

The Student View of 1st year Laboratory Work in the Biosciences – Score Gamma?

Mike Collis¹, Alan Gibson², Ian Hughes³, Gill Sayers³, Martin Todd⁴,

¹British Pharmacological Society, London; ²King's College, London; ³Centre for Bioscience, the Higher Education Academy, Leeds; ⁴AstraZeneca, Alderley Park, Macclesfield

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Abstract

Students registered on 1st year bioscience courses in 9 universities were surveyed for their views on the laboratory classes they were taking. Returns were obtained from 695 (70%). Student views were varied, some viewing particular features of laboratory classes as 'good' while others viewed the same features as 'bad'. Students identified as the best features of laboratory classes:

- learning new skills and using new equipment;
- the opportunity for social interaction;
- the function of practicals to illustrate material given in lectures;
- the acquisition of new knowledge through practical classes;
- high interest value of practicals.

Most students preferred the laboratory classes they had experienced at school to those at university.

From the students' views about the worst features of practicals, issues are identified, attention to which may improve the view students take of 1st year laboratory classes. In outline these issues were the:

- effectiveness and consistency of staff in TEACHING laboratory classes;
- importance of students forming friendship networks in practical classes;
- perception that 1st year practicals are long, boring and tedious;
- poor organisation of practicals;
- magnitude of the transition which students are undergoing from school to university type work and environment.

Keywords: 1st year, practicals, laboratory classes, student experience

Introduction

It is reported by some employers (Association of the British Pharmaceutical Industry, 2005; Biosciences Federation 2005a; 2005b) that there is a shortage of appropriately skilled graduates in some bioscience areas particularly with regard to graduates with laboratory skills and aptitudes. One of the factors which has led to a general reduction in the practical experience available to students in Years 1 and 2 has been the introduction of teaching of generic skills and knowledge which has, in part, been found a place in the curriculum at the expense of some practical work. In addition, there is an increasing trend for students to take final year research projects based outside the traditional research laboratory context. The desire to reduce costs and the increased number of students are further pressures to reduce practical classes and the larger number of students means practicals may need to be simpler and more 'cook-book' in

nature. These and other factors have contributed to a reduction in the involvement of students in laboratory work and in their development of laboratory skills and aptitudes.

In order to combat this trend it was thought worthwhile to discover students' views on the practical work they undertook in Year 1 of bioscience courses so that changes could be made which might improve the students' view of practical work and feed through, into 2nd and 3rd Years, a student body more interested and involved in practical work. It was with this particular purpose in mind that this survey was carried out. It was not designed to make comparisons between universities or to compare or recommend syllabi. A full report of all the data obtained from the survey can be found at www.bioscience.heacademy.ac.uk/events/themes/practicals.aspx

Method

A questionnaire was designed to elicit students' views on the practical work they undertook in Year 1. The questionnaire was sent to academic colleagues in 9 universities who agreed to distribute it to students currently in Year 1 bioscience practical classes and to collect the completed questionnaires and return them to the Centre for Bioscience, Higher Education Academy. The questionnaires were distributed and completed in March/April, 2007. Data from completed questionnaires were transcribed manually into a database. Not all students answered all questions. Those questions requiring a graded answer were scored as stated, usually on a 0–10 or 1–10 scale and data are presented as means \pm standard error, n=number of responses included. A small number of responses were adjusted or ignored (e.g. age given as 1984 which appears excessive and was converted to 23; hours of scheduled practicals per week >30 (three responses)).

Where free text responses were elicited these were carefully examined to see if certain themes could be identified, albeit represented by different words. Where this was possible the number of responses contributing to each of the themes was counted. For example '*people, working with them*', '*meeting new people*', '*making friends in practicals*' and '*working in a group*' could all be taken to describe a social/group theme of practical classes. Where the data have been treated in this way, a description of the themes, the number of student responses contributing to each, the total number of responses which aligned with the themes and the number which did not, are all given in the appropriate table. It should be noted a single response by a student could be counted in more than one theme i.e. '*long, boring practicals*' counted as a response in two themes, one counting comments about the length of practical classes and the other recording comments on boring/tedious practicals.

Characteristics of student sample

A total of 695 completed questionnaires were returned from 9 universities (% return in parentheses): Birmingham, 9 (12%); Bristol, 63 (78%); King's College London 122 (81%); Leeds, 114 (63%); Manchester, 178 (77%); Manchester Metropolitan, 45 (56%); Portsmouth, 110 (73%); Reading, 13 (37%) and Sunderland, 41 (62%). The mean age of the students was 19.9 years (range 17 to 64), 436 (62%) were female, 257 (36%) male, and 2 students did not declare. Students were scheduled to work in laboratory classes for 6.48 ± 0.12 hours per week; n=677. The range was 1.5 to 23 and the median was 6 (3 answers of 30 or above have been eliminated from the data). The median staffing ratio (academic and non-academic staff) in the laboratory classes was 1:10 and the range 1:10 to 1:27.

When asked about the course they were on a large proportion (>50% at some universities) of students gave their course simply as '*BSc*' or '*Honours BSc*' without specifying the discipline (171). The largest single category which was specified was '*Biomedical Sciences*' which may hide future specialisation or be a generic registration for first-year students in biosciences.

Because of this uncertainty, the nature of the course being undertaken by students making returns was not analysed further though numbers are shown below.

Anatomy (3)	Neurosciences (28)
Applied Anatomical Sciences (13)	Neurosciences with Japanese (1)
Applied Biomedical Sciences (10)	Nutrition (12)
Biochemistry (29)	Nutrition with Dietetics (17)
Biology (3)	Pharmaceutical Sciences (11)
Biomedical Science(s) (162)	Pharmacology (85)
Biomedical Sciences with Forensic Biology (1)	Pharmacology with Physiology (6)
Chemistry and Pharmacology (1)	Pharmacology and French (1)
Cognitive Neuroscience and Psychology (5)	Physiology (19)
Human Physiology (6)	Physiology with French (1)
Human Sciences (25)	Rural Environmental Sciences (4)
Human Nutrition (1)	Study Abroad (1)
Life Sciences (8)	Veterinary Anatomy (1)
Medical Biochemistry (19)	Zoology (2)
Medical Sciences (44)	None/other (5)

Responses to the various survey questions

1. "Do you usually work in a laboratory alone, with a partner or as part of a group?"

The numbers responding to this question and the related question, asking which mode of working the students would prefer (numbers in parentheses) were respectively: 37 (44), 519 (483) and 197 (182).

The group size for *actual* working varied from 3 to 18 (median 3) and for *preferred* working from 3 to 15 (median 3). It should be noted a number of students gave positive answers to both the 'with partner' and the 'in group' sections of this question. Hence the total number of responses is greater than the number of students in the survey. With regard to working alone or in groups, the mode of working in the laboratory meets students' preferences as there are only small differences between the *actual* laboratory working mode and the students' *preferred* laboratory working mode.

2. Students were asked to score (on a 0 (little, fewer) to 10 (lot, more) scale) their views on a number of questions as shown below (mean \pm standard error, n).

2a. "To what extent did you enjoy the laboratory classes you have done?"

6.60 \pm 0.06, n=687.

2b. "How much do you feel you learned from practical classes?"

6.90 \pm 0.06, n=688.

Both values, being moderately above neutrality (5), indicated a positive view for both enjoyment of and learning from, practical classes.

2c. "If you had the choice would you opt for more or less laboratory classes in this year?"

5.23 \pm 0.09, n=651

2d. "Would you opt for a second year module with lots or only a little practical?"

5.47 \pm 0.09, n=661

Both mean scores were close to neutrality and the distribution was sharply peaked at a neutral value of 5. Even though students enjoyed practical classes and felt they learned from them, there was little indication that students wanted more at this stage.

3. "Did you enjoy practical classes at school?"

Graded high (10) for enjoyed school practicals more than at university and low (0) for enjoyed school practicals less than practical classes at university. The mean value 6.33 ± 0.08 $n=679$ indicated that, overall, practicals at school were more enjoyable than practicals at university.

This question also asked for free text responses on "what made the difference?". Associating the individual scores with the comments made indicated that a small number of students had not necessarily scored this question as expected. For example, a score of 7 (indicating moderate preference for practicals at school) was associated with a comment '*more variety at uni*'. Similarly, scores of 6 were associated with '*the uni practicals are more complex and interesting*' and '*classes in high school common, classes at uni were interactive and fun*'. It is possible therefore all students did not score this question in a consistent manner but the effect this possibility may have had on the mean score is unknown.

An alternative way of examining these data is to compare the number of students giving a score <5 (142; prefer university practicals) and the number giving a score >5 (454; prefer school practicals). The distribution of the scores given for this question is shown in Figure 1. Overall there is a view that practicals at school were better than practicals at university.

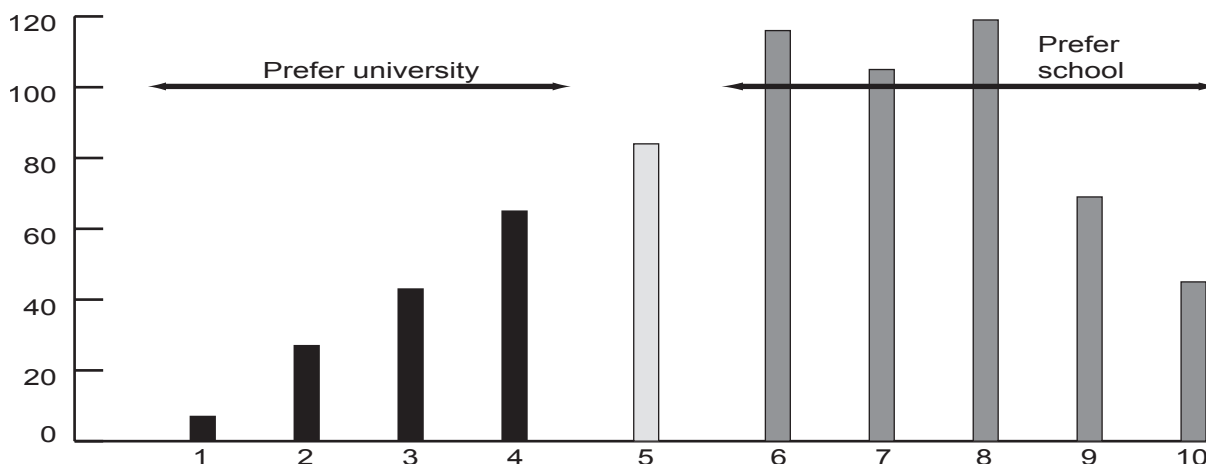


Figure 1 Showing the distribution of scores (0 to 10) in student responses to the question 'to what extent did you enjoy practicals at school?' (Graded high for enjoyed school practicals more than university; graded low for enjoyed university practicals more than school practicals)

Students were also asked to say "what made the difference" and 550 made a free text response. These responses were divided into 3 groups for analysis into themes as described in Methods. The three groups were defined as:

- those who had given a value of <5 in response to the question above indicating that they preferred the practicals at university (142, of whom 131 made comments);
- those who had given a value of >5 indicating they preferred the practicals at school (454, of whom 357 made comments);
- and those who had given an answer of 5 indicating no preference (85, not analysed further).

An analysis of the contents of the free text responses is shown in Table 1.

Considering the data on students' preferences for practicals at school or university suggests overall many students preferred the practical work at school. Examination of the free text responses suggests there are several components to this. Better teaching and more attention

feature strongly and several students mentioned passionate teachers who they had known for years and with whom they had established relationships. The more relaxed atmosphere and more fun were also important to students as was the smaller group size and the fact they knew everybody in the group.

Table 1 Showing the themes and number of responses to the question as to what made the difference between school and university practicals. Responses are divided into those from students who enjoyed practicals more in university and those from students who enjoyed them more at school.

Practicals better at university	No. (%)	Practicals better at school	No. (%)
More advanced; more challenging; more autonomy; more responsibility	33 (27%)	Better teaching; known teacher longer; more assistance and attention	61 (23%)
Better equipment; better facilities	28 (23%)	Better access to equipment; better organised	51 (19%)
More interesting	27 (22%)	More relaxed; more fun	45 (17%)
Better staff; better explanations; more guidance; better organisation	22 (18%)	Easier; less challenging	40 (15%)
More relevant	12 (10%)	Groups smaller; know everybody/ people better	34 (13%)
		More interesting	32 (12%)
Total included in themes (97%)	122	Total included in themes (79%)	263
Total comments	131	Total comments	357

For the minority of students preferring university practicals, the better staff, better explanations, better guidance and better organisation were important as was the more advanced aspect of university practicals with greater challenge, autonomy and responsibility.

The fact some liked to be challenged while others did not illustrates the variability between students in their needs, wants and likes. There are also some pointers here as to how the views of students on first-year practicals could be improved which are reinforced in responses to later questions. A notable quote from one student who said, regarding school practicals: *'Very good explanations and demonstrations given. Much more help given. A lot more teaching around the subject before the practical and told exactly what to do and why.'*

4. Students were asked "To what extent do the following words characterise your feelings about the lab classes you have done" (scored 0 to 10; 10 = highly applicable)?

Stimulating	6.57 ± 0.07, n=609
Fascinating	6.52 ± 0.07, n=619
Repetitive	5.81 ± 0.09, n=601
Boring	4.63 ± 0.08, n=579
Waste of time	3.06 ± 0.08, n=575
Frustrating	4.58 ± 0.10, n=595
Repeat of school	2.22 ± 0.07, n=568

While most of the distributions of the scores showed the usual bell-shaped curve or a smooth curve the distribution of answers scoring for “frustrating” showed a nearly flat distribution (Figure 2) quite different from the distributions of scores for the other words.

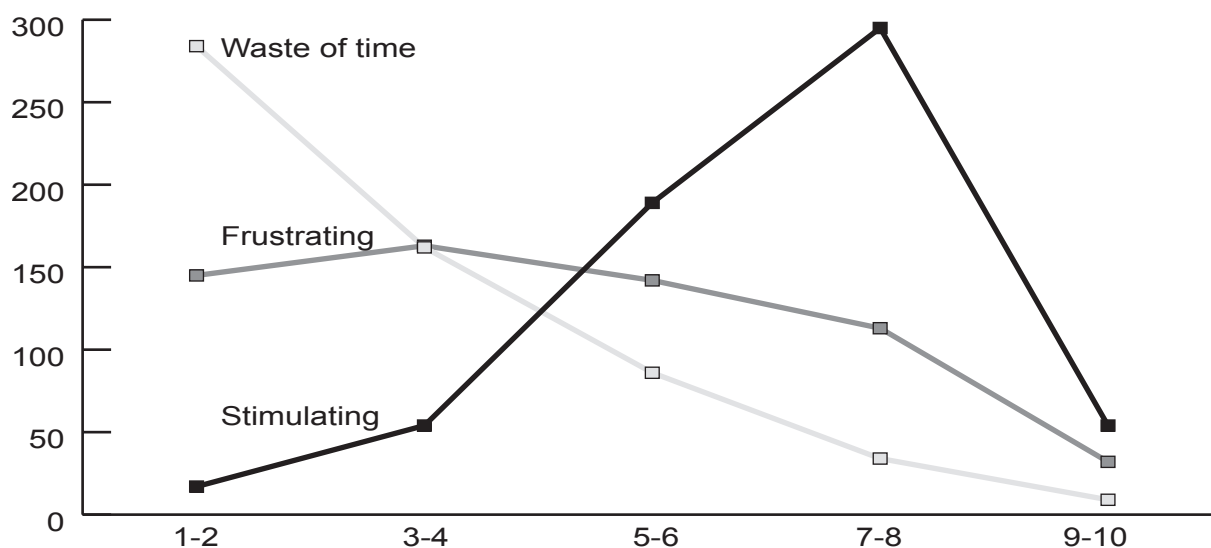


Figure 2 Showing the distribution of scores (0 to 10) in student responses to the question ‘to what extent did you enjoy practicals at school?’ (Graded high for enjoyed school practicals more than university; graded low for enjoyed university practicals more than school practicals)

Since a neutral score is represented by 5 it is clear the students found the practicals reasonably stimulating and fascinating, somewhat repetitive, but not particularly boring overall. The flat distribution of the scores for “frustrating” shows some students found practicals very frustrating while others did not and the divergence of feeling about this aspect of the practicals was considerable.

Most were agreed however that practicals were not a repeat of what had been done at school. For this aspect the distance of the mean value from a neutral value (-2.78 units) shows the size of the distance from neutrality obtained for a firmly held view. It provides a context in which to weigh the distances from neutrality found for “stimulating” (+1.57); “fascinating” (+1.52); “repetitive” (+0.81); “boring” (-0.37); “waste of time” (-1.94) and “frustrating” (-0.42), none of which were as large by a considerable margin. This also demonstrates that the question is able to elicit graded responses representing the students’ views. Thus while it is pleasing the students found the practicals slightly stimulating and fascinating, these scores were not as far from neutrality as might be hoped. Similarly, repetitive and boring were close to neutrality while it would have been hoped these aspects would have been viewed more positively. It is also interesting to compare some of the free text responses (particularly to “the three worst things about practicals”) where boring/tedious were frequently used words (see table 4).

Overall the scores do not indicate that there has been a failure to provide suitable practicals but they do indicate there is significant room for improvement. It should be possible to provide practicals which are viewed much more positively overall though bearing in mind the variability between students, it is unlikely that everybody will be completely happy with any practical.

5. Students were asked “What was the most valuable practical class you did and why?” The first part of this question produced a great range of replies. Some identified practicals not run at all participating universities, some identified subject areas, some discipline areas and some scientific topics. Because of this diversity of interpretation and response

this part of the data has not been analysed further. With regard to the second part of the question, "why was this practical class most valuable?" the variety of responses (590 (85%) out of 695) could be grouped into certain themes which are shown in Table 2.

Table 2 Responses to "why was this practical most valued?"

Nature of Theme	Number	%
Interesting, fun and enjoyable	90	15
Helped my understanding of material already taught	82	14
Learned new knowledge/material	71	12
Learned to use new equipment; acquired new skills	53	9
Saw science and/or theory in action	40	7
Related to job or career	25	4
Well explained and well organised practical	20	3
Plenty of hands-on work	18	3
Interactive and involving	11	2
Total responses in themes (70%)	410	
Total responses	590	

Some students provided a response which fitted with more than one theme. The remaining responses (180, 30%) were too diverse to be grouped into themes. For example: 'because it dealt with handling chemicals rather than wasting time looking at their effects', 'accuracy of results' and 'sadistic value'

6. Students were asked to identify the "three best things about the practicals they have done." Overall 621 (89%) of 695 identified one or more 'things'. From these replies it was possible to identify themes as shown in table 3, together with the numbers contributing to each.

Table 3 Responses to "... What were the THREE BEST things about the practicals you have done?"

Nature of Theme	Placed 1st; number	Placed 2nd; number	Placed 3rd; number	Total number(%) ¹
Learned to use new equipment, learning new skills	112	95	54	261 (42%)
Social groupings, making friends meeting people	48	61	47	156 (25%)
Illustrate material presented in lectures	53	30	28	111 (18%)
High interest value	64	27	16	107 (17%)
Acquisition of new knowledge	36	25	23	84 (14%)
Contribution from staff, help and explanations	24	32	21	77(12%)
Large hands on component	32	26	5	63 (10%)
Learning method different from lectures	20	26	16	62 (10%)
Fun	9	9	7	25 (4%)
Well organised/explained	7	8	6	21 (3%)
Totals	405	339	223	967
Residual unallocated responses [% totals]	201 [33%]	162 [32%]	173 [44%]	536 [36%]

¹The total number of responses and its percentage of the total number of students responding to this question. Student responses (621 out of 695 returns providing some answer to at least part of this question) grouped into themes as above. Some students provided a response which fitted with more than one theme. The number of residual responses which were too diverse to be classified into themes is also shown. For example: 'everything is laid out for you'; 'don't have to put anything away'; 'taking prescription drugs'

7. Students were asked to identify the “*three worst things about the practicals they have done*”. Overall 604 (87%) of 695 identified one or more ‘things’. From these replies it was possible to identify themes as shown in table 4, together with the numbers contributing to each. The responses to these two questions have in part been analysed together since there is some cross-over between the themes identified for the two questions.

Table 4 Responses to “... What were the **THREE WORST** things about the practicals you have done?”

Nature of Theme	Placed 1st; number	Placed 2nd; number	Placed 3rd; number	Total number(%) ¹
Too long	172	42	29	243 (40%)
Poor organisation, too much waiting about e.g. for reagents, poorly explained procedures	39	71	44	154 (26%)
The write-up; too long, too time consuming, too many, no help	37	53	29	119 (20%)
Lack of staff, staff unhelpful, incompetent	43	28	30	101 (17%)
Tedious/boring	54	30	13	97 (16%)
Timing; too early, too late, 0900h starts, Friday practicals	38	20	17	75 (12%)
Repetitive.	28	22	16	66 (11%)
Groups too large, partners unhelpful	6	19	11	36 (6%)
Pre- post- practical tests (e.g. MCQ)	2	7	10	19 (3%)
Number of practicals	5	8	4	17 (3%)
Faulty/unavailable equipment	3	9	5	17 (3%)
Totals	427	309	208	944
Residual unallocated responses [% totals]	181 [30%]	147 [32%]	117 [37%]	445 [32%]

¹The total number of responses and the percentage it represents of the total number of students responding to this question.

- a. It is clear from table 3 that “learning to use new equipment and learning new skills” ranked first in the list and that “illustrates material presented in lectures” (3rd) and “acquisition of new knowledge” (5th) were also high up. It was also pleasing that students thought the practicals had a “high interest value” (4th).
- b. The high importance given by students to “social groupings, making friends, meeting people” (2nd) was unexpected and may well reflect the very important social integration aspect of first-year and the crucial importance to students of the formation of effective friendship groups. While the social aspect of practical groups was valued there was a down-side as 36 students identified groups as being a problem principally because of their size but also because of the nature/attitudes of some of the members.
Quotes were:
‘if one person made a mistake the whole experiment was wrong’
‘being with groups of people who don’t care’
- c. Good contributions from staff (6th) were appreciated by 19% of the responding students in this question but this must be read in conjunction with the data from the question asking about the three WORST things about the practicals (table 4) where lack of staff, unhelpful and incompetent staff (4th) were identified as bad features of practicals by 24% of the responding students.

Some quotes (worst things) were:

- 'staff were rude if you didn't understand something'*
- 'demonstrators were always busy with somebody else'*
- 'lecturers not explaining procedures properly'*
- 'lecturers sometimes contradict each other'*
- 'demonstrators few and unapproachable'*
- 'Dr X made us feel that we shouldn't be here. He was patronising, rude inappropriate and tries to humiliate students in front of others'*

And (best things)

- 'lab techs very helpful and friendly'*
- 'demonstrators always at hand'*
- 'support from staff'*
- 'being responsible for your own results'*
- helped me put knowledge learned in lectures into practice'*
- 'learning how to use the special equipment'*

There were no marked differences between universities and students at a single university reported both very good and very bad interactions with staff. It appears therefore to be dependent on the individual and will, of course, reflect student attitudes and behaviours to staff, as well as vice versa.

- d. The single clearest opinion was that the practicals were too long with 243 students expressing this view (172 of them placing it first).
- e. The 2nd worst element was poor organisation and explanation (154 but only 39 placing this first). However, 21 picked good organisation/explanation as being one of the best aspects of the practicals.

Quotes were:

- 'waiting around for one thing to finish'*
- 'queuing for experimental apparatus'*
- 'labs done before lectures linked to them'*
- 'waiting ages for things'*
- 'a lot of waiting'*

- f. The third substantial element involved criticism of the write-up (119 students). They were thought to be too time consuming, too difficult and irrelevant. Some students did not favour being assessed through the write-up and others disliked the strict application of deadlines and lack of flexibility.

Quotes (worst things) were:

- 'weekly write-ups'*
- 'practical reports are not relevant'*
- 'long practical write-ups'*
- 'very difficult and lengthy write-ups'*

- g. The tedious/boring nature of the practicals was cited by 97 students as one of the worst things but this does not take us much further as there was a singular lack of comment as to WHY these were thought to be tedious/boring. Some insight can perhaps be obtained from the observation that 66 thought the practicals repetitive and 27 thought there were too many. It is also counterbalanced by 107 who thought the practicals had a high interest value and 25 who thought they were fun.

Quotes were:

- 'they are all the same' - 'Histology especially – there is nothing interesting'*
- 'even though they may be boring I'm glad we do them. It really helps to understand the concepts we learn'*

- h. Another theme identified by 75 students was the bad timing of practicals though there was no consistency. Too early in the day, 0900h starts, too late in the day were all mentioned and practicals on Friday afternoon came in for sustained criticism (at a single university). This must be seen in the context of “never being able to please all of the people all of the time” and that nearly 90% of the students did not single this out as being a worst aspect and were presumably satisfied with the timing of the classes.
8. Answers to the question “what single thing would you change about practicals” largely supported the themes already identified as a bad aspect of practicals. The length of the practicals, lack of contribution by staff, poor organisation of the practicals and group size were the first four on the list (Table 5).

Table 5 Responses to “What single thing would you change about the laboratory classes you have done?”

Nature of Theme	Number	%
Length of the practical class	89	22
More staff, more available and more knowledgeable staff	64	16
Organisation of class, less waiting about, available reagents, better explained procedures	57	14
Number of students in class, in group or particular individuals in group	37	9
Time of class during working day ¹	36	9
Fewer, shorter, less time consuming write-ups	27	7
Nothing to be changed	21	5
More reliable, available equipment	17	4
Increase interest in class, less boring	15	4
More varied	13	3
Less content or more time to complete	10	3
Reduce repetition of practical work	8	2
Number of practicals ²	7	2
Totals		401
Residual unallocated responses		154 (28%)

¹ Some would change 0900h starts, morning practicals, practicals ending in late afternoon and especially Friday practicals. ² 6 to reduce number, 1 to increase number

555 students responded out of 695 returns. Those responses grouped into themes as above totalled 401. Some students provided a response which fitted with more than one theme. The remaining responses (154, 28%) were too diverse to be grouped into themes. For example:

‘get rid of registration’
‘physical exertion in some labs’
‘make sure I understood before I left’

Quotes were to change:

‘anything biochemistry related’
‘dealing with hazardous chemicals’
‘smell of alcohol and disinfectant’

Discussion

In any survey where returns are less than 100% there is a question as to how representative are the results. In this survey the average percentage return from 7 universities was 70% which is a very good return rate. The 2 universities with return rates <50% contributed only 3.2% of respondents to the data which are therefore not likely to be greatly influenced by any selectivity

in the returns from these universities. A second factor which may influence the results is that the views of the students at each university are not equally represented in the overall data. The extent to which these two factors may influence the data must be borne in mind.

This survey of the views of 695 1st Year bioscientists was carried out to try to identify ways in which the first-year laboratory practicals could be improved for the students in the hope that more might then take opportunities to participate in practical work in years 2 and 3 and progress to careers in practical biosciences. Data were processed with the objective of trying to identify things which might be given attention or done differently so the students' view of first-year practicals improved. For this reason comments identifying individual practicals as good or bad (e.g. '*Plasmodium practical*', '*eye practical*', '*blood practical*') have not been included in those responses grouped into themes since no information was given about what was good or bad about the practical class.

It must be borne in mind that 695 students were surveyed and that themes represented by a score of less than 40 were therefore identified by less than 10% of the responding students. Put another way, 90% of the students did not single this out as an issue.

Clearly the students felt practicals did help their learning and a repeated message from the free text responses was that practicals were very useful to illustrate and reinforce material presented in lectures.

Students clearly valued:

- learning new skills and using new equipment;
- the opportunity for social interaction;
- the function of practicals to illustrate material given in lectures;
- the acquisition of new knowledge through practical classes;
- high interest value of practicals.

Causes for concern were:

- the length of practicals;
- the poor organisation;
- the associated write-up;
- the tedious/boring/repetitive nature of practicals;
- the contribution of staff.

The organisation of practical classes could clearly be improved but with regard to the other four themes the extent to which they do accurately reflect laboratory work is worth consideration. It may be that we do not want to reflect these realities of some laboratory work at this stage of the student experience and should concentrate more on classes designed to allow experience of the excitement of discovery and generate enthusiasm for laboratory work. An alternative view is that some aspects of laboratory work ARE tedious and boring and the sooner students appreciate this the better.

Quotes were:

'I did enjoy the classes and generally got good results which was encouraging but I don't have the patience or attention to detail to do it for a final year project'

'I find lab classes interesting when you can relate them to what you are learning. It's exciting to demonstrate something in a practical class when you have only read about it'

Two interesting suggestions emerged which might be areas for development in spite of the difficulties of timetabling and plagiarism they would precipitate.

'students should be able to do a lab again until they are satisfied with it'

'it would be useful to have a take away example of a perfect experiment for revision purposes'

Finally it is worth reporting some of the very positive comments made:

'well organised, good experiments, good teaching'

'more lab work. Good enjoyable reinforcement'

'on the whole I love them and find them really useful and always fun to do'

'brilliant lab classes with helpful tutors and great instructions. I've learned a lot and enjoyed so much. Thanks.'

Overall the data do raise concerns that for many students the experience of practicals in the first year is not good. There is no single cure-all which has been identified but there are some themes which can be identified from the data which do suggest some ways forward.

The effectiveness and consistency of staff at all levels teaching the practicals. It is certainly within the power of universities to ensure staff are competent and able to TEACH (as opposed to just run the practical) at the appropriate level and in an appropriate manner. The availability of staff and student access to staff can also be addressed.

The importance students place on familiarity, knowing people in their class, their teachers and forming their friendship networks should be recognised, encouraged and enabled.

There is strong evidence to suggest students find the 1st Year practicals long, boring and tedious. They may be perceived as overly long *because* they are tedious and boring and there is *'too much waiting around'*. This could perhaps be addressed by slicker organisation and by making the relevance and importance of particular practicals more explicit. However, while appreciating that teaching skills is important (and valued by students) there should be an additional explicit objective for 1st Year practicals — enthusing and interesting the students in laboratory work by ensuring they experience the excitement of discovery. This could be done by more directly linking the practicals into research-like situations where students can experience the thrill of discovery. We may need to develop some new, interesting practicals which link to the skills agenda and more directly to research. An injection of resource may be necessary to enable this to happen.

The issue of organisation in practicals. The emphasis on *'waiting around'* for one thing or another. In part this may be an issue of equipment shared between too many students but if waiting is inherent in the practical, some activity needs to be timetabled in to fill the space.

The practical write-up was identified as a negative feature of laboratory work. Clearly there are some misconceptions illustrated by the quote *'these are pointless unless assessed'*. It needs to be made clearer to students what part write-ups play both in new learning, consolidation of existing knowledge and in real life, in the recording, interpretation and audit of scientific results.

We need to address the heavy emphasis students place on equipment (complicated, advanced, better) and get across that equipment is not an end in itself. It surely must be what can be done with the equipment which is important for science. Repeatedly students emphasised their interest in equipment, never what it enabled them to do.

The issue of students enjoying practicals at school because they felt more relaxed. This in part may come from the greater familiarity they have with the school environment and the players (compare the years they may have been in a school with the weeks they have been in university). At the first practical, *everything* and *everybody* is new to students at university.

There needs to be recognition of the magnitude of the transition which students are undergoing from school to university type work. As one student said *'it felt like I'd been thrown in at the deep end and without a float'*. We recognise the difference between 1st and 2nd Year laboratory work and between 2nd and 3rd Year laboratory work. We should perhaps consider if it would be beneficial to 'ramp' the first-year practicals. Start in a very supported and spoon fed environment to allow students to make the necessary transitions over a set of laboratory classes in semester 1 rather than wholly in the first practical. Some attention might also be paid to consideration of desirable and explicit learning objectives for first-year practicals. These should involve not only improved technical skills and knowledge, re-enforcement of lecture material and handling of data, but also the 'collaborative' and social aspects should be included as desired outcomes as well as explicit facilitation of the change from the practical work done at school, and the generation of lasting enthusiasm for practical science.

It is also worth noting there is diversity in the student body. Some liked to be stretched and challenged. Others preferred the easier less challenging environment. We perhaps therefore should make provision for this by not adopting a one-size-fits-all approach. It will be difficult to develop practicals which allow able students with aptitudes to be challenged while not putting off those less interested/able in the laboratory.

Finally to emphasise a point. We must recognise that 50% of students taking biosciences courses will take employment outside bioscience, let alone involving practical laboratory work, and courses at university need to provide a good and appropriate experience for these students. We, as bioscientists working in a practically orientated environment and seeing a need to produce graduates who have the appropriate practical skills, attitudes, experiences and aptitudes, must recognise that one size does not fit all. However, first-year students are NOT graduates and there remain at least a further 2 years to shape them. Those graduates anticipating working in a practical bioscience environment will need to be able to do practical work for sustained periods, to follow instructions/methods which are not always clear, to work in groups and manage their time and appreciate that work does not start only after 0900 nor finish on Friday lunchtime. We should not therefore simply comply with what the students would like. We could however recognise there are some improvements which can be made in 1st Year practicals and that for some students there is a very significant transition. If we can address the issues and smooth, ease and make less precipitous the transition to university practical work we may increase those who develop a genuine interest in practical work in later years.

Conclusions

While most students in the Biosciences progress to careers not involving practical work, some will become involved in practical studies in education, research and industry. The early experience in University is likely to have profound effects on whether some students see practical science as an attractive and exciting career choice. The survey results suggest ways in which 1st Year Bioscience practical classes could be more engaging and stimulating, hopefully moving from gamma to a score of beta or even alpha.

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Communicating author:

Ian Hughes, Centre for Bioscience, Higher Education Academy, Faculty of Biological Sciences, University of Leeds, Leeds LS2 9JT
Tel: 0113-343-4313 Email: i.e.hughes@leeds.ac.uk

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