USING PEER REVIEW TO ENHANCE THE QUALITY OF ENGINEERING LABORATORY REPORTS

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ABSTRACT

Peer review of third year bioprocess engineering laboratory reports was introduced in an attempt to improve the standard of report writing in the BSc in Biotechnology degree programme at DCU. Preliminary results suggest that the review process leads to improved report writing skills. The student response to the initiative was very positive but it was strongly felt that the process should be anonymous. On average, marks awarded by students were higher than those awarded by the lecturer but there was a slight tendency to award more extreme marks.

INTRODUCTION

A recent survey of technical professionals found that they spend more than 40% of their time writing[1]. The ability to write in a clear, concise and consistent way is, therefore, an essential part of science and engineering training. Undergraduate students must frequently write reports describing their laboratory experiments and despite their being provided with detailed handouts on report writing, it is still found that basic errors frequently recur. These range from simple typing errors, to unlabeled or incorrectly labeled graphs, to structural errors. Since the students *do* know what is required of them in report writing, these errors would seem to be due to a lack of attention to detail on their part.

The value of peer review in developing both critical thinking and student writing skills is well documented[2]. The first drafts tend to be improved because the students know that their peers will be reading their paper. They also tend to think of their paper as being written for a general audience rather than being written specifically for the instructor. Additionally, the student is provided with a formal opportunity to reflect on his/her work and to revise the draft in response to the review. The reviewer benefits by being forced to consider the elements that lead to an effective report and to learn from their fellow students. However, the lecturer must provide sufficient structure and guidance to ensure that the students provide realistic and instructive reviews that are not overly positive or negative.

The main objectives of the pilot project described here were to address three areas of student writing: (i) a lack of attention to detail in submitted laboratory reports (e.g., careless proofreading, units missing on graphs etc.), (ii) a general tendency to be careless and imprecise in the use of language (Table 1) and (iii) a lack of a clear understanding of some

basic ideas regarding appropriate content and style in scientific papers (e.g., results in the Materials and Methods section etc.).

To address these issues, it was proposed that write-up sessions would be scheduled where students would be given some formal instruction in technical writing. Furthermore, peer review was introduced whereby each student would review the laboratory report of one of his or her classmates. The peer review would serve to make students more careful about their submitted work and, by reviewing other student's work, become more aware of those areas of report writing in which they themselves might be prone to making errors.

Table 1 Some quotes from student reports illustrating poor and imprecise use of language

- "Xanthan gum, a non Newtonian liquid was used as it adds terminal viscosity which lowers the jacket convection"
- "Heat transfer is plotted against time and the slope gives us the rate of heat transfer."
- "This experiment hopes to investigate how different agitation speeds and different flowrates of the cooling liquid affect the heat transfer coefficient, U (W/m^2K)"
- "The graphs obtained were so "perfect" (their R values were exactly 1) that the slopes were unusable values."
- "Turning the steam nosel to sterilise the vessel, turn the valve in a clockwise position until the sample starts coming out."
- "Data was representative of mathematical approximation, and both factors investigated that effect U (W/m^2K) were found to be true."

METHODS

The class was divided into 4 groups (A-B) consisting of 3 or 4 students. It should be pointed out that this was an exceptionally small class in comparison with the usual third year class cohort, which is normally in the range 25 to 35 students. Each group did 4 experiments, each lasting a full day and everyone was required to write a full report on **two** of those experiments. Reports were to be written as a 6-page research paper and students were provided with a 'Guide for Authors' to mimic a real research paper submission. The laboratory schedule is outlined in Table 2.

Each student reviewed two reports with the aid of the reviewer form shown in Table 3. They reviewed the report from a student who was not in his or her group and whose report covered an experiment that the reviewer had not yet done. The first review was carried out completely anonymously, i.e., the report was assigned a manuscript number by the lecturer rather than containing the name of the author. A similar approach was used for the second report but in this case the review session was unsupervised and, as revealed by the student survey, anonymity was not maintained.

Table 2 Laboratory Timetable

	Monday					Wednesday				
	Exp 1	**Exp 2**	**Exp 3**	**Exp 4**		**Exp 1**	**Exp 2**	**Exp 3**	**Exp 4**	
Wk 1	A	B	C	D		B	C	D	A	
Wk 2	**Write-up session**					**Peer review session**				
Wk 3	C	D	A	B		D	A	B	C	
Wk 4	**Write-up session**					**Peer review session**				
Wk 5	**Re-write session**					Short Exam				

For assessment purposes, *the student reviews did not count towards the report writer's mark* but the review itself was assessed and marked by the lecturer. On receipt of the *student* review of their second report, students were given the opportunity to make any necessary modifications to their report in a re-write session before final submission. All work was conducted electronically.

Table 3 Peer Review Form

Reviewer Name

Manuscript Number

Use as much space as you need to write brief answers or comments as appropriate. Email the completed form to folgreg@gmail.com. *The completed form should not exceed three pages in total.*

1. Give a brief overview of the main merits and demerits of this report.

2. Does the Abstract describe what was done in the experiment, how it was done and what was found? Is it of an appropriate length? Is it self contained?

3. Does the Introduction set the scene and describe the aims and objectives of the experiments?

4 Is the Materials and Methods section clear and would you be able to repeat the experiment based on the information provided?

5. Are the Results described clearly and in a logical order? Are the Tables and Figures legible and appropriately labeled? Is there any duplication of material or provision of unnecessary material? Is there appropriate discussion of the results, including discussion of the quality of the data?

6. Do the conclusions follow logically from the results?

7.	Based on a marking scheme of : Abstract (20%), Introduction (15%), Materials and Methods (20%), Results (30%), Conclusions (5%), Overall Presentation (10%), give this paper a mark out of 100.
	Overall Mark:

Results

Figure 1 shows how the student marks compared with the lecturer mark for both reports. The root mean square difference on the first report was 17% while that on the second report was 11%, suggesting that the student marks were in general quite realistic and became more consistent with the lecturer having gained some experience. For both reports, students were more likely to be more generous with their marking than the lecturer. Analysis of the report marks showed that the average lecturer mark on the first report was 54% while the average on the second was 59%, suggesting some improvement in the quality of the student reports. However, this may have been due to feedback from the lecturer and may not be solely due to the incorporation of peer review into the laboratory. Likewise the average mark awarded by the students increased from 61% in the first report to 64% in the second.

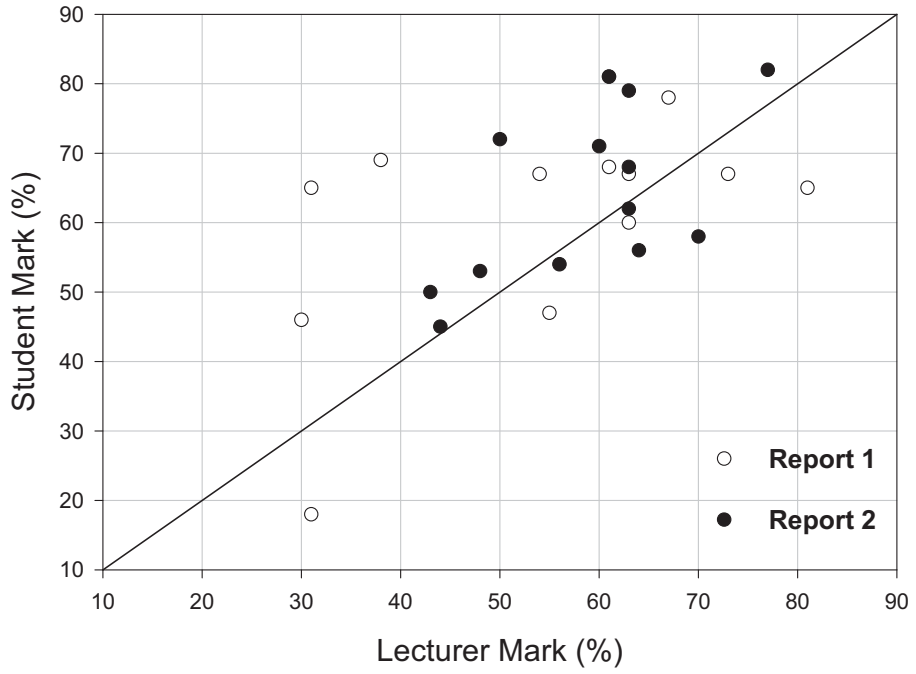

Figure 1 Comparison of student marks with lecturer marks

Student opinion was surveyed and there was unanimous agreement that the introduction of peer review was a positive development. Some student comments are listed in Table 4. Given the importance of anonymity, peer review must be carried out under the supervision of the lecturer or demonstrator under exam-like conditions.

The administration of the peer review system is potentially time consuming especially with large class groups. The lecturer must spend a considerable amount of time 'anonymising' reports, assigning reports to reviewers based on well defined criteria and coordinating the receipt and return of both reports and reviews. In this module, this was done electronically and required considerable care to avoid errors. Furthermore, the success of the peer review system depends crucially on the lecturer giving *rapid feedback* on both the reports and the reviews.

Table 4 Some Student Comments on peer review

- "With the peer review system, after correcting a paper, flaws in your own paper were more obvious. Feedback was only constructive from reviewers so everybody was a winner."
- "A possible but not essential improvement would be to emphasise the anonymous aspect of the course as some people could be swayed in decision making."
- "I found the peer review, when done under anonymous conditions to be very constructive and raised the general standard of reports in the class. This is due to both having your friends view and scrutinising your paper, as well as detailed feedback about the paper. It was also useful to be put in the frame of mind of a teacher, forming the mentality of what to look for."
- "I learned as much from the report writing and correcting as I would preparing for an exam. I nearly felt I learned more with less pressure and more enjoyable."
- "When reviewing I found that I discovered mistakes in other reports that I had not discovered in my own. This made me much more careful when carrying out my second report."

Conclusions

The incorporation of peer review into engineering report writing is undoubtedly a beneficial exercise. Furthermore, it can be achieved without excessive workload with small class groups (< 20 students). Further work is required however to see if this approach is logistically feasible with larger class groups.

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