Lab skills of new undergraduates

Report on the findings of a small scale study exploring university staff perceptions of the lab skills of new undergraduates at Russell Group Universities in England.

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Executive summary

By the time they come to university we should be teaching them advanced lab skills, we should be teaching them concepts and so on rather than how to use a microscope.

In April/May 2011 an electronic survey was developed to examine university staff perceptions of the standard of laboratory skills possessed by students with science A levels from schools in England and Wales. The survey was distributed to admissions tutors and those involved in first year lab teaching in Biological Sciences, Chemistry and Physics departments in Russell Group universities in England. Of a contact list of 75, 34 respondents completed the survey (45%). Twelve of these respondents also participated in a follow-up telephone interview.

The main findings are:

- Across the board respondents that new undergraduates lack at least some confidence in the lab (100%), and are not well equipped with lab skills (97%).
- Over half (57%) felt that the level of lab skills had declined in the last five years, compared to 29% and 37% that reported a decline in levels of new undergraduates' knowledge and understanding respectively.
- This was despite all respondents (100%) stating they had increased the grades required for entry to their courses.
- Some said the decline was gradual and had taken place over the last 10-20 years, others felt it had become more pronounced in the last 3-5 years.
- Some felt there was little or no real decline, but that university teachers were becoming more aware of new undergraduates' skill levels and adapting accordingly.
- The largest factor contributing to the lack of skills was cited as students' limited exposure to practical work at school. Respondents reported teaching students that had done very little practical work and whose teachers relied heavily on demonstrations and/or videos. Decreasing levels of 'hands-on' practicals in school was seen as linked to the decline in skills of new undergraduates. Some also said that the proportion of their cohort with limited exposure was increasing.
- University teaching staff had made a number of changes to their lab-based teaching:
    - Simplifying first year lab courses by providing more step-by-step instructions, removing complex experiments or allowing more time;
    - Increasing the focus and/or time spent on basic skills;
    - Increasing the levels of support through more staff time or demonstrators;
    - Introducing online pre-labs
- It appears that three factors interacted to stimulate the changes: a deficit and/or decline in students' lab skills, awareness of student needs and general improvements or new/good practices in teaching and learning i.e. not all the changes were down to poor/declining skills, but this was a factor for some.
- Some interviewees felt that the changes they had made across their teaching (including labs) had an impact on the level of the degree that their students would leave with. A few felt that a current four year degree was equivalent to a three year degree a decade ago. Others felt there was little or no impact on this.

1 Methodology

In April/May 2011 an electronic survey was developed to examine university staff perceptions of the standard of laboratory skills possessed by students with science A levels from schools in England and Wales.

It was decided to focus on Russell Group universities in England for several reasons:

- Practicality: the timescale of the study was tight and this gave a useful focus;
- These institutions were most likely to have traditional Biological Sciences, Chemistry and Physics departments where appropriate staff could be identified;
- These universities would tend to have the highest entry requirements, so changes in skill levels identified here might be indicative of changes across the HE sector.

A contact list of admissions tutors and staff involved in teaching first year practicals was developed through web-based and telephone research. We also used personal contacts in some institutions to identify potential respondents.

The survey was distributed directly to 75 potential respondents. As well as those on the initial list, a number of respondents replied with suggestions of colleagues that might give a useful response. These individuals were subsequently contacted and added to the database (i.e. included in the 75). Nine of these contacts were sent a link to forward to others, so the list of potential respondents is likely to be higher than 75 but this is not possible to know. In one department, the contacts discussed the survey and a single response was submitted by a representative. This may have been the case in other institutions, but it was not reported.

2 Samples

The survey distribution period fell over the bank holiday weekend, close to the Easter break. This meant that many universities were closed or staff were on leave until the last few days the survey was open.

Thirty-nine responses to the survey were received and 34 completed the survey. Of the 75 people contacted this represents a 52% response rate and a 45% completion rate. Given the timing of the survey, these are strong response rates that reflect the study participants' interest in this issue. All (100%) of respondents gave permission for their feedback to be used as evidence in the Select Committee inquiry.

At the end of the survey, respondents were invited to participate in a telephone interview. Eighteen participants opted in and twelve were successfully contacted to discuss the issue further.

Twelve of the 15 Russell group universities are represented in the survey sample with between 1 and 5 responses. Those excluded are UCL, King's and Warwick. Eight institutions were represented with between one and three telephone interviews.

Institution	# responses
Imperial College London	3
Newcastle University	1
University of Birmingham	1
University of Bristol	3
University of Cambridge	5
University of Leeds	1
University of Liverpool	3
University of Manchester	5
University of Nottingham	2
University of Oxford	4
University of Sheffield	4
University of Southampton	2
(blank)	5
Grand Total	**39**

Respondents were also asked to state what department they came from. These were grouped broadly into three categories: Chemistry, Physics and Biological Sciences. Physics included Physics and Astronomy departments, while Biological Sciences encompasses Life Sciences, Plant Biology and Animal Sciences. Engineering staff were not targeted, so the respondent from that discipline may have completed the survey after having it forwarded by a colleague.

Subject	Survey	Interviews
Chemistry	14 (41%)	4
Physics	14 (41%)	5
Biological Sciences	5 (15%)	3
Engineering	1 (3%)	0

Respondents from the Biological Sciences are under-represented in the survey sample; however it was possible to interview all the respondents that opted in from that discipline.

There was a balance between admissions tutors and lab managers in both interview and e-survey samples. Note that the term 'lab manager' in this case refers to those that run and teach first year labs, rather than a lab manager that might oversee the smooth running of the facilities. There was some ambiguity about this term: where respondents wrote something into the 'other' field that fit this description their responses were recoded as lab managers.

Role	Survey	Interviews
Admissions Tutor	13	5
Lab manager	13	6
Admissions tutor and lab manager	3	0
Other	5	1
Blank	5	0

'Other' responses (some were recoded as lab manager) were:

- University Teacher (undergraduate teaching & labs)
- Director of Teaching and Learning
- Director of Laboratory Learning and Teaching
- Director of Teaching
- joint "Head of Class" for first year practical classes
- College Senior Chemistry Tutor
- Director if (Undergraduate) Teaching
- Associate Dean Education
- Biology Programme Director; Plant Science Programme Director
- Level 1 Practical Co-ordinator

The table below shows how many years respondents had been teaching undergraduates. From the interviews, it was clear that for some these were not all at the same institution, although others had been at the same institution for longer and were able to describe changes that had taken place over the last decade or more.

Number of years teaching undergraduates	Survey	Interviews
5 or under	4	2
6-10	7	3
11-15	7	3
16-20	5	1
21 or over	11	3

3 Findings

Throughout this report the e-survey and interview findings are presented side-by-side. To distinguish between the two, e-survey quotes are highlighted in ***blue text*** and interview quotes are highlighted in ***red text***.

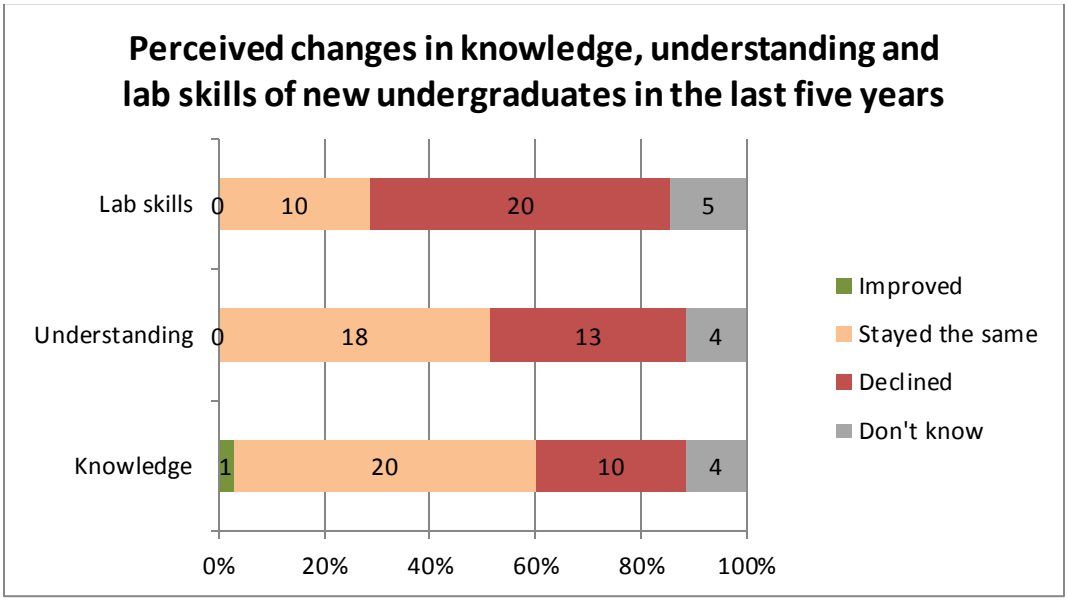
3.1 Entry requirements

As expected with the Russell Group universities, entry requirements were high. The lowest reported entry requirement was BBB at A level (for one chemistry department and one Biological Science department). All others asked for at least one A, with many asking for AAA. Several also now asked for at least one A* at A level. The highest entry requirement reported was A*AAA. Some distinguished between BSc and MSci courses, with MSci requiring higher grades.

All respondents (100%) had increased the grades required for their courses. There was little change in the subjects required apart from a few with a greater emphasis on maths. The exception was biological sciences: two respondents said that they are less strict on the additional science and allow entrants with, say, geography or psychology rather than chemistry. This was also reflected in the interviews, where one said it this had been relaxed to increase the number of eligible entrants.

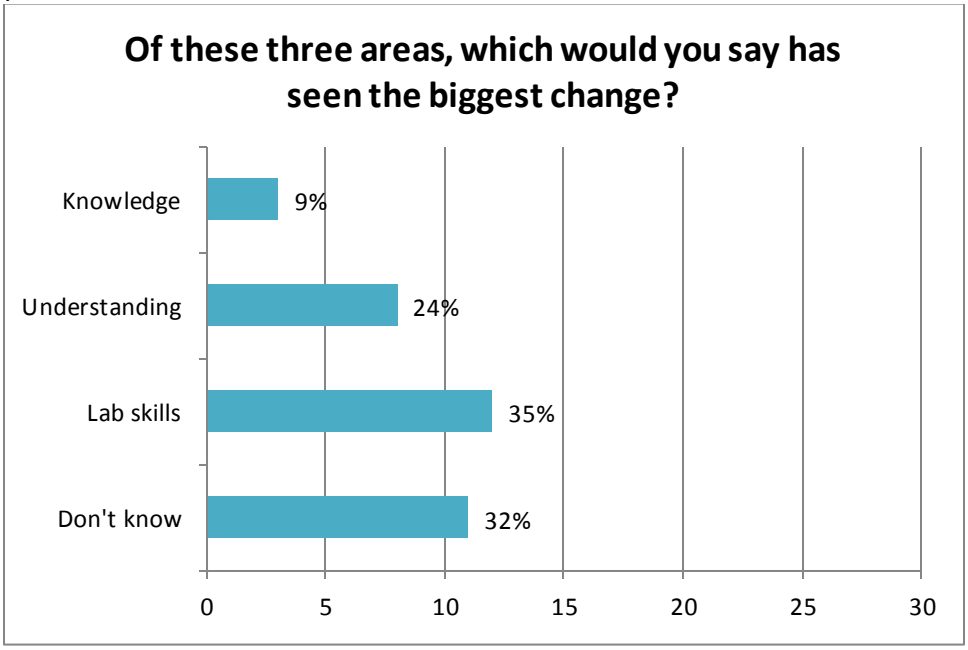
3.2 Knowledge, understanding and skills overview

The chart below summarises respondents' perceived changes in the levels of knowledge, understanding and lab skills of new undergraduates.



The largest proportion of respondents reported a decline in lab skills among new undergraduates, compared to knowledge and understanding.

Respondents were also asked in which area they had seen the biggest change. Results are presented below.



A third (35%) of respondents reported that there was the largest change in lab skills. A similar proportion (32%) said they did not know, for some this was because they did not teach in the lab, or taught mainly in the lab and had little exposure to students in other learning environments.

Findings from the rating questions were crosstabulated by subject and by respondent role (admissions tutor/lab manager). Given the small sample sizes, it was difficult to identify trends. Lab managers appeared to be more likely to cite a decline in lab skills than admissions tutors or others. They were also more likely to cite a lack of skills or confidence in the lab than others. There was a slight trend that those from physics departments gave more negative responses, but this may well be down to the natural fluctuations in responses rather than an actual link. Still, this would be worth exploring further in a future study.

A more detailed breakdown of responses to the questions about knowledge, understanding and skills are provided in the next sections.

3.3 Knowledge and understanding

Respondents were asked:

Over the last five years, have you noticed a change in the level of knowledge among new undergraduates entering your university directly from the English/Welsh school system?

By 'knowledge' we are referring to their familiarity with different topic areas within your subject.

Responses were:

- 1 (3%) felt the level of knowledge had improved among new undergraduates
- 20 (57%) felt the level of knowledge had stayed the same
- 10 (29%) felt the level of knowledge had declined among new undergraduates
- 4 (11%) said they did not know

Respondents noted that changes in school science meant that students come with different knowledge, rather than less knowledge. Several commented that the difference meant there was less knowledge that was relevant to the subject at university level. Some commented that there was less breadth of relevant knowledge as well as less depth. A few (especially physicists) commented on a decrease in levels of mathematical knowledge.

> *Students do not know fewer things, but know less that is relevant to University chemistry.*

The next question was:

Over the last five years, have you noticed a change in the level of understanding among new undergraduates entering your university directly from the English/Welsh school system?

By 'understanding' we are referring to a deeper grasp of concepts and processes, rather than a recall of facts.

Responses were:

- 0 (0%) felt the level of understanding had improved among new undergraduates
- 18 (51%) felt the level of understanding had stayed the same
- 13 (37%) felt the level of understanding had declined among new undergraduates
- 4 (11%) said they did not know

Several respondents commented that students find it difficult to link concepts together and solve problems independently.

> *There seems to be a lack of recognition of the connections which exist between areas for many students. This hampers their holistic grasp of topics.*

Several also commented on a decline in mathematical ability

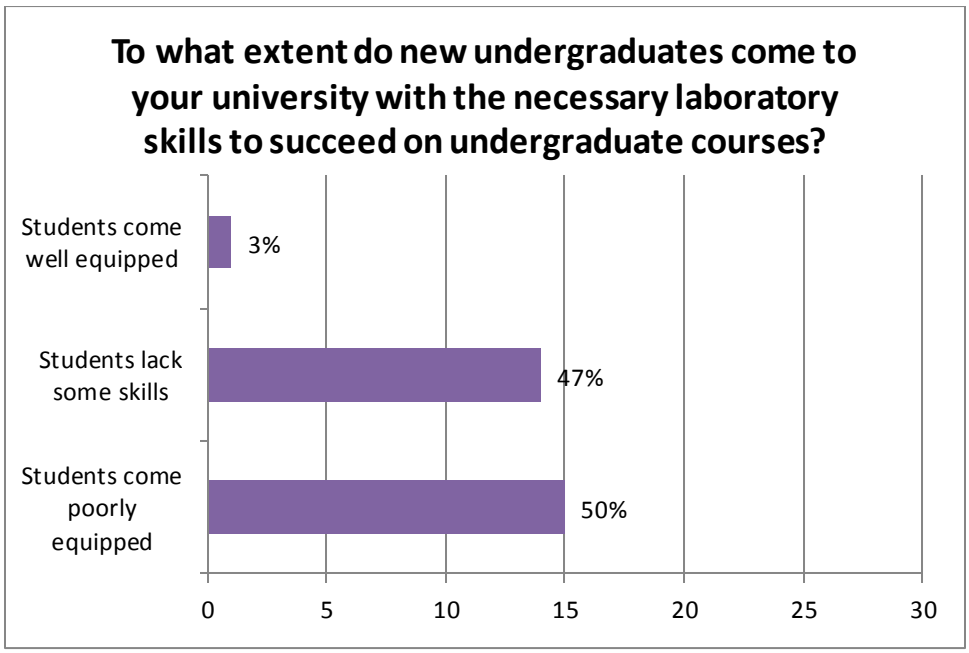
> *There appears to be a steady decline in the ability to define and solve problems mathematically. There seems to perhaps be a trend to more rote learning of solutions to specific problems at school.*

One also hinted at the greater range of abilities, a theme that was further explored in the follow-up interviews.

> *With our increased entry requirements we have some excellent students with a deep understanding of concepts but our average to lower ability students struggle more now than 10 years ago*

3.4 Lab skills

Skills for success



Excluding those that said they 'don't know', a large majority (97%) of e-survey respondents rejected the idea that students come well equipped. Half (50%) said students come poorly equipped. Lack of time spent doing practicals at school and the fact that students do not have access to certain pieces of equipment that university teachers might expect were raised in the open responses.

> *Lack of experience. A lab skill is not a formula that can be taught once and applied by rote. It is the integrated experience of what works and what does not.*

A few also commented on the diversity of experience levels, and how the university adapts.

> *The point is that we at the university have to adapt to accommodate the students whatever preparation they have had before.*

E-survey respondents were also asked which specific skills new undergraduates have, and which they lack. Responses here are broken down by subject.

Subject area	Lab skills students are perceived to have	Lab skills students are perceived to lack
Biological Sciences	• Experimental design	• Mathematical skills • Manual dexterity • Making observations (including identification skills) and drawing • Use of microscopes and other equipment
Chemistry	• Basic skills (titrations mentioned by several, also weighing) • Manipulating common glassware • One said that students were keen to do the practical work	• Although one respondent said students were able to use common glassware, several commented that they lacked skill in handling glassware, especially more modern equipment. • Error estimation • Making and recording observations • 'Thinking about what they are doing while they are doing it' • Presenting data and writing up
Physics	• Competent with computers and IT	• Ability to set up apparatus • Ability to take accurate measurements • Awareness of experimental error • Technical and manual ability • Initiative in the lab • Lab report writing • Electronics

Interviewees gave further examples that highlighted the extent of the issue:

> *They can't apply these tools and these skills outside the narrow environment in which they were taught.*

> *They'll know you need a volumetric flask but if I go down and say to them can you make an accurate solution they wouldn't know how to do it because I've not said you need to use a volumetric flask to do it. That wouldn't come up in an exam because on the practical exam they would have their equipment given to them so they don't have to think about it. In my lab all the glassware's around and they pick what glassware they want to use.*

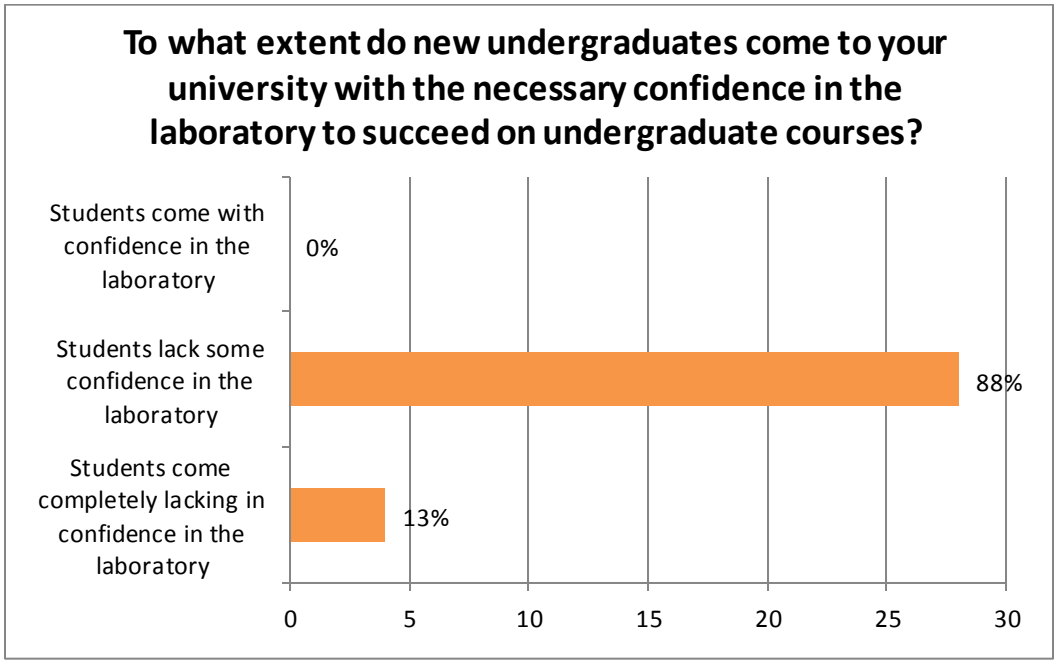
Interviewees were also asked specifically about lab books and about health and safety. All said that students had very limited experience of using lab books prior to university. Some

went on to say that they would not necessarily expect students to have come across this way of working at school.

> *We certainly get students that come here and they know how to do a lab book and it's great but the majority of them don't. They've not really come across it and it isn't their fault, it's something that's not expected at that level really.*

Health and safety concerns were also explored with interviewees and the lack of skills was not seen to have much impact because this is such a high priority in the lab. A few reported that extra measures taken to help students perform well in the lab (especially in building confidence) also helped promote health and safety.

Confidence



Again, respondents that said they 'don't know' were removed from the sample for this question. No e-survey respondents felt that new undergraduates are confident in the laboratory when they arrive at university. Some felt that this was to be expected and hadn't changed much over time.

> *This is fairly general, and was the case when I went to uni in 1993 too!*

Most linked lack of confidence to students' limited experience with practical work prior to university. Some also commented on students' desire to find the 'right answer' at the expense of an appreciation of the experimental process.

> *They seem to have less and less hands on experience at school and in the home. They find it difficult to diagnose and think through problems and are quick to blame equipment rather than their own technique.*
>
> *Confidence in this context comes from being familiar and competent with lab skills, as they have done little practical work at school they cannot be expected to be confident.*

The interviews allowed the e-survey findings to be explored in greater depth. All interviewees reported a deficit in skills of new undergraduates, but were keen to stress that they did not see this as the fault of the students. Those that taught in the lab had sought feedback from students on their lab work at school. They reported hearing that some students had done very little practical work at A level.

> *When I've said to them have you done practicals before? What they'll say is yeah we've watched a video, we never actually did anything or the teacher demonstrated something at the start of the lab or the ones where they've had practical exams have said yeah the only time we did a practical was we did a mock practical and then we did the same practical in the exam, so they just don't have any experience of actually being in a lab doing chemistry.*

Interviewees speculated that the cost of equipment in school, non-specialist teachers lacking confidence, the relatively low proportion of marks available for demonstrating lab skills and limited technician support could all be factors that dissuaded teachers from running practicals. Many also commented that they felt increasing pressure for exam results meant that teachers and students focused on marks at the expense of understanding or problem-solving. While most highlighted a lack of practical work at A level as the main factor, a few noted that changes at GCSE level also had an influence.

> *If the students are not doing some of the academic material at GCSE then how can they be expected to launch straight into things at A Level? You have to give them the foundations to make sure they understand it. So you might be starting at a slightly different level and you can't say that the GCSEs are bad because they're not, they're good but it's just that the coverage is different and maybe they're not as well prepared for an A Level in chemistry.*

For biologists, wider entry requirements may also be a factor that contributes to students' lack of skills.

> *Unfortunately maybe a third to a half of ours haven't done chemistry. So it's that broader base I think you'll see in the background for biologists than you will for chemists … I think perhaps there's a higher proportion now coming in who have only done two sciences rather than three or there's been a move towards things like geography or psychology which are not as experimental in their nature.*

E-survey respondents were asked whether students from state schools had better or worse skills than students from independents schools, and whether students from England/Wales or overseas generally had better skills. Many found it difficult to differentiate as they were unaware of students' backgrounds or because it depended on the country in question.

When asked about state/independent schools, 20 (61%) did not know if there was a difference, 10 (30%) felt that students from independent schools had better skills and 3 (9%) felt there was not much difference. This was largely put down to the independent sector providing more opportunities for practical work, and potentially having more confident specialist teachers. However, several pointed out that this was not necessarily true of all independent schools.

We see very few undergraduates from independent schools. What really makes the difference is the quality/dedication of the teacher and the support within the school/college for science teaching. For example, some schools really encourage their students to take part in enrichment activities (e.g. workshops offered by Universities such as ourselves) and some teachers find it extremely difficult to get permission from senior management to bring students out of school.

Interviewees also drew distinctions between schools that did different amounts of practical work, rather than differentiating between state and independent schools.

We've got some schools that do a practical a week and I could name you some local schools where I know they do fantastic stuff, their kids love it, they arrive bright eyed and bushy tailed and it's not a problem. But we've got other places where they only do what they have to do for the ISAs. So they do like two practicals a year.

Two thirds of respondents (65%) were unsure whether there was a difference in lab skills among students from England/Wales and overseas. Two (6%) felt that students from England/Wales had better skills, three (9%) felt overseas students' skills were better and 7 (21%) felt they were about the same.

Very variable. Students from some countries are clearly well prepared, others less so. Overall non-UK students are probably about equal to UK students.

Changes in levels of lab skills

Respondents were asked:

Over the last five years, have you noticed a change in the level of laboratory skills among new undergraduates entering your university directly from the English/Welsh school system?

By 'laboratory skills' we are referring to the ability to work with apparatus effectively. We do not include experimental planning or data analysis etc. in this definition.

Responses were:

- 0 (0%) felt the level of laboratory skills had improved among new undergraduates
- 10 (29%) felt the level of laboratory skills had stayed the same
- 20 (57%) felt the level of laboratory skills had declined among new undergraduates
- 5 (14%) said they did not know

Many respondents reported a decline, although some said it had taken place over a longer period than the last five years.

Many students are telling us that they have done no practical work at school so they struggle with basic skills like using a microscope, with which they previously would have had some experience. Although I would say the decline has taken place over a longer period than 5 years.

As indicated by the quote above, many respondents reported students telling them they had done little or no practical work at school, and that this had been replaced by teacher demonstrations or videos.

> *Many of them claim to never have carried out an experiment only watched teacher/videos of. Most of them have no idea how to act in a lab or where to even begin when carrying out an experiment, i.e. no idea what equipment is called,*

A lack of confidence and ability to work independently were also raised by some.

> *Lab skills have fallen precipitously and this has been accompanied by a loss of confidence among students in what they can do and a drop in their ability to work without specific and very detailed instructions.*

A few also described how this changes once students reach university.

> *Students are nervous about practicals when they come to University, but they really enjoy the practical once they get settled in.*

A similar question was asked later in the e-survey, when respondents had reflected on the types of skills students had/lacked and their confidence levels. It asked whether respondents felt there had been a change in the general level of lab skills, confidence in the lab, or specific skills for new undergraduates over the last five years. They were asked to describe any changes.

There was an interesting divergence here. Some respondents stated that there had been no change, while others felt there had been a strong decline. A few said that the change had been taking place over longer than five years. Many referred to their comments in earlier parts of the survey. Comments included:

> *Not that I have noticed in my teaching.*
>
> *Five years is too short a time period. 15-20 years yes, I believe there is a difference.*
>
> *Although it fluctuates from year to year it is noticeable that at entry students lack confidence in the lab, and the situation is getting worse.*
>
> *As mentioned before, the amount of experience in the lab varies quite dramatically. On the whole, it seems that less practice is gained in schools these days. Whether this is due to health and safety concerns, finance or lack of appropriate facilities, I cannot say.*

Most of the interviewees (all but two) felt that new undergraduates' skill levels were getting worse. Of these, some felt that the decline had been slow and steady for a long period of time (10-20 years) while others felt there had been a sharper decline in the last 3-5 years.

> *It's been ongoing. It's not something that just switched on in the last five years, I mean my timescale teaching at universities in this country, I guess is around 15 to 20 years and it's been noticeable throughout that period.*
>
> *So from when I first started you might have been talking about one or two students like this whereas I would say now it's a good 60 or 70% of students just have no*

confidence at all of their ability in the lab and it's only getting worse as the time's going on.

Those that reported little change felt that there had always been a gap between the skills new undergraduates had and the skills university teachers expected of them. One felt that it was the assumptions about students that had changed, not the students themselves.

When I first came here I think there was a lot of false assumptions as to what students could do. They used to have this joke that in the first year lab you couldn't hear the sound of the weeping because it was masked by the sound of the crashing glass. They were being asked to do things that were beyond their capabilities and it was very, very difficult for them and so about ten years ago we really notched down the expectation of the practical course a lot and since then my impression has been that they can broadly cope with it.

Another respondent described how the changes at his institution were in part in response to the changing skill levels, but also about the awareness of them:

I think it really is the students' needs are changing. I mean we were a bit behind the curve in some senses in that some things have stayed more or less the same for a while whereas the students' needs and abilities have clearly been evolving fairly steadily and so the mismatch between the two has just grown to a level where we needed to do something quite large to match them up better.

Some interviewees framed the decline as creating a broader range of skill levels in the student body.

I think it has stretched out the students in the sense that the brighter ones just catch on so quickly that it doesn't matter much to them that they didn't come in with such strong preparation. But you really notice it in the weaker students that they just haven't had that training to actually have those lab skills and the maths skills and the physics skills.

One interviewee felt that the wider range was understandable because they were accepting five times more students now compared to 20 years ago. Others mentioned that it was difficult to differentiate between students given so many now get the top grades at A level.

All of these students are coming in pretty much with As in maths and physics at A Level and so in fact it's possibly somewhat alarming that the variation is so big. I mean there are a reasonable number of students who've got As in maths and physics who come to university and really struggle with first year.

In discussing changes in undergraduates' skills, there was also an issue with some comparing lab skills of students now with their own experiences as students, rather than their earlier experiences as teachers. This means that the decline may be over-emphasised in some cases. However, I would say there is strong enough evidence for a decline in skills even taking this into account.

3.5 Steps taken to address the lack of skills

The e-survey asked whether respondents had made any changes to lab-based teaching in their departments in response to the lab skills that new undergraduates bring with them. Most listed changes they had made, although for some of the responses it was unclear whether these were in response to changes in the levels of undergraduates' skills, or general improvements in teaching and learning.

Nine e-survey respondents reported ways that experiments had been simplified for undergraduates, e.g. by providing more detailed instructions, removing more complex experiments/material, reducing the number of experiments or including instructions on basic techniques.

> *We have redesigned the whole first year course - removing much of the material previously taught and starting at a lower level and with much less expected in each class*
>
> *The difficulty of the experiments have steadily been made easier by having second years perform experiments formerly done by first years, etc. or removing the more complex part of the experiments like flash column, GC use, etc.*

One interviewee described this as moving towards a more 'school-like' pedagogy.

> *We've kind of displaced the university entry level into what would be entry into our second year. So we've ended up teaching our first year students more and more like school children and then what we've found paradoxically then is we find that they get hit by the transition from our first to second year.*

Seven respondents described an increased focus on basic or core skills in the early years of their degrees.

> *I have made substantial changes in our first year laboratory in the last five years. We are beginning to focus down on experiments that focus on core skills whereas we would have commenced with more sophisticated experiments in the past.*

Three respondents commented that they had always had a focus on basic skills at the start of their courses, so this had not changed. However one interviewee felt that the foundation course had become increasingly important.

> *It's required to do the foundation lab which gives standardisation of skills across the board. I don't think that has changed over the years; there has always been a range of skills from students from different backgrounds. It's fair to say that it's more important now than ever before. I've only been here two years, but talking to my predecessor he says the course is more and more important as we go along because people just don't have that experience at school.*

One respondent described how changes coming in next year would mean more basic skills are taught in first year, but that more complex experiments would also be introduced to further extend students' knowledge and skills.

From next year we have completely redesigned our lab course for year 1. It has been extended to last year round and will contain additional introductory experiments to improve our students basic lab skills. Additional more complex experiments have also been added to better prepare the students for future years of study and to improve links to lecture courses.

A few also commented that more time was allowed for first year labs or basic techniques within them.

Reduced the number of exercises we give the students in some labs to allow them longer time to grasp the simple techniques.

Originally maybe ten years ago we might have expected to spend half an hour just revising with them the use of microscopes and then move on to look at plant cells and do things like scientific drawings and so on. Whereas now we might spend an hour and a half or two hours on the microscope stuff and then still have students at the end of that being confused about what they're doing and then not really getting onto looking at plant cells and looking at crickets and what have you.

Four respondents mentioned the introduction of online pre-labs where students could familiarise themselves with an experiment and its equipment before the practical itself. These were seen as helping students develop better skills, but it was unclear whether they were introduced specifically to address a decline in skills, or simply to make the most of new opportunities for teaching and learning.

Our prelabs include videos of the techniques being used in any given practical, theory videos and an online quiz. These have been very helpful in increasing confidence, although there's no substitute for real lab experience.

Three e-survey respondents commented on changes in the way that demonstrators are deployed to offer support. Two reported employing more demonstrators and one said that demonstrators are required to work more closely with students.

We have also had to increase the number of demonstrators in some practicals to help students struggling with skills

For some interviewees, the changes were in direct response to changes in levels of student skills. For others, they were linked to periodic reviews of teaching (that in turn responded to student needs) or based on new or good teaching practices, such as the introduction of e-learning or online pre-labs.

We're identifying how to teach well and so our teaching methods are improving.

Some students have a fear of the lab and online pre-labs help them. They are able to view pictures of the equipment beforehand and they give them a better idea of what they're going to be facing when they come in to the lab.

One interviewee had been through a large review recently where the input of a secondary school teacher had been valuable.

We do a major course review every five years or so, so this was just the latest of the major course reviews but we did it in a rather more major way than we usually do in that we actually for example we had a school teacher seconded to the department for the year and she helped out in lots of things.

This process had opened his eyes to how science is learned in school and major changes to the way labs and other courses were taught were made as a result. One or two other respondents reported having good links into the secondary education system and this was seen as very helpful in responding to new undergraduates' needs.

We can deal with it because we know what to expect, we do a lot of schools work. Having that broad knowledge keeps us aware of issues and we seem to be able to get them up to the level we want.

So it appears that three factors interacted to stimulate the changes:

- A deficit and (for some) a decline in students' lab skills perceived by university teaching staff
- Lecturers' improved awareness of how difficult the labs were and/or their awareness of students' skill levels
- General improvements and new/good practices in teaching and learning.

3.6 Impacts of changes on degrees

The final survey question asked:

Are there any other ways that new undergraduates' lab skills affect the courses, students and/or staff in your department?

Many respondents reiterated points raised earlier. However four respondents suggested that the lack of skills had an impact on project work undertaken later in the degree course. These comments were:

Progress through the lab course is to an extent set back by the poor standard of skills among the intake. This has a knock-on effect on the types of experiments, and their complexity, that we can offer in the later years of the degree.

It is now quite unusual for a student project to be of sufficiently high calibre to lead to a publication in a refereed journal.

The interviews were an opportunity to find out whether university teaching staff thought that changes in lab skills had any impacts on the quality of the degrees students eventually obtained. We expected that interviewees might be reticent to comment on this, but they spoke quite frankly about it.

Some felt that the changes they had made across their teaching (but certainly including labs) naturally had an impact on the level of the degree that their students would leave with.

I mean it makes sense to start from where they are and not have a big mismatch between what we assume they know and what they actually know and then we want

to ramp it up and obviously ideally we'd like to ramp it up to the same level that we've always ramped it up to but if you start from lower down it just becomes impossible to reach quite the same level.

I mean there's no doubt that it's influencing the quality of the degree and the quality of the graduates. They're starting from a lower base when they come in to university.

Others felt that through improved teaching and learning approaches (and modern technology) they were able to move their students along faster to reach the same end point.

I think we've just moved with the times really and what we're teaching now are skills that modern biologists need. I wouldn't be doing my job if I didn't think we could make up for the deficiencies of what we get ... I don't think there's a diluted sense of a graduate, in fact quite the opposite.

Several mentioned the move to four year degrees as beneficial in terms of allowing more time in the lab. Some felt that a current four year degree was the equivalent of the three year degree 10 years ago, but others felt the standard of the BSc had stayed about the same.

It's kind of like the starting point's got lower but the end point's had to stay the same and that's why I think a lot of universities now have moved to four year courses as opposed to three year courses, that it is being recognised that there is a – I don't want to say deficiency because again that's very negative and I can't stress enough that it's not that they don't have knowledge, it's just different knowledge.

My feeling is that actually at the end of a four year degree they've reached the same point that they used to have reached at the end of a three year degree. So in that sense clearly yes there has been a diminution in what we can actually do within a given period. But we use the longer period of a four year degree to get them to a higher level.

A few reported hearing that employers now provide more training 'on-the-job' to bridge the gap in skills.

I think there's a lot more training from what I've heard from people who have finished a degree here and then gone on to other places. I think that employers do recognise that there's other training that needs to be done now.