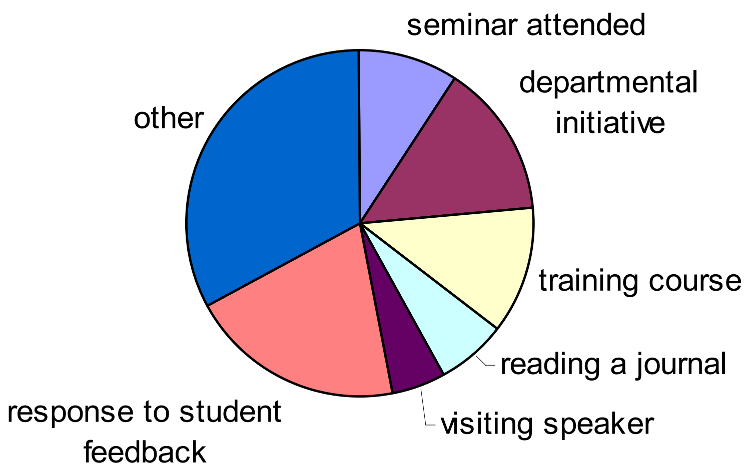


Figure 84 Reasons[sta81a] that have prompted staff to produce new teaching materials or adopt new methods.

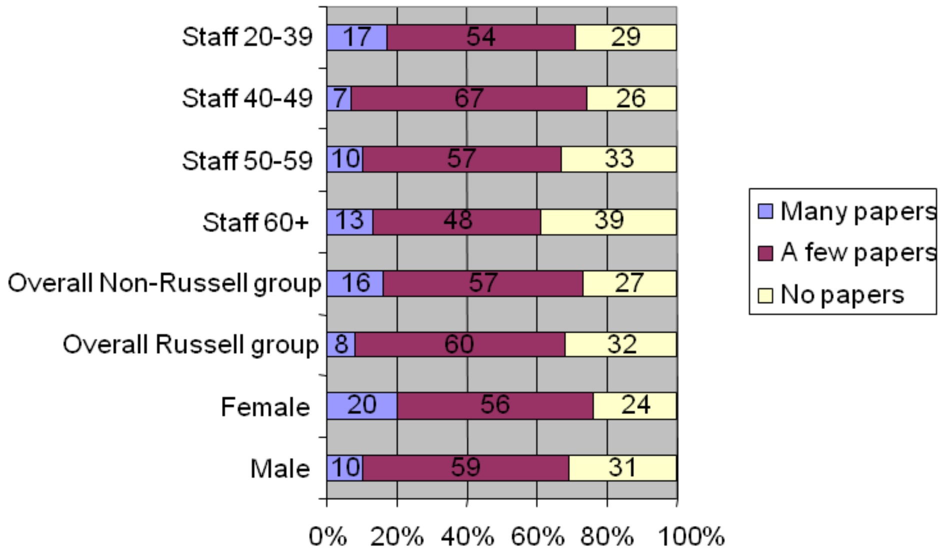


Figure 85 Extent of staff readership[sta85] of research papers in physics education.

In terms of age and gender, some indication again of a greatest interest in educational matters from the youngest group, and female staff – twice as many of whom, on average, regularly read the physics education literature compared with male staff. About one-fifth of staff[sta86] have undertaken some research or scholarship into physics education for undergraduates, with a clear decrease in age and with the youngest group being twice as active (33% of staff in the under-40 age group) than older groups (~17% of these staff), and female staff slightly more active (27%) than male (20%) – although this latter may again be largely a result of the comparatively younger age of the female sample. Not surprisingly, about twice as many staff have been involved in educational research (perhaps for local needs) than have published[sta87] it (11%). A higher proportion of female staff (15%) publish in the education area than males (9.5%). Some of the unpublished research activity of the younger age group may result from pursuing a higher educational teaching qualification.

16. Conclusions

This report provides a comprehensive snapshot of the learning experiences of full-time physics undergraduates in a UK university in 2008. It also provides a rich overview of many aspects of teaching and learning.

We offer the report to all interested stakeholders, which we anticipate will include Heads of Physics Departments, Directors of Teaching, academic staff engaged in teaching physics (including those in cognate departments), employers of physics graduates, administrators, planners, members of the Institute of Physics, teachers, careers advisors, parents, and current and potential students. We hope that the information that it offers will provide encouragement to all engaged with education in physics at HE level, and incentives to develop further what is already clearly a quality product.

If there is any surprise in the finding of the study, it lies in the absence of unexpected revelations about the state of the discipline. The questionnaires and the interviews generally told us what we expected and hoped to hear – that the teaching and learning experience of physics undergraduates in the UK is positive and effective. It is not static and is building on a solid basis of educational experience. There is evidence that it is developing through the elaboration of the curriculum, through innovation in approaches to teaching, through the imaginative use of technology, and through the extension of the learning environment, all for the benefit of present and future students. The prospects for students entering a physics department in the UK are shown to be sound, and we trust they will continue to be enhanced.

Thanks are owed to the many academic staff and students who gave up time to answer the rather long questionnaires, and to those Directors of Teaching who sought out information that may not have been readily available to them. Further thanks are due to Dr Robert Lambourne, who chaired the Advisory Panel, and wrote the Preface, to Michael Gagan who was the Consultant on the sister review of chemistry, and to all the Panel members who travelled to meetings and perused early drafts of the Report and the Survey Analyses.

All the supporting documents – the questionnaires, the Staff and Student Survey Analyses, and the tabulated responses - may be accessed through the HEA Physical Sciences Centre website for anyone who wishes to explore the collected data in depth, and assistance is available from the Centre. <www.heacademy.ac.uk/physsci/home/projects/subjectreviews>

17. Glossary of terms

Accreditation. Review of formally submitted undergraduate courses by the Institute of Physics. Accredited courses satisfy the academic requirements in subject knowledge, skills and abilities for Institute Membership.

Applicants. This term derives from the terminology used by UCAS. It refers to the prospective students who apply to UCAS for entry to full-time, undergraduate programmes. Where applicants apply for more than one subject area they are counted as belonging to the subject area representing the majority of their choices (their preferred subject) as described by the JACS code. For some subjects this can give the impression that there are more accepts than applicants. This measure can be used as an indicator of the number of prospective students firmly committed to the discipline and the popularity of the discipline. The ratio of applicants/accepts can be taken as an indicator of the extent to which demand from committed students is being met (if less than unity) or not met (if greater than unity).

Assessment. May be summative (carries marks which count towards an outcome), formative (does not carry marks but is designed to help students assess their progress) or diagnostic (does not carry marks but is designed to determine whether or not a student already has the required knowledge and/or skills or should be required to attend some particular learning exercise to achieve an appropriate standard).

Benchmark. A set of statements through which the academic community can describe the nature and characteristics of programmes in a specific subject or subject area. They also represent general expectations about standards for the award of qualifications at a given level in terms of the attributes and capabilities that those possessing qualifications should have demonstrated. The QAA published benchmark documents for undergraduate physics, astronomy and astrophysics degrees in 2002 and 2008.

Bologna process. Started in 1999 with the aim of achieving greater convergence and mobility of students between European countries. Includes a framework of three cycles: first cycle: typically 180–240 ECTS credits, usually awarding a Bachelors degree. Second cycle: typically 90–120 ECTS credits (a minimum of 60 on second-cycle level), usually awarding a Masters degree. Third cycle: Doctoral degree. No ECTS range specified.

CETL. Centre for Excellence in Teaching and Learning. An initiative funded in England by the Higher Education Funding Council for England to provide, within an institution, or across a consortium of institutions, a focus for development of a particular aspect of teaching and learning.

Contact hours. Direct face-to-face or online contact time between teaching staff and students, usually formally timetabled, as represented by hours of lectures, practicals, tutorials, seminars etc. Contact hours (teaching) for a student may include some time spent in activities partially supported by non-academic (technical and other support) staff, or activities involving more than one teacher. Contact time should be seen in the context of the total expected study time (notional learning time) for a student usually being about 40 hours per week during term time. Contact hours (workload) for a member of staff is the time during which they are directly teaching students or facilitating student work, either face-to- face or online, and does not normally include preparation or assessment time. Note that contact hours (teaching) for a student may be very different from contact hours (workload) for a member of staff since a one hour, one-to- one tutorial would represent one hour of student contact time (teaching) but would represent six hours of contact time (workload) if the member of staff was looking after six students.

FE. Further education. Post-secondary education, including any level of education from basic training to Higher National and Foundation Degree.

HEFCE. Higher Education Funding Council for England. A public body of the Department for Innovation, Universities and Skills which promotes and funds teaching and research in Universities and Colleges of Higher/Further Education in England.

HEI. Higher education institution. An institution such as a university, community or technical college that awards academic degrees.

HESA. Higher Education Statistics Agency. HESA is the central source for the collection and publication of higher education statistics in the UK.

Higher Education Academy. Formed in October 2004 to "work with the higher education community to enhance all aspects of the student experience".

Industrial placement. A (usually) credit-bearing part of a degree programme spent in industry, or a research establishment. It most frequently lasts a year (although periods from a few weeks upwards are known), and is usually supervised by an academic and an industrial supervisor. A placement student is usually paid by the employer. Sometimes called a sandwich placement if period is for a year.

IOP. Institute of Physics. The professional body for physics in the UK. Accredits undergraduate degrees as a qualification for Institute membership, or a part-qualification for Chartered Physicist.

JACS. Joint Academic Coding System. JACS is the system used by HESA and UCAS to classify academic subjects of study at universities in the UK.

Lectures. Timetabled teaching often of large numbers of students and usually lasting for about 50 minutes. The activities which take place in a "lecture" may often involve much more than listening and increasingly involve interaction between the lecturer and the students and/or between the students.

MPhys/MSci. Undergraduate integrated Master of Science degrees. The MSci is an undergraduate academic degree qualification awarded after typically four years studying a science discipline (e.g. physics) at a HEI; MPhys is a degree of equal standing, but specific to physics or a physics-based subject (e.g. astro-physics).

Notional learning time. This is the estimated learning time taken by the "average" student to achieve the specified learning outcomes of a module or programme at a university. The most widely used notional learning time per credit in the UK is ten hours. For "credit-based" HEIs the total notional learning time is therefore 1200 hours for a 120 credit full time undergraduate year and 1800 hours for a 180 credit full time postgraduate year.

PBL. Problem-based (or project-based) learning. Student-centred instruction in which students collaboratively solve real-life problems (or work on projects), often including reflection on the experience. Students are usually encouraged to take responsibility for group-work and organise and direct the learning process with support from a facilitator or tutor.

Postgraduate students. This term derives from the terminology used by HESA. Students enrolled on programmes leading to higher degrees, diplomas and certificates, and professional qualifications, reported by the universities to HESA, including part-time and full-time students. Includes taught and research degree students.

Practical work. Can be "wet" (for example, laboratory work) or "dry" (for example, computer simulations and/or paper-based data interpretation exercises). Usually associated with a formal schedule which students must follow in early years of a course, but may use a more open-ended investigative approach later. Often assessed on the basis of a write-up of the exercise rather than the actual performance of the student in the laboratory.

Project. A final year project is a substantial piece of work, in which students work on a research question, usually in a laboratory context (although this may be a computer laboratory), often while attached to a research team. Usually carries a substantial number of credits and involves the writing of a 6,000 to 10,000 word dissertation. Other shorter projects may be taken at other times during the course, possibly also in a library context (researching published literature), or in other innovative contexts that may or may not be based on the discipline being studied (for example, producing teaching material for schools).

QAA. Quality Assurance Agency for Higher Education. An independent body funded by UK Higher Education stakeholders, whose remit is to ensure the quality of education delivered in UK Universities and other institutions of Higher Education.

RAE. Research Assessment Exercise. The RAE is an exercise that has been undertaken approximately every five years on behalf of the four UK higher education funding councils to evaluate the quality of research undertaken by British HEIs.

Research project. See 'Project.'

SSC. Sector Skills Council. SSCs are state-sponsored, employer-led organisations that cover specific economic sectors in the UK. They have four key goals: to reduce skills gaps and shortages; to improve productivity; to boost the skills of their sector workforces and to improve learning supply. There are currently 25 SSCs covering about 85% of the British workforce. They are licensed by the Government to provide employers in their sector with the opportunity for coherent leadership and strategic action to meet their skills needs.

Tariff. This term derives from the terminology used by UCAS. The UCAS Tariff was introduced in 2002–03 and establishes agreed equivalences between different types of qualifications (for example, A-levels, Baccalaureates, Scottish Higher or other qualifications) and measures achievement for entry to higher education in a numerical format. This allows comparisons between applicants with different types and volumes of achievement. However, the tariff system does not include all qualifications.

Tariff points. This term is taken from UCAS terminology (http://www.ucas.com/students/ucas_tariff/tarifftables/). For example:
A-level tariff: Grade A=120; B=100; C=80; D=60; E=40
Advanced Scottish Highers tariff: Grade A=120; B=100; C=80; D=72
Scottish Highers tariff: Grade A=72; B=60; C=48; D=42

Tutorials. The format and academic content of a tutorial is variable, but usually involves the interactive teaching of a small group of students by an academic. They are less formally structured than a lecture and may involve academic discussions, professional and personal development activities, or skills development. Some larger "problem-solving classes" are sometimes also considered as tutorials. Where pastoral support is the main function, the tutorials are often referred to as "Personal Tutorials"

UCAS. Universities and Colleges Admissions Service. UCAS is an institution that collects and distributes information for applications to almost all full-time undergraduate degree programmes at British universities and colleges. It provides a central service through which prospective students apply for undergraduate study.

Undergraduate (UG) students. This term derives from the terminology used by HESA. It includes all full-time and part-time students registered on specified first degree programmes as reported by the universities, such as a bachelor's degree (BSc) or an undergraduate integrated Master's degree (MPhys, MSci).

UK education systems. The education systems in the four countries comprising the UK are diverging and features of one are not necessarily seen in others. For example, in Scotland the first degree is four years in length (England and Wales three years). The arrangements for tuition fees and student funding differ in each of the UK countries. National Teaching Fellowships and CETLs operate in England only. Prior to university, Scottish school pupils study Highers and Advanced Highers rather than A-levels.

Appendix 1: UK universities offering physics degrees in 2008/9

	BSc	MPhys	Russell/non-Russell
UNIVERSITY OF ABERDEEN	B		NR
ABERYSTWYTH UNIVERSITY	B	M	NR
UNIVERSITY OF BATH	B	M	NR
UNIVERSITY OF BIRMINGHAM	B	M	R
UNIVERSITY OF BRISTOL	B	M	R
UNIVERSITY OF CAMBRIDGE	B	M	R
CARDIFF UNIVERSITY	B	M	R
UNIVERSITY OF CENTRAL LANCASHIRE	B	M	NR
UNIVERSITY OF DUNDEE	B	M	NR
DURHAM UNIVERSITY	B	M	NR
THE UNIVERSITY OF EDINBURGH	B	M	R
UNIVERSITY OF EXETER	B	M	NR
UNIVERSITY OF GLASGOW	B	M	R
HERIOT-WATT UNIVERSITY	B	M	NR
UNIVERSITY OF HERTFORDSHIRE	B		NR
UNIVERSITY OF HULL	B	M	NR
UNIVERSITY OF KEELE (with a joint subject)	B		NR
UNIVERSITY OF KENT	B	M	NR
UNIVERSITY OF LANCASTER	B	M	NR
UNIVERSITY OF LEEDS	B	M	R
UNIVERSITY OF LEICESTER	B	M	NR
LIVERPOOL JOHN MOORES UNIVERSITY	B*	M*	NR
UNIVERSITY OF LIVERPOOL	B	M	R
IMPERIAL COLLEGE LONDON	B	M	R
UNIVERSITY COLLEGE LONDON	B	M	R
QUEEN MARY, UNIVERSITY OF LONDON	B	M	NR
KING'S COLLEGE, UNIVERSITY OF LONDON	B	M	R
ROYAL HOLLOWAY, UNIVERSITY OF LONDON	B	M	NR
LOUGHBOROUGH UNIVERSITY	B	M	NR
UNIVERSITY OF MANCHESTER	B	M	R
UNIVERSITY OF NOTTINGHAM	B	M	R
NOTTINGHAM TRENT UNIVERSITY	B	M	NR
UNIVERSITY OF OXFORD	B	M	R
THE QUEEN'S UNIVERSITY OF BELFAST	B	M	R
UNIVERSITY OF ST ANDREWS	B	M	NR

UNIVERSITY OF SALFORD	B	M	NR
UNIVERSITY OF SHEFFIELD	B	M	R
UNIVERSITY OF SOUTHAMPTON	B	M	R
UNIVERSITY OF STRATHCLYDE	B	M	NR
UNIVERSITY OF SURREY	B	M	NR
UNIVERSITY OF SUSSEX	B	M	NR
SWANSEA UNIVERSITY	B	M	NR
UNIVERSITY OF WARWICK	B	M	R
UNIVERSITY OF THE WEST OF SCOTLAND	B		NR
UNIVERSITY OF YORK	B	M	NR

Key: B Offers BSc in Physics; M offers MPhys or MSci in Physics; * indicates only with astronomy/astrophysics; R Russell group university; NR Non-Russell group university.

All universities except Aberdeen, Cambridge, Dundee, Heriot-Watt, Imperial College, Oxford, Strathclyde, Warwick and West of Scotland offer degree courses with title Astrophysics, Physics with Astronomy, Space Science or similar, although nearly all physics departments offer modules in astronomy/astrophysics even if they have no degree course with “astro” in the title.

The Open University offers BSc in Physical Science

Source: IoP Physics on Course 2009
http://www.iop.org/activity/education/Promoting_Physics/Career_Resources/file_31428.pdf

Appendix 2: The European context

The UK is participating in the 'Bologna Process' which was inaugurated in 1999 with the aim of creating a European Higher Education Area (EHEA) by 2010. By that date, within the area, degrees should be harmonized in accordance with a three cycle (Bachelor-Master-Doctorate) structure that will facilitate comparability, quality assurance and recognition and thus encourage mobility, fair access and personal development for students, graduates and staff. The process is now based on cooperation between education ministries, higher education institutions, students and staff from 46 countries, and involves several international organisations.

This report has not attempted to canvas detailed views about the Bologna Process or the extent to which individuals believe that the courses and programmes with which they are familiar are Bologna compliant. This is partly because there is a widespread (though certainly not unanimous) view amongst UK academics that the Bachelor-Master-Doctorate system is already well established here so that action over Bologna is mainly a concern for other European countries. However some have voiced serious concerns over comparability, particularly at Masters level, so it is appropriate to include a few comments about the current status of the harmonization of physics degrees across Europe and the developing context in which UK degrees will be viewed.

Progress towards the 2010 target has varied from country to country and it seems likely that some of the participating nations will still not have completed the planned or anticipated changes to their national systems by 2010. Nonetheless, substantial changes have taken place and various forms of official and unofficial monitoring are in place to gauge the nature and extent of those changes. Amongst these monitoring programmes two are of particular relevance to physics.

The first is a study of Bologna implementation in physics departments being carried out by the International Centre for Higher Education Research at the University of Kassel in Germany. This is a three year study, supported by the European Physical Society, based on a sample of 25 Bologna signatories that jointly contain a total of 374 physics departments. Data from the first round of surveys are still being gathered and analyzed but some preliminary results based on curricula submitted by 128 departments (55% of the sample sought) have already been released. Amongst these is the finding that the most common durations of the first and second cycles are 3 + 2 years or 3.5 + 1.5 years. Also, the European Credit Transfer and Accumulation System of credit points is widely used with 1 ECTS point requiring 25 to 30 hours of student work and 60 ECTS points being acquired in one year (1 ECTS point is usually equated with 2 UK CATS points but there are issues in both systems about the amount of work students really do to earn a point). The modularization of degrees, which is seen as facilitating mobility, is proving to be a serious challenge in some countries, and there is some tension between the aim of Bologna-style macro-level structural alignment and locally supported micro-level diversity in degree programmes. Not surprisingly, at several prestigious universities where there has been no tradition of awarding Bachelor degrees, there is still little interest in these 'new' degrees which are often seen as an inadequate preparation for employment.

The second study of obvious relevance to physics is that carried out by the European Physics Education Network (EUPEN) particularly through its project STEPS (Stakeholders Tune European Physics Studies). Numerous publications from EUPEN and STEPS provide detailed survey-based insights into degree profiles, teaching methods, learning outcomes and competencies, assessment practices, quality assurance and graduate destinations. A particularly useful starting point for those interested in these matters is the 86 page booklet 'Reference Points for the Design and Delivery of Degree Programmes in Physics' (ISBN 978-84-9830-168-7) prepared by the Physics Subject Area Group of the Tuning project and published by the University of Deusto, Spain. One clear outcome of the substantial body of work summarised there is that, despite many differences in detail, there is a remarkable level of agreement across Europe about what constitutes a 3 year Bachelor degree in physics. Equally clear is the much greater diversity to be found in Master level programmes. Further details of the work of EUPEN/STEPS can be found at the website <www.eupen.ugent.be/>

Appendix 3: Comparison with National Student Survey 2007 and Institute of Physics (IOP) survey

National Student Survey

The National Student Survey has been carried out annually since 2005 to investigate students' views of the higher education institution they were attending, and "to provide the public and the HE sector with comprehensive, comparable views of students about the quality of their education." (NSS briefing note for students' unions). The questionnaire used has 21 items designed to capture six essential dimensions of teaching quality – Teaching and Learning, Assessment and Feedback, Academic Support, Organisation and Management, Learning Resources, and Personal Development – together with a final Question 22 seeking a measure of overall satisfaction.

The 2007 data are available at <www.hefce.ac.uk/learning/nss/data/2007/>, and contains responses from approximately 800 physics students in 15 Russell group universities, and approximately 450 students in 11 Non-Russell universities. The questionnaire uses a five-fold multiple choice for each question, and a convenient form of analysis is to calculate the percentage of responses which 'mostly agreed' or 'strongly agreed' with each statement in the questionnaire. The results are shown in Table A4.1, and graphically in Figures A4.1, A4.2. We give here the means (weighted by student number), and also the lowest and highest percentage response from students in any department as an indication of overall limits.

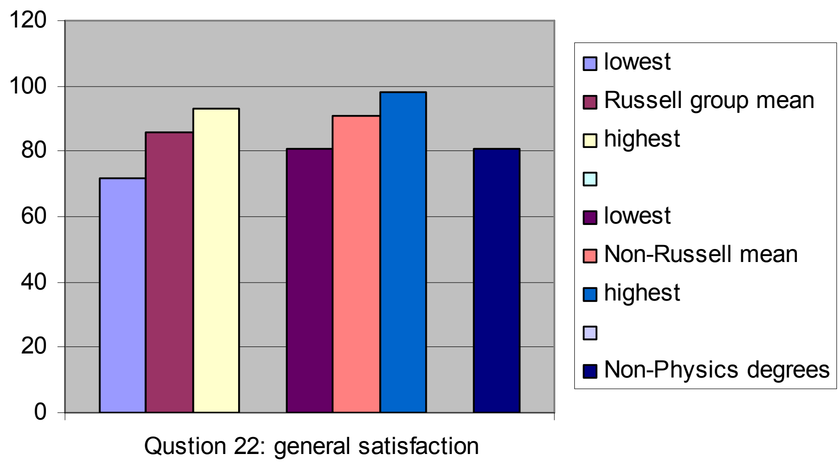
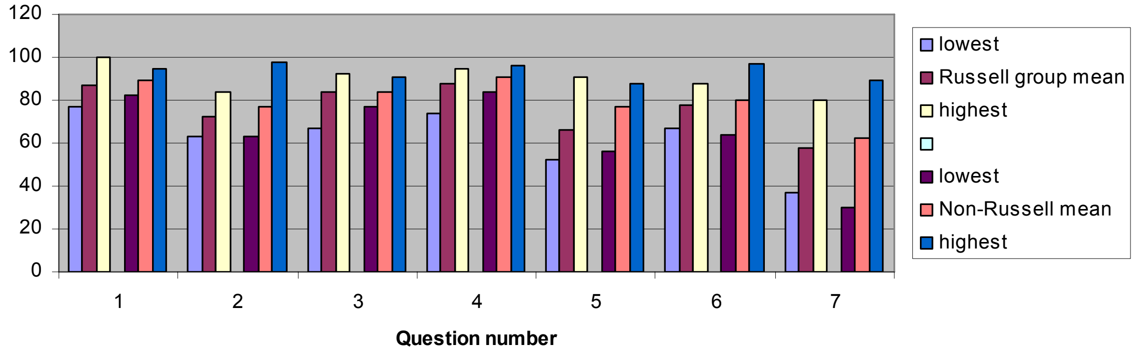
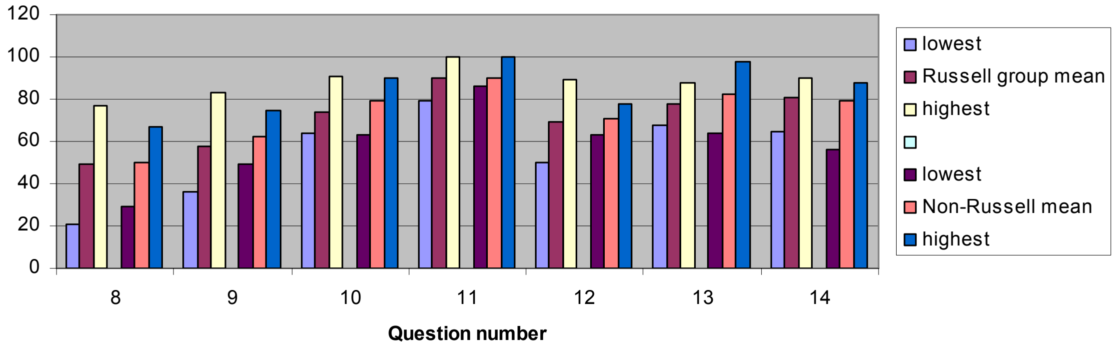


Figure A4.1 The response of physics students to the statement "Overall, I am satisfied with the quality of the course". The columns give the percentage of responding students who 'mostly agreed' or 'strongly agreed' with the statement. The right-hand bar gives the overall response for all degree subjects.

Table A4.1 Physics department results from the National Student Survey. The table gives the percentage of responding students who 'mostly agreed' or 'strongly agreed' with the statement.

Statement	Low	**Russell group mean**	high	low	**Non-Russell group mean**	High
The teaching on my course						
1. The staff are good at explaining things	77	**87**	100	82	**89**	95
2. Staff have made the subject interesting	63	**72**	84	63	**77**	98
3. Staff are enthusiastic about what they are teaching	67	**84**	92	77	**84**	91
4. The course is intellectually stimulating	74	**88**	95	84	**91**	96
Assessment and feedback						
5. The criteria used in marking have been made clear in advance	52	**66**	91	56	**77**	88
6. Assessment arrangements and marking have been fair	67	**78**	88	64	**80**	97
7. Feedback on my work has been prompt	37	**58**	80	30	**62**	89
8. I have received detailed comments on my work	21	**49**	77	29	**50**	67
9. Feedback on my work has helped me clarify things I did not understand	36	**58**	83	49	**62**	75
Academic support						
10. I have received sufficient advice and support with my studies	64	**74**	91	63	**79**	90
11. I have been able to contact staff when I needed to	79	**90**	100	86	**90**	100
12. Good advice was available when I needed to make study choices	50	**69**	89	63	**71**	78
Organisation and management						
13. The timetable works efficiently as far as my activities are concerned	68	**78**	88	64	**82**	98
14. Any changes in the course or teaching have been communicated effectively	65	**81**	90	56	**79**	88
15. The course is well organised and is running smoothly	73	**84**	97	52	**85**	97
Learning resources						
16. The library resources and services are good enough for my needs	72	**89**	100	79	**90**	98
17. I have been able to access general IT resources when I needed to	78	**91**	100	68	**93**	100
18. I have been able to access specialist equipment, facilities, or rooms when I needed to	65	**87**	95	65	**84**	100
Personal development						
19. The course has helped me to present myself with confidence	61	**68**	83	57	**75**	84
20. My communication skills have improved	53	**70**	93	70	**78**	84
21. As a result of the course, I feel confident in tackling unfamiliar problems	68	**77**	91	62	**81**	89
22. Overall, I am satisfied with the quality of the course.	72	**86**	93	81	**91**	98





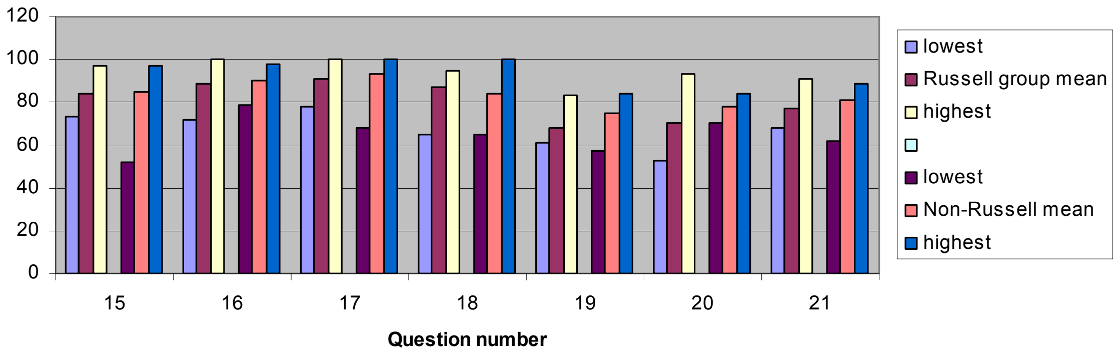


Figure A4.2 Graphical representation of physics department results from the student survey (See Table A4.1). The columns represent the percentage of responding students who 'mostly agreed' or 'strongly agreed' with the statement.

Direct comparison of the NSS with this "student learning experience" report can only be made for a limited number of the questions, but there appears to be reasonably good agreement:

NSS Q22 "Overall, I am satisfied with the quality of the course" agreement: 86% Russell group, 91% non-Russell group.

This can be compared with Table 1 in section 5.5 where 86% (Russell group) and 82% (non-Russell group) of the students rated the majority of their teaching as "Excellent" or "Good"

NSS Q1,2,3 on students' views on staff attitudes can be compared with students' views on types of teaching in section 5.5 and their perception of the priority that staff give to teaching in that section's Figure 34.

NSS Q4 "The course is intellectually stimulating" (agreement 88% Russell, 91% non-Russell) is consistent with (although the comparison is not exact) the discussion in section 5.1. Figures 19 and 20 show that 3% or less of students thought that they were not being sufficiently challenged in at least some modules in their current year of study, and with the benefit of hindsight a higher proportion (8%) felt they could have been challenged more in previous years.

NSS Q6,7,8,9 on feedback can be compared with the results and discussion in section 6.5 The results again seem similar.

NSS Q20 "My communication skills have improved" (agreement 70% Russell, 78% non-Russell) compares well with Figure 57 in section 7, where 70% (Russell) and 80% (non-Russell) of students report that they feel they have been given sufficient exposure to communication skills training during their course.

Comparison with IOP survey

"Physics – building a flourishing future" Report of the Inquiry into Undergraduate Physics", Oct 2001 Institute of Physics, London, ISBN 0 7503 0830 3 and available at:
<www.iop.org/activity/policy/Projects/Archive/file_6418.pdf>

This valuable report has a very different approach than our "student learning experience" investigation, and it is complementary rather than directly comparable. It emphasises the importance of physics degrees for industry, commerce, academic research and society. There are major concerns in the recruitment of sufficient numbers of physics students. Possible new interdisciplinary degrees are proposed, particularly for the less mathematically-inclined. It emphasises the problems of funding of physics departments, and of the erosion of regional provision through department closures.

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To request copies of this publication please contact the Centre.

Higher Education Academy Physical Sciences Centre
Department of Chemistry
University of Hull
HULL
HU6 7RX
United Kingdom

Tel: +44 (0)1482 465418
Fax: +44 (0)1482 465418
psc@hull.ac.uk
www.heacademy.ac.uk/physsci

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