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Reflective analysis of quality of lab report prior to submission

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ABSTRACT

Students were asked to complete 4 questionnaires where they were asked to evaluate their understanding of 4 pieces of lab work and how well they felt they would be able to write reports on this work. There was a statistically significant increase in both their mark, and their anticipated mark between the first report and subsequent reports, suggesting and enhanced learning experience in terms of the requirements necessary for production of such a report. However, in general, students did not feel that the process of completing questionnaires generated a beneficial reflective approach to their learning experience.

INTRODUCTION

Laboratory practicals are a well-established teaching tool in the biological sciences. In part this is due to the belief that a student may learn by being told about something, but a deeper comprehension of this information only becomes possible following first-hand experiences. This assumption is based on the concept that practical experience involving more of the senses than can be achieved by teaching theory alone during a lecture (Klappa, 2004). The nature of biology means that all knowledge and the theory to support it have been acquired either by observation and/or experimentation (Jones et al., 2001). Hence, laboratory work in biological sciences has the potential to provide two different forms of learning experience for a student. Firstly, it has the potential to augment the learning experience from lecture material and thereby give a better grounding in the subject area. However, it has a secondary role to play, as it can provide training in observational skills for the student planning to pursue a career in biology.

When an individual makes an observation, it does not become general, or public, knowledge until it has been reported. Instead it remains a private observation known to only one person. In order that this information can become more widely known, it is essential that it is reported in some way. The normal way to report an observation is via the scientific literature. In order that observations may be published in this manner, anyone authoring such a report has to adhere to a specific set of guidelines, which although it may vary from journal to journal, has a number of factors which are common across all journals (e.g. necessity for citing literature).

Team working has been proposed to act as a useful tool for: promoting autonomous learning; developing life-long learning; and encouraging student (peer) feedback (Race, 2001). This is another facet promoted by laboratory work, as generally practicals require cooperative work being undertaken by a group of students, with each individual sharing part of the collective process of acquiring and assimilating the new information being gained during the lab work.

Thus, selecting a lab-based theme for this teaching cycle allows for consideration of a topic which generates learning at a variety of different levels.

RATIONAL AND BACKGROUND TO TEACHING CYCLE 1
This teaching cycle involves two different modules which were co-taught, one at degree level (RS module), and the other at HND or Foundation degree level (RD module). The modules were both worth 10 credits and teaching was done by a combination of lectures and practicals. Assessment was carried out by a combination of coursework and final exam. The coursework was assessed by means of 4 different lab reports, each carrying equal weighting. Combined together they made up 40% of the final mark for the RS module, and 60% of the final mark on the RD module.

I had taught the two modules the previous year, and had asked for all lab reports to be submitted as a single portfolio, which would then be marked as one. One of the comments, made by a few students, on the module evaluation forms was that since this was the first time that they had been required to write a lab report, it was likely that they were still developing a writing style. Hence, a lack of feedback on the previous reports before completing the next report could unfairly prejudice those who had been unsure about the precise requirements of a lab report.

Taking this information into account, lab reports were submitted every 2 weeks, which meant that the students had always received feedback on one lab report before the next one was due for submission. In addition, I asked them to complete a questionnaire for submission at the same time as their lab report. In this they would have the opportunity to reflect on their comprehension of the lab, both immediately after leaving the laboratory and also at the time of submitting their report. This had the added advantage that it also gave me an indication of the student’s individual expectations of the mark for that particular piece of work. In the previous year one student had challenged the mark she had been awarded. By adopting this approach, I hoped that inviting students to assess their work prior to submission would give me two additional benefits; by comparing anticipated marks with those awarded would help to identify in advance students who might feel that the mark awarded was unfair, and secondly it would provide a safeguard against students who decided increase their expectations after the return of their reports. However, the main objective of the approach was to try and have students reflecting on both the quality of their work, and also how best to improve the quality of their work.

METHODOLOGY

In total around 75 students were enrolled on either RD16710 (Equine Anatomy) or RS11310 (Equine Anatomy and Physiology). As part of this module students are required to attend four different practicals: construction of a plastic model horse; dissection of the distal equine limb; dissection of the equine cranial aspect; and dissection of the equine digestive tract. The class was split into 3 sub-groups of approximately equal size, with each topic being run three times. The first three topics involved the students carrying out the work in groups of 4-5 individuals, with advice available when needed. The final topic was run in the form of a demonstration, as the size of the dissection lab allowed for only a single digestive tract to be used at any one time. However, despite running the lab as a demonstration, students were allowed to inspect and photograph the dissection at regular intervals.

Students were then required write a report on each of the four labs. This was intended to serve two different functions; allow them to demonstrate that they had understood the lab and also to train them in the writing of scientific reports. Reports had to be written and submitted for assessment by the following week. At the same time as they were submitting their lab report, students were asked to complete a questionnaire, an example of which is seen in Figure 1.
You are asked to complete the details of this questionnaire and submit it with your lab report. Please do not attach this page to your report. Instead submit it as a single sheet of paper in the box.

The information which you supply in this questionnaire will be treated confidentially, and will have no bearing (either positively or negatively) on the mark awarded for your work.

The purpose of the information supplied in this questionnaire is to determine the following three factors:

(i) After completing the report, do students feel that they have a better, or worse, understanding of the lab than they had immediately after leaving the lab?

(ii) By the time of submitting the fourth, and final, lab report on this module, do students have a more accurate expectation of the mark that they are going to be given for their work? Note that this may mean that students originally underestimate their mark as much as they might overestimate their mark.

(iii) As students get a better appreciation of the amount of information necessary to achieve a particular mark, does their mark increase with time?

Please complete the following three questions and add your name at the bottom of the form.

1. Immediately after leaving the lab, what mark did you think that you would be able to achieve from this work?

   Immediately after the lab, I thought that I could probably get: [ ] out of 15.

2. At the time of completing the report, what mark did you think that you would be given for this work?

   After completing the report, I thought that this work was worth: [ ] out of 15.

3. If the two marks are not the same, is there a particular reason for the two marks being different?

   A higher mark could be due to reading something, or a classmate explaining work, which has made the lab clearer.
   A lower mark could be due to you feeling ill at the time of writing the report, or realising that you had not actually understood the lab as well as you had first thought.

Figure 1
An example of the questionnaire which was distributed to the RD16710 students. An equivalent form, but with an upper limit of 10, instead of 15, was distributed to RS11310 students.
Marks were tabulated in Microsoft Excel. Mean and standard deviation values were calculated for all values (mark expected at the end of the lab, mark expected at the time of submission, and the mark awarded after marking) for each lab. Pair-wise analysis for marks from each lab was performed between the following variables and plotted:

i. The mark expected at the end of the lab versus that at submission.
ii. The mark expected at the end of the lab versus that at awarded.
iii. The mark expected at submission versus that awarded.

F-test supported t-tests were performed to determine if different datasets were significantly different. These analyses were performed for a specific category of mark (i.e. mark expected at the end of the lab, mark expected at the time of submission, and the mark awarded after marking) for each of the 4 time periods (i.e. labs 1-4), as well as each category of mark within a single time period. When comparisons between samples from a single questionnaire were analysed, a paired t-test was used.

RESULTS

The mean mark expected at the end of the lab, expected at the time of submission, and the mark awarded after marking at each lab are presented in Table 1, together with the number of submissions within each category.

<table>
<thead>
<tr>
<th></th>
<th>Data from questionnaires</th>
<th>Data from marking</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Submissions</td>
<td>Mark at lab</td>
</tr>
<tr>
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<td>50</td>
<td>53.3 (9.40)</td>
</tr>
<tr>
<td>Lab 2</td>
<td>42</td>
<td>60.0 (9.43)</td>
</tr>
<tr>
<td>Lab 3</td>
<td>32</td>
<td>57.1 (12.09)</td>
</tr>
<tr>
<td>Lab 4</td>
<td>30</td>
<td>70.8 (12.35)</td>
</tr>
</tbody>
</table>

Table 1
The mean mark expected at the end of the lab, expected at the time of submission, and the mark awarded after marking at each lab. Values shown in parenthesis are the standard deviations.

In the case of comparing data from questionnaires from labs 1 and 3, a significant difference was detected between the two anticipated marks (P<0.01) and (P<0.001) respectively. The other two pair-wise comparisons were not significantly different – based on a cut-off value of P>0.05 denoting no significant difference. In all cases, the mean anticipated mark either at the end of the practical, or at the time of submission, was always significantly less than the actual mark awarded.

The mean mark anticipated at the end of the fourth practical (the only one which was run as a demonstration) was significantly higher than the mean anticipated mark for any of the other practical (in all cases P<0.0005). The equivalent mean mark anticipated at the time of submission was also significantly higher than that seen for practicals 1 or 2. The mean anticipated mark at the time of submission for practical 1 was significantly less than the equivalent for any of the other practicals (P<0.05 in all cases) and the equivalent anticipated marks for were also lower at the end of practical 1 than for practicals 2 and 4 (P<0.01) in both cases.
Fig 2A

Lab 1 analysis

Fig 2B

Lab 1 analysis

Fig 2C

Lab 1 analysis
Mark anticipated at time of submitting report

Mark anticipated after lab

Lab 2 analysis

Fig 2A

Mark anticipated after lab

Mark anticipated at time of submitting report

Lab 2 analysis

Fig 2B

Mark anticipated after lab

Mark anticipated at time of submitting report

Lab 2 analysis

Fig 2C

Mark anticipated after lab

Mark anticipated at time of submitting report

Lab 2 analysis

Fig 2D

Mark anticipated after lab

Mark anticipated at time of submitting report

Lab 2 analysis

Fig 2E

Mark anticipated after lab

Mark anticipated at time of submitting report

Lab 2 analysis

Fig 2F
Fig 2G

Lab 3 analysis

Mark anticipated at time of submitting report

Mark anticipated after lab

Fig 2H

Lab 3 analysis

Mark anticipated at time of submitting report

Mark anticipated after lab

Fig 2I

Lab 3 analysis

Mark anticipated at time of submitting report

Mark anticipated after lab
Fig 2
Relationship between the mark expected after the lab versus that at submission (Fig 2A, 2D, 2G and 2J), the mark expected after the lab versus that awarded (Fig 2B, 2E, 2H and 2K) and mark expected at submission versus that awarded (Fig 2C, 2F, 2I and 2L) for practicals 1 (Fig 2A-C), 2 (Fig 2D-F), 3 (Fig 2G-I) and 4 (Fig 2J-L). The gradient line on graphs shows points where both values are identical.

In Figure 2, it is clear that there students generally underestimated the mark they were likely to be awarded, both at the time of completing the lab, and also at the time of submitting their report. Figures 2A, 2D, 2G and 2J re-iterate the point that was seen from the t-test analyses, whereby students generally appeared to anticipate a higher mark at the time of submitting their report than they did at the time of leaving the lab, although a small number of students found the opposite. The one lab which went against this trend was the final lab, which was run as a demonstration, with students listening to a description of the dissection as they watched it being done – rather than carrying out the work on their own. However, the difference in this case did not have any statistical significance associated with it.

Comments regarding differences between anticipated marks at the time of submission versus anticipated marks at the time of completing the lab varied greatly. However, in most cases where the anticipated mark was higher at the time of submission, this was attributed to the student having gained additional information from private study or by reflection on or re-structuring and collation of the notes that had been taken during the practical. Where the mark anticipated at submission was less, the normal reason cited for this centred around not having taken adequate notes during the practical and relying too much on memory alone or leaving the writing of the report until the last minute, although a few did cite ill-health at the time of writing the report as the major factor.

DISCUSSION

After the first practical, 72% of the students returned their questionnaire. This figure declined with each lab until it reached 42% after practical 4. The reason for this drop in submission of questionnaires is unclear, but it was interesting to note that students did not respond particularly positively to the questionnaires – as testified in one of the questions in the module review form. At best most felt relatively ambivalent about the forms, with a considerable number suggesting that it gave little or no benefit to their writing of reports.

The students repeatedly underestimated the mark they were likely to achieve for any particular piece of work. How much of this could be attributed to some degree of false modesty on the part of the students is unclear. Although the marking of reports was carried out anonymously, the questionnaires were returned separately and had the name of the student on the document. It is possible that few students would wish to be seen to expect what might be seen as an unrealistically high mark.

It is interesting to note that practical where students felt most confident about writing their report (based on the anticipated mark at the end of the practical) was the last one. There are two likely reasons for this observation. Firstly, the students have already had feedback on two other reports at the time of the lab, and a third by the time of submission. Therefore, it is possible that they have now attained a new-found confidence in their ability to write a piece of scientific writing. Secondly, and not mutually exclusively, this was the only practical where they were able to listen to a description of the dissection taking place by somebody with experience in this type of work. Thus they were being directed towards the most relevant points to observe, and
reducing the potential for the learning experience to be under-fulfilling due to a lack of experience. If the second point does prove to be of greater importance, then this puts the other labs into some sort of context, whereby it suggests that even though there are staff available for consultation during these practicals, the option of allowing freedom to explore as seen fit by the students, may reduce the learning experience in terms of making observations. This would appear to advocate that students should be ‘talked through’ the dissections to maximise their theoretical learning experience.

However, there is a counter argument. While having a practical described to them may enhance their theoretical knowledge of the area, it does not allow them to develop another important skill necessary in biological sciences; namely the role of first-hand learning. This is only achieved by learning how to carry out the laboratory based research itself. Given the importance attached to a scientist being able to generate primary datasets to work with, the development of practical, lab-based skills is probably as important as that of knowledge acquisition. Hence, with a view to training scientists of the future it is essential that a balance be attained which combines development of both practical and theoretical knowledge and skills.

It is also interesting to note that the anticipated marks and the actual marks increase after the first practical (Table 1). Thereafter, the students appear to have some degree of understanding of what is required of them in terms of writing a report, with some of them being a bit naïve about the actual requirements at first. Interestingly, in the module evaluation forms this point was alluded to by a few students who admitted to not fully appreciating the requirements for a good lab report.

REFERENCES


FEEDBACK AND PERSONAL REFLECTION

I am not convinced about the merits of the questionnaire in terms of promoting a deeper reflection on the part of the students at the time of leaving the lab or submitting their reports. However, it has provided me with some very useful data for critical evaluation of the delivery of applied aspects of the module.

Firstly it helped me to identify the potential problems a student may have in terms of writing a report, and in particular their first report. I have taken this point on board and have introduced a fifth practical. However, I have continued to include four of these in terms of assessment. This means that first report is purely formative and allows the students to have one attempt at producing a report before anything is going to count towards their mark for the module. In addition, I have now written a series of example lab reports (on a different, but related theme) of varying standards to let the students see the difference between a good, average and poor report.

Despite my reservations about the value of the questionnaire to the students, I have repeated the use of it – and found similar trends the following year, with little perceived benefit to the students. I am tempted to avoid using it again on an annual
basis, but periodic use may prove useful in future as a means of evaluating how applied aspect of the module is being received.