A Staggered Approach to Developing Report Writing Skills within the Civil Engineering Discipline

Tim Wilkinson

The Department of Civil Engineering, The University of Sydney

Abstract

An important generic skill of an engineer is the ability to communicate – particularly through writing technical reports. But where do you students learn these skills? Merely giving an assignment which involves writing a technical report is not sufficient.

In the first year of a new Mechanics of Solids course, the author was surprised by the level of report writing and data analysis ability of students. This paper outlines the various initiatives taken in a period of five years to help students make the transition from basic report writing skills learned in high school, to some more relevant technical engineering writing skills.

Some of the changes involved

- Introduction of common assessment criteria across various courses in structures, geomechanics and fluids.
- Use of an introductory laboratory session with a small report required.
- Use of document templates to assist in the layout and appropriate terminology of the report
- Staggered/stage submission milestones to correct gross errors before the final submission.

The changes have resulted in some small improvement of grades within the original course concerned, but has also resulted in better performance in some subsequent courses. Higher level skills such as critical analysis remain varied amongst students.

Background and motivation

In 2001 the author was assigned to teach "Structural Mechanics", a second year core course within the Department of Civil Engineering at The University of Sydney. The syllabus of this course is primarily the concepts of stress and strain under various types of structural action such as axial forces, bending, shear and torsion.

The author was keen to introduce a practical component to this course, particularly since syllabus restructures in the past had removed many of the laboratory sessions in early years. The key requirements in the design of the laboratory session were:

"Proceedings of the 2005 ASEE/AaeE 4th Global Colloquium on Engineering Education

- Reinforce a key concept of the course
- Require almost zero input from staff while in operation
- Safe and foolproof
- Be small and short enough to allow many small groups to operate
- Involve instrumentation and measurement skills
- Involve data manipulation and presentation
- Contain a technical writing component

In addition, this period saw some changes to the curriculum approach at The University of Sydney. A previous curriculum review by Engineers Australia had resulted in the inclusion of more generic skills – particularly communication, teamwork and management. The communication aspect was specifically addressed by separate courses devoted to communication skills. As part of a course restructure in 2003, related to credit point standardisation, the communications courses were removed, and individual technical subjects were required to encompass more generic skills within the specific context of those courses. Cost and manpower resources were significant considerations, and discussions on some of these implications have been considered previously (eg [1]).

Experimental Design

The physical design of the experiment was straightforward. A simply supported beam was loaded in various positions with dead weights. Students took measurements of deflections, dimensions and strain. Typical instruments used included micrometers, strain gauges and dial gauges. Figure 1 shoes the approximate layout of the experiment.

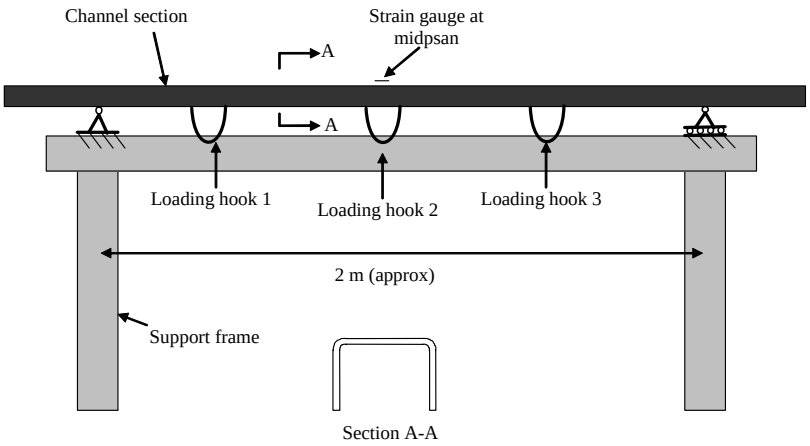

Figure 1: Experimental Layout

It was important to ensure that the student groups were as small as possible to maximise student involvement. Groups of 3 were used, and given a class size of 120 (now 160 in 2005), it was required that 40 groups could perform an approximate 90 minute session over a period of about 5 weeks during non-scheduled class time for the students. It would not be possible to provide direct supervision though laboratory staff were nearby if required.

A key criterion was to make the activity "self-serve" for students, hence simple but sufficient instructions on using the instruments were needed. Similarly it was not considered

appropriate to involve computerised data acquisition systems to minimise possible sources of error. Figure 2 shows a typical example of the simple, clear yet detailed instructions given to students.

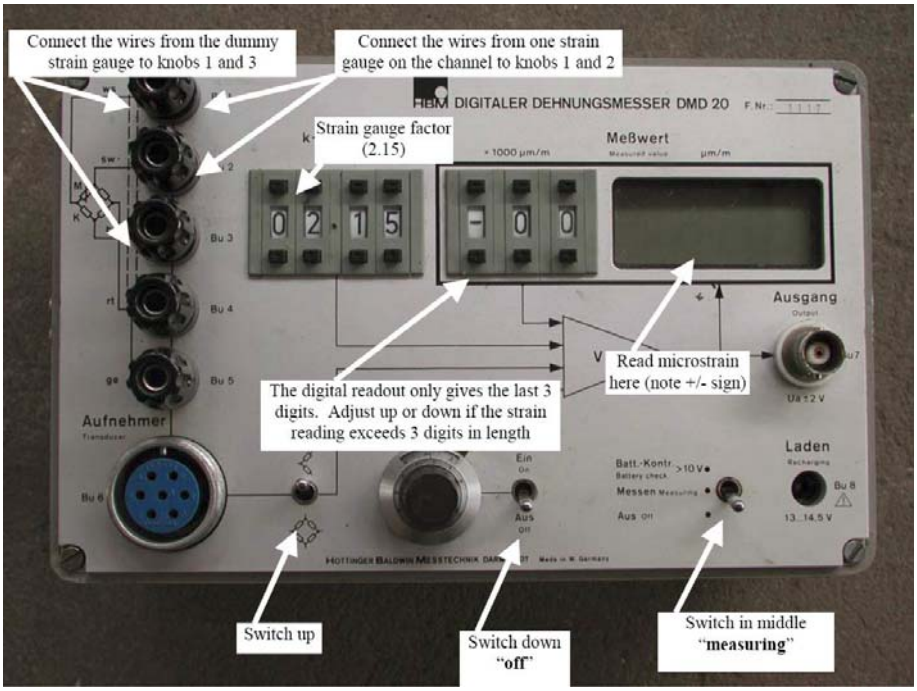

Figure 2: Typical set of student instructions

Students were expected to manipulate the experimental data to obtain results such as stiffness and curvature. Parallel theoretical calculations were performed, and students were expected to compare experimental results and the theoretical predictions.

Report Writing

In the first year of implementation, students were given assessment criteria and some basic guidelines on report writing. Given that this was the first technical engineering report that most students had given, and that limited guidance was given, it was understandable that there were several short comings in most of the reports.

Some of the key issues identified were

- Use of non-technical language
- Use of first person, and inappropriate tense
- Incorrect graphs and results (such as that shown in Figure 3)
- Conclusions asserted that were not based on the results.

After these experiences in the first year of teaching this course, the challenge then lay to devise strategies to assist students develop their skills over a greater period of time.

Some of the strategies that have been used included:

- Developing a common set of guidelines and assessment criteria across the spectrum of technical engineering courses in structures, soils and fluids. Ensuring students are concerned only about a common set of standards allows them to concentrate on the report itself.
- Introducing an additional laboratory session and report on a smaller topic, providing students an opportunity to practice before the "official" report. A Microsoft Word template was created, in which the practice report was half written for the students. This provided guidance for the type of layout that was required, and some typical phrases and sentences that would be used in a technical engineering report..
- Distributing examples of typical engineering experimental reports.
- Incremental submission of key components of the report. Approximately one week before submission of the final report, students are obliged to submit a draft of their key results tables or graphs. This enables the tutoring staff to check that gross errors have been avoided.
- Peer review of assignments prior to submission.

Discussion and significance

Report writing and the associated ability to analyse results to produce meaningful conclusions are complex skills that develop over a period of time. Hence it is difficult to assess how successful this approach has been in improving report writing skills. Certainly within the confines of a one semester unit of study, improvements will be limited, and even over several years at undergraduate level it is difficult to quantify improvements.

The feedback from some other courses where basic reports are required has been generally positive. These courses cover fundamental engineering disciplines such as fluid mechanics and soil mechanics, where reports are designed to consider a basic theorem within that course. To some extent this is because all students are using word processing/spreadsheets and this leads to students hopefully reviewing their work more closely. The use of a common set of guidelines and marking criteria has also been identified.

In later years, more initiative is required from the students in establishing the appropriate structure of the report, and considering the issues that should be included. This culminates in the final year thesis. Quite often there is no well defined structure/questions to answer. The issues in these cases are more about what to include in the report and how to present an argument. These are higher order skills and it is acknowledged that these may take more time to develop.

Within the individual unit of study there have certainly been some improvements.

The overall presentation has improved considerably by providing an initial template for students to use. Despite increased computer use at school, a considerable number of students have limited experience in word processing and spreadsheet software. Each year there are several cases of students downloading files in the incorrect way, difficulties in saving files, and problems with producing graphs. However, the experiences in this unit of study increases student confidence in such tasks.

Many difficulties arise in incorrect analysis of the results and use of the inappropriate type of graph within Excel. An example is shown in Figure 3 – by default Microsoft Excel graphs are "line charts" rather than "x-y scatter plots" which are appropriate in this case. Consequently, students were armed with incorrect results and had difficulty trying them within the report. A change has been implemented so that students are now required to submit their results one week before the report is due. The results are checked for approximate correctness, and hints are given to assist students to correct any errors. Advice on formatting and presentation is also given at this stage.

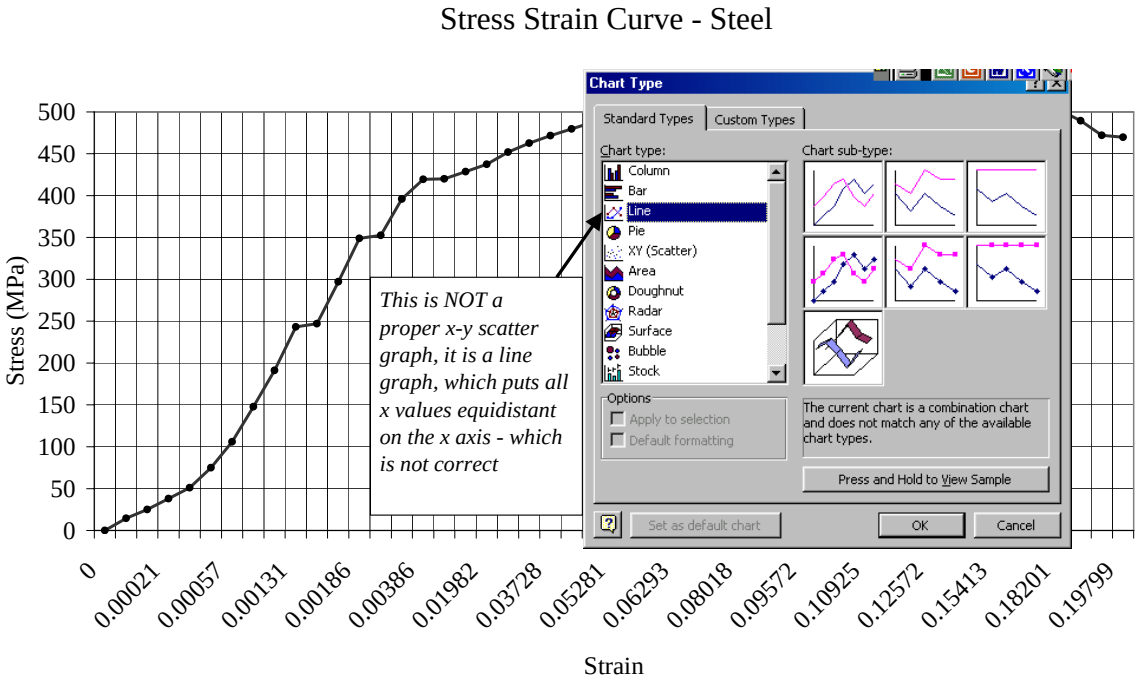

Figure 3 – An example of an incorrect graph with comments

Checking the student results approximately one week before submission has several advantages:

- It spreads out student work load, reducing the need for the last minute rush
- It enables students to make their conclusions based on correct results, reducing the need to speculate about the reasons for flawed results.
- Students who have made mistakes are required to correct them and analyse the results correctly. This is a better outcome than submitting the incorrect results and later receiving the marked assignment with feedback mentioning the results were wrong.
- Overall workload for staff is not increased, as this is done within the confines of the timetabled tutorial sessions.

There are some continued frustrations within this process, and some specific areas where it has been difficult to achieve notable improvement. It appears that many of the problems identified by the author have been highlighted in previous publications (eg [2], [3], [4], [5]).

- Within a technical engineering course, it is difficult to improve specific grammatical and language skills. The most notable example is use of the first person rather than the third person and passive voice. Instructions are included for students on appropriate language use - "The dimensions of the specimen were measured" rather than "We measured the dimensions of the specimen".

- Relating technical and presentation issues from other subjects or other assignments is difficult to instil. Students appreciate the significance of units and significant figures when doing normal problems, but these issues are often forgotten when synthesising the results into a report.
- The initial attempts to gain meaningful assistance from the student peer reviews of assignments have had only small success. Currently no marks are assigned to this process, and students appear to leave this till the last minute. The author may consider different strategies for this in the future, such as those from [6].

This illustrates a regular dilemma for university teachers when deciding the amount and nature of guidance and feedback that should be given to students. Students are being inundated with information from a variety of courses in which they are enrolled. "Best practice" statements, and student feedback often mentions that students are looking for more guidance, marking criteria, and sample answers – however in some situations this volume of information is resulting in students not being able to digest the important points. The challenge to university teachers is to provide a more co-ordinated approach, developing standard guidelines and instructions across a larger number of units of study.

Due to the large numbers of students, rather than giving individual feedback on submissions, a more comprehensive group feedback summary is given, highlighting the areas of good performance, and areas where improvement is needed. This approach has mixed results, as it requires students to form the link between their own reports and the summary of comments given. With time restraints it is not feasible to give detailed comments on every issue in a report, the challenge exists to ensure that the group feedback is meaningful.

Recommendations

Increasingly, engineering academics are being required to incorporate generic skills within their curricula to a greater extent. Within the time and budget constraints it is difficult to assess these skills at a detailed level.

Two key recommendations that can be deduced by the experiences to date are:

- While it is important to give guidance and assistance on issues such as report writing, it is important to seek to create common guidelines and marking criteria across an entire discipline. This reduces information overload for the student and ensures there is less confusion when trying to satisfy the requirements of different lecturers. There are challenges to ensure this outcome – many modern learning management systems are not conducive to sharing information and documents between courses.
- Development of graduate attributes and generic skills such as report writing, requires a gradual approach – much like the development of technical skills. A co-ordinated and gradual approach, in which the skills are further developed during each semester over a 3 or 4 year period will start to yield results.

Summary

This paper has highlighted the author's experiences while trying to incorporate the generic skill of report writing. A staged program has been used to provide a variety of resources for

students to assist them in their report writing – sample templates, guidelines, and milestone submissions. A key component has been developing common guidelines and assessment criteria across the spectrum of engineering disciplines of structures, soils and fluids. Initial assessment has shown that lower level skills have improved. The challenge remains to quantify whether higher level skills, such as critical thinking, have been improved by this approach.

References

1. Middleberg, A.P.J., Laboratory Projects, Should students do them or design them?, Chemical Engineering Education, 1, 34-38, (1995).
2. Airey, D & Hull, T, Integration of Laboratory Experiments in a Project Based Course, 13th Annual Conference, Australasian Association for Engineering Education, 2002.
3. Kristin Walker. Integrating writing instruction into engineering courses: A writing center model Journal of Engineering Education. Washington: Jul 2000.Vol.89, Iss. 3, pp 369-375.
4. Plumb, C & Scott, C., Outcomes assessment of engineering writing at the University of Washington, Journal of Engineering Education, Jul 2002, Vol.91, Iss. 3, pp 333-338.
5. Wheeler, E & Robert L McDonald, RL, Writing in engineering courses, Journal of Engineering Education, Oct 2000, Vol.89, Iss. 4; pp 481-487.
6. Sharp, JE, Olds, BM, Miller, RL & Dyrud, MA., Four effective writing strategies for engineering classes, Journal of Engineering Education., 1999, Vol.88, Iss. 1, p 53.

Bibliographic information

Dr Tim Wilkinson is a Lecturer in the Department of Civil Engineering at The University of Sydney. His research interests are related to the behaviour and design of steel structures, predominately thin-walled open and closed cold-formed sections. From a learning and teaching perspective, Dr Wilkinson is the final year student adviser, and was a members of the committee that formulated the 2003 course restructure for credit point standardisation. His most recent learning and teaching activity was being a member of The University of Sydney working group on Research Led Teaching.