Improving written communication skills of students by providing effective feedback on laboratory reports

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***Abstract**: An important and sometimes overlooked opportunity to develop the written communication skills of Engineering students exists in laboratory subjects where students write a number of laboratory reports. This paper describes an improved approach to teaching the writing of laboratory reports which focuses on providing more effective feedback on student reports. Comprehensive report writing guidelines, clear assessment criteria and a detailed marking scheme were devised and then used as the basis of teaching report writing and of providing systematic effective feedback on reports. Comparison of the quality of reports submitted before and after the introduction of the approach suggests that this approach is successful in improving the written communication skills of students. The use of detailed assessment criteria also simplifies the marking process for demonstrators and ensures that expectations and feedback remain consistent among demonstrators.*

Introduction

While there is a widely recognised need for the development of the written and oral communication skills of undergraduate Engineering students, it can seem difficult to find room in the already crowded technical curriculum to include the teaching of these vital skills. Different ways of integrating the teaching of these skills into the engineering curriculum have been investigated (e.g., Borthwick, 1994; Marsh and Tomlinson, 1994; Clinch and Goulter, 1992), including in laboratory-based subjects (e.g., Hessami and Sillitoe, 1997; Silyn-Roberts, 1993). In these subjects, the students are required to present and discuss the results of experiments in formal laboratory reports, and thus there is an excellent opportunity in these subjects to incorporate some development of the students' writing skills.

Fundamental to the learning of writing skills is a clear understanding of the requirements of the writing task. Students need to understand exactly what they are expected to produce in order to write well. Thus, detailed guidelines are necessary. Given that students have been writing laboratory reports since senior secondary school, it is often assumed that they already have this understanding of the requirements of good reports. For example, it is assumed that the students will know what to write in the discussion and how to write effective conclusions. However, students often write reports of poor quality or reports that could be significantly better in a number of aspects.

Also fundamental to the learning of writing skills is the use of effective feedback so that students can improve their writing. Ideally, students are required to write a number of reports as formative assessment tasks during the course of a subject so that there is the opportunity for them to receive

helpful feedback on each report before they write the next. According to Guskey (1988), four characteristics of effective feedback in formative assessment tasks are that the feedback is (i) immediate, (ii) specific, (iii) prescriptive and (iv) positive where possible. This means that feedback needs to be provided as soon as possible after the assessed task; comments must identify precisely what is wrong so that students know what to correct; comments must provide guidance about how to correct these errors; and that improvements should be noted and praised. Such formative feedback has clear benefits for students' learning (O'Moore and Baldock, 2006) and, in addition, formative assessments also have the advantage that they provide the lecturer with feedback about areas of weakness in report writing and this knowledge can inform subsequent targeted teaching.

Despite the significant benefits to both learning and teaching, there are a number of challenges in providing such feedback, particularly with large numbers of students. It is time-consuming for demonstrators to mark large numbers of reports while indicating not only the problems in the reports but also suggesting ways of correcting these problems. It may also be difficult for different demonstrators to mark consistently and to provide students with feedback that is similar in extent and emphasis. Thus, demonstrators need to have good marking schemes that enable them to mark efficiently and consistently and to provide appropriate feedback.

This paper reports a new approach to teaching laboratory report writing which focuses on providing more effective feedback on student reports. This approach was introduced in a subject where, despite students receiving feedback on the four reports submitted for assessment, there was no apparent improvement in the writing. The existing approach to teaching report writing and to marking reports is outlined. The new approach based on more explicit teaching of report writing and systematic formative feedback on reports is then presented and evaluated.

Teaching approach in 2005

Second level Thermodynamics in Mechanical Engineering, usually a large class with over 200 students, is a subject in which students perform four laboratory experiments. In 2005, the assessment consisted of a final examination (70%), three semester tests (15 %) and four laboratory experiments (15%). One of the stated objectives of the subject is the development of communication skills, and as one of the ways of achieving this objective, students were required to write four laboratory reports individually, despite the burden of marking that this imposed. The format for each report was the same. Brief guidelines outlined the report requirements specifying that the aims, discussion of results and conclusions needed to be presented in one A4 page, with 2-3 pages of numerical results and graphs presented within the laboratory handout provided to students. However, detailed guidelines about the expected content of each section were not provided. Rather than specific assessment criteria, a broad marking scheme was provided to the students, with reports being marked out of a total of 10.

Before the laboratories began, demonstrators for the subject met with the subject lecturer to discuss the laboratories, the schedule for marking and administrative matters, and they were given the report requirements and the broad marking scheme. When laboratories began, the laboratory reports were marked and returned to students, and, given the very real constraints of the laboratory schedule and the large numbers of students involved, the reports were sometimes returned after the students had submitted the next report. Feedback on reports inevitably varied to some degree between demonstrators, in the extent of, and the emphasis in, the feedback as the demonstrators devised their own criteria for their marking within the broad scheme provided. At the end of semester, the average marks for the class for each of the four reports were calculated and it was found that these average marks were almost the same. Thus there had been no improvement in the writing of reports between the first and last reports submitted.

There was an excellent opportunity in this subject to try to improve the written communication skills of the students, so a new approach to teaching report writing was adopted the following year. This approach is described in the next section.

Teaching approach in 2006

Report writing guidelines

In 2006, Level 2 Thermodynamics was run in the same way as in 2005, with the same four laboratory experiments, forms of assessment and breakdown of marks. While the requirements for the reports stayed the same, new detailed guidelines on the writing were provided to students. The guidelines, adapted from the departmental report writing guidelines of the Department of Chemical Engineering at Monash University, provide explanations of the expected content of each section of the report. Specific advice is given particularly in areas where students often have difficulties, for example about what constitutes an effective Discussion section. The guidelines have a particular emphasis on aspects of the writing, with the language features of each section of the report explained and examples of useful expressions and vocabulary given. In addition, a section of the guidelines is devoted to ways of achieving the scientific writing style required in laboratory reports.

Marking and comment scheme

A detailed marking scheme was then devised by an experienced demonstrator (Naomi Brammer) using the broad breakdown of marks suggested by the subject lecturer (Mir-Akbar Hessami). The aim was to produce a marking sheet that could be used by all demonstrators to provide specific and detailed feedback to the students on the report content and written expression, and also to provide a simple and consistent marking process for demonstrators.

Based on the key features of report sections outlined in the report writing guidelines, detailed assessment criteria were devised and then incorporated into the marking sheet. For example, the detailed assessment criteria for the Results and Discussion are: *accurate calculated data, discussion of trends, comparison of results, interpretation, comparison with expectations,* and *comments on errors.* Other assessment criteria can be seen on the sample marking sheet given in Figure 1 below. Marks are allocated to each of these criteria.

Thermodynamics Laboratory Experiment Report – Marking Sheet

GENERAL COMMENTS: *Room for improvement in discussion and conclusion. Refer to report writing guidelines.*

AIM:
- goals of experiment

Good

2 / 2

RESULTS & DISCUSSION:
- accurate calculated data
- discussion of trends
- comparison of results
- interpretation
- comparison with expectations
- comments on errors

Give much more interpretation

13 / 20

CONCLUSIONS:
- summary of findings
- key numerical values
- comparison with expectations
- limitations, required future work

See comments in report

1 / 8

REFERENCES & NOMENCLATURE:
- correct referencing style in text
- correct referencing style in list

2 / 4

QUALITY OF FIGURES:
- labelling and scale of axes
- data points and trend lines
- clear informative captions
- appropriate presentation

Very good

10 / 10

WRITING STYLE:
- formal, scientific writing style
- choice of language/expression
- spelling and grammar

Use formal language in reports

4 / 6

TOTAL: 32 / **50**

Figure 1: Sample marking sheet, with comments

To use this marking sheet, the demonstrator determines if the student has met all the given assessment criteria in each aspect of the report. If not, the demonstrator circles the criteria where improvement is necessary. Thus the demonstrator does not have to formulate comments and write these in full on every report. In this way the student is given very specific feedback, and is able to understand where they failed to meet expectations and where marks were deducted. There is also room here for the demonstrator to provide additional comments about how the student can correct these mistakes in subsequent reports. In addition, at the top of the sheet there is a space provided where the demonstrator can make any general helpful comments if relevant.

This marking sheet was provided to students as part of the guidelines, and after the demonstrator had filled it in, it was attached to the marked reports. Reports were marked out of a total of 50 rather than 10 to enable students to understand more readily exactly how their performance related to the particular assessment criteria and thus the requirements stated in the guidelines. Marked reports were returned to students before the next report was due, ensuring that students had the opportunity to incorporate the suggestions from the feedback into the next report.

Demonstrator training

Before laboratories began, the demonstrators met with the subject lecturer and an academic skills lecturer (Jane Moodie) to prepare them for using the new approach to providing feedback. The demonstrators were very committed to providing effective feedback to help students improve their written communication skills. The new marking scheme was discussed, and they felt that given the clear assessment criteria, that it would be simpler to mark the reports. They also felt that it would make it easier for each of them to provide more consistent and more easily justifiable marks to students.

Two sample student reports, one of an excellent standard and the other of a poor standard, were then used to demonstrate the use of the assessment criteria and the marking scheme. In particular, this enabled more inexperienced demonstrators to understand more precisely what constituted a good report. In addition, the demonstrators' comments on these two reports were examined.

Finally to help them identify areas of weakness in the reports, typical problems with report content and writing were also discussed. A handout listing these common problems was provided by the academic skills lecturer.

Explicit teaching of report writing

In addition to the guidelines on laboratory report writing, a lecture on report writing was given to the whole class before the laboratories began. Based on the guidelines, this lecture covered the expected report content and structure, features of the required writing style, and the assessment criteria and marking scheme.

After the reports for the first two laboratories had been marked, a number of common areas of weakness in the reports were identified by analysing the marking sheets. These areas included misunderstandings about the purpose of the aims and conclusions, lack of detail and interpretation in discussion, and incorrect referencing style. Further teaching on these points was provided electronically to the whole class in materials placed on the subject webpage.

In the laboratories, demonstrators provided further instruction on report writing, drawing attention to the assessment criteria and marking scheme, and they encouraged the students to take note of the comments that had been made on their previous reports. The demonstrators emphasised the specific expectations of their particular laboratory, for example clarifying what analysis was required and what should be commented upon in the discussion. Based on the marking of earlier reports, they also provided some teaching on typical areas of weakness.

Detailed feedback and comments

As has already been described, each student received timely formative feedback on each of the four laboratory reports written in this subject. For each aspect of the report, any circled criterion on the marking sheet indicated an area that needed to be improved in subsequent reports.

Additional comments often provided prescriptive feedback that provided guidance about how to improve. Examples of such comments for the Results and Discussion section included "*Give more detailed discussion of trends*"; "*Comment on source of errors*"; "*Make a brief comment on limitations*" and "*What were your expectations?* ". Examples for the Writing Style section included "*Use full sentences*"; "*Check your spelling*" and "*Try to be more concise*". Further examples are shown on the sample marking sheet given in Figure 1. Demonstrators often referred students to the report writing guidelines for more detailed help with the requirements.

As with conventional marking of any assessment task, the demonstrators also provided feedback on the text of the reports where necessary. The comments here, as with those on the marking sheets, provided both specific feedback about the particular problems and also prescriptive feedback about how to correct these problems. Examples included "*Compare with other data*"; "*Be more specific here*"; "*Provide a reference here*"; "*Can you suggest more physical reasons for this?"* and "*Repeat your key findings in the Conclusions".* In addition, the demonstrators made very positive comments on numerous reports when the written communication was good, including one which said *"Excellent report. This is the best report I've seen this semester! 50/50."*

Outcomes

The aim of the new teaching approach was to improve students' written communication skills in laboratory reports. To ascertain whether there had been any improvement, the average marks of the class for the four reports were compared for 2005 and 2006. These marks are listed in Table 1.

Table 1: Average laboratory report marks in Thermodynamics in 2005 and 2006

	Average Mark			
Year	Report 1	Report 2	Report 3	Report 4
2005	7.7	7.8	7.7	7.6
2006	6.6	7.1	7.4	7.8

As can be seen in the table, the average marks for the four reports in 2005 were almost the same, indicating that there had been no apparent development in the written communication skills of the students. However, the average marks for the four reports in 2006 show a steady improvement from 6.6 to 7.8, suggesting that the changes to the teaching approach adopted in 2006 had resulted in improvements in student writing.

To ascertain whether student satisfaction with the feedback provided in the subject had changed from 2005 to 2006, the student evaluations from the annual Faculty Unit Evaluation for the subject were compared. In the responses to both questions relating to feedback, it was found that student satisfaction had improved. The mean score for satisfaction with the provision of constructive feedback on student work increased from 2.48 to 3.23, while the mean score for satisfaction with the provision of timely feedback increased from 2.70 to 3.3. Thus it appears that in 2006 students were happier with the feedback provided on laboratory reports.

Of note are the high average marks shown in Table 1 for all reports, as even 6.6 as the average mark for the first report in 2006 seems quite high. The generous marking on laboratory reports occurs in other engineering subjects more generally, and lecturers suggest that these high marks may be the result of demonstrators being reluctant to give low marks. The reasons for this need to be investigated in the future, but it points to the need for more demonstrator training in marking. To ensure reliable marking, a moderation exercise needs to be undertaken before the laboratories commence.

Conclusions

This paper has presented a successful teaching approach to improve students' written communication skills within one second level subject. The approach focuses on providing more effective feedback on laboratory reports.

The strengths of this approach are that it is

- better for students, who are provided with more effective feedback that enables them to improve their written communication in laboratory reports;

- better for demonstrators, who find it easier to mark reports consistently and to provide clear useful feedback;
- better for lecturers, who find it easier to see common problem areas in report writing where more teaching needs to be provided.

Using this approach across a department in all subjects with laboratory work would further enhance the systematic development of students' written communication skills.

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