Case Study of Practice

Guidance Techniques to Improve Student Engagement in Critical Reflection Regarding the Preparation of Technical Reports

Knowles M.J. and Dixon D.[1] (*University of Sunderland*)

Abstract

In this paper an interactive approach to encouraging final year engineering students to engage in reflection regarding the style, formatting, structure and content of their final year project reports is presented. The range and variation of projects within this module, which contains students studying in four engineering subject areas, is substantial and means the correct approach to the write up is unique and specific to each student. Thus a level of personal reflection in determining the correct approach to report writing is necessary here in addition to being a key employability skill and as such an interactive, technology enhanced approach is proposed.

---

[1] Corresponding author email address: michael.knowles@sunderland.ac.uk

Introduction

Final year projects are a significant component in many degree programmes, particularly in subjects tied directly to graduate level professions such as engineering. Such projects provide opportunities for students to develop and demonstrate a number of skills and attributes which are seen as desirable to future employment in the profession in question. These include:

- Self-guided development of a programme of research and analysis on a particular subject – often of their choice or conception.
- Independent execution of all aspects of the project
- The application of appropriate project management and control techniques
- Critical self-evaluation of both the final outcome (the 'product') of the work and the process (the 'project') used to produce it.
- Presentation of the results in the form of a written report whose style and form is compatible with what might be expected in industry.

In the UK the professional attributes which are required by professional engineers are described in the UK-SPEC document produced by Engineering Council (2014) – a confederacy of professional bodies from a range of fields within the engineering profession. The highest level of professional registration which can be achieved by an engineer is 'Chartered Engineer' (CEng) status, the standards for which underpin the accreditation of many engineering degree programmes. Engineering qualifications in Higher Education can be accredited against this standard via the 'Accreditation of Higher Education Programmes (AHEP)' document (Engineering Council 2014a). This provides a distillation of details within UK-SPEC which need to be addressed during an accredited degree programme.

CEng status is a milestone many graduate engineers aspire to in the early years of their career. In order to reach this standard, candidates must demonstrate the following competencies (Engineering Council 2014):

> A: Use a combination of general and specialist engineering knowledge and understanding to optimise the application of existing and emerging technology.
>
> B: Apply appropriate theoretical and practical methods to the analysis and solution of engineering problems
>
> C: Provide technical and commercial leadership
>
> D: Demonstrate effective interpersonal skills.
>
> E: Demonstrate a personal commitment to professional standards, recognising obligations to society, the profession and the environment.

Thus it can be seen that independent, self-guided technical projects are a key part of engineering degree programmes – particularly those which are accredited against the CEng standard via AHEP. Preparing the final report is thus a significant opportunity for the student to begin to develop the skills they will extend in industrial practice. These skills will ultimately be used to demonstrate the UK-SPEC competencies, specifically in terms of competence D which includes the ability to address the following points:

- "communicate in English".
- "prepare communications, documents and reports on complex matters"
- "Reports, letters, emails, drawings, specifications and working papers (e.g. meeting minutes, planning documents, correspondence) in a variety of formats".

Such expectations exist internationally within the engineering profession and as a result, a wealth of research has been published on the subject of teaching technical writing skills (see, for example, Mort et al 2012,Gieder et al 2012, Skinner and Mort 2009).

One of the key aspects to the preparation of technical reports such as those describing a final year project is the need to balance the adherence with expected norms of style, structure and layout with the need to adapt and customise these attributes to suit the content being described. Final year project students are almost universally allocated an individual supervisor who can advise on this process but this is only beneficial if the student has already grasped and engaged with the need to consider details of the report in the context of the project they are undertaking.

In this paper an approach designed to initiate this type of individual reflection across an entire cohort of diverse students will be described. The approach has been designed to appeal to students with a diverse range of backgrounds and in particular different levels of experience of preparing technical reports.

Encouraging reflection in report writing

Objectives

The activities described herein were conducted as part of a final year project module covering four distinct Engineering subject level at Bachelors level. The subjects concerned were Electronic and Electrical Engineering, Mechanical Engineering, Automotive Engineering and Manufacturing Engineering. The latter programme exists purely in 'top-up' form meaning the students had entered the final year directly. For the other three programmes the student body was composed of entrants at all three levels of undergraduate study. In all programmes the students came from a range of ethnic and linguistic backgrounds. It is often assumed that students have the appropriate range of writing skills at the point of entry (Skinner and Mort 2009) but for such a diverse group of students a more flexible approach is required (Mort et al 2012). While the value of measures to enhance and develop writing skills earlier in the programmes is recognised,

this diversity of backgrounds and entry points means that sessions delivered as part of the project module are essential. The objectives for the session described were:

- To provide students with some background information regarding the expected standards for the presentation of technical report of this type
- To encourage the students to engage in a degree of reflection regarding their project work to determine the optimal style and structure for their report.

Two, two-hour long lectures sessions were available for this session, scheduled at the approximate mid-point of the project module. These sessions had not previously occurred as part of the module and were included when it emerged that there was, in some cases, a misalignment in expectations in terms of the presentation of the report in terms of both format and style. Furthermore, supervisory staff had made observations regarding relatively poor coverage of topics recently added to the project marking scheme – namely an increased requirement for project management and control to be reported and the addition of ethics as a required topic. Thus a further aim of the sessions was to provide advice regarding the reporting of these topics.

Session 1

It was decided that the first session would be run as a linear run through the traditional structure of the report. The intended outcome of the session was to provide students with a 'checklist' of aspects of report writing against which they need to consider the specific details of their project and refer to the bespoke advice available from their supervisors. The content covered in this section included:

- The marking scheme for the project with some insight into what the markers will be looking for
- The formatting requirements including practical advice on the use of visual images
- A description of some of the 'norms' regarding the structure of technical reports of this type.

Underpinning the entire session was the recognition that each project is an independent and unique piece of work. Thus students were encouraged to reflect on the relevance of the advice given to their particular project. Wherever possible formatting requirements were not specified and options were given with students encourage to make judgements as to the approach best suited to their project.

While it is recognised that the one way transmission of information in a large class like this is often necessary but rarely optimal (Exley, 1999, p271), previous experience in the project module has given the impression that students appreciate such sessions in this context when they provide them with validation that the approach they are taking is the correct one. Many students request examples of previous project reports or lists of the required headings. Thus the approach taken here aims to provide students with some

confidence that they are moving in the correct direction while still leaving open question and encouraging self-reflection.

Session 2 – Interactive encouragement to engage in self-reflection

The second of the two sessions described here involved a number of interactive activities. The aims of the session were to:

- Build on the topics covered in the previous session such as report structure and what would be expected in terms of coverage of ethics and project management
- Encourage students to consider aspects of their own project and how this might influence decisions on content and presentation
- Encourage students to consider their own writing style and whether this was appropriate and fit for purpose
- Encourage students to reflect on their awareness of the ethical aspects of their projects.

In each of the activities the students were encouraged to interact using the Socrative app on their mobile devices (Socrative, 2015). This software allows students to vote in polls or submit free text answers regarding a particular topic, with the results being accessible in real time via the internet. Furthermore the results can also be accessed in spreadsheet or visual format by the lecturer for analysis after the session. Socrative had been involved in earlier sessions where students were encouraged to critically assess a range of artificial project objectives and select those they considered optimal from a list provided to help them understand what is involved in writing good objectives. These sessions had met with positive feedback from students so it was decided to use Socrative once again.

The first activity involved the students being given 30 seconds to write down five bullet points describing their project. Upon completion of the exercise peer assessment was utilised and the students were asked to swap their list with the person next to them. Each student then used Socrative to share anonymously a) the number of bullet points actually written and b) whether these bullet points gave them an understanding of the author's project and c) whether the project sounds interesting.

The results of the exercise were as follows:

- The average number of bullets produced was 2.6
- 75% percent of students felt they understood what the other persons project was about
- 73% of the participants felt their partner's project sounded interesting.

The results indicated that, despite the inherent difficulty in developing and writing five bullet points in such a limited amount of time, the students were able to successfully summarise their projects in a manner that was both informative and interesting.

Summarising work in this way is an important skill both for the oral examination and as a wider, employability skill.

The second activity was introduced with the instruction that students would be given three minutes to write continuously about a subject and that any pauses and the reason for these pauses should be recorded. This approach mirrored the 'free writing' activity advocated by Johnson et al (2012) where students are required to write about a particular topic for a fixed period of time without preparation. The topic about which the students were asked to write was *"Ethical Considerations in your Project"* and the time allocated to this activity was three minutes.

The feedback that the students were asked to provide on this occasion related to their own work and involved answering the following questions:

- Why did you pause?
    - Couldn't think of anything to write
    - Trying to think of the correct word
    - Distracted by others
    - Couldn't see the point
    - Any other reasons?

- How many words did you write?

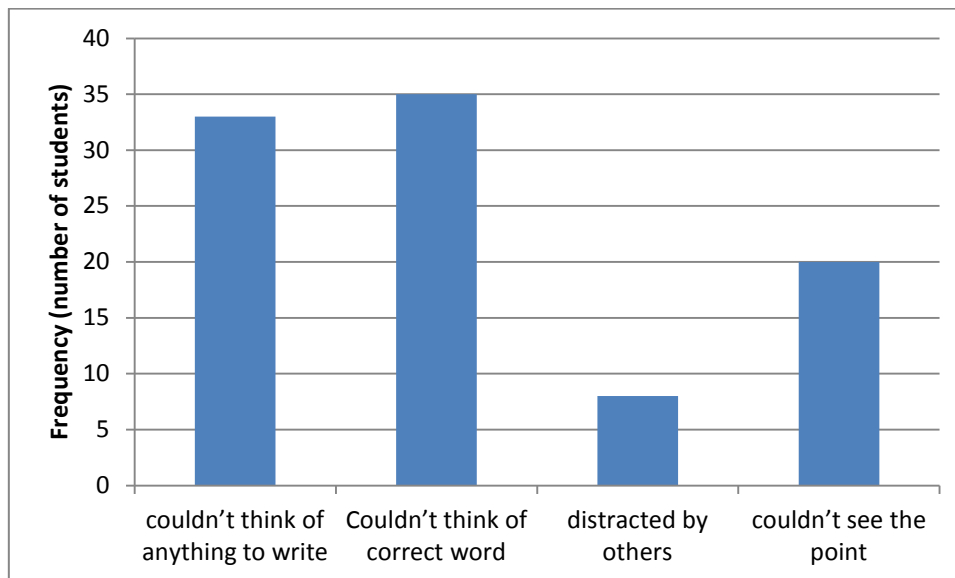The results of the poll are shown below in figures 1 and 2.

Figure 1 – Results of poll regarding reasons for pauses in writing. 58 responses were received in total, students were able to select multiple options.
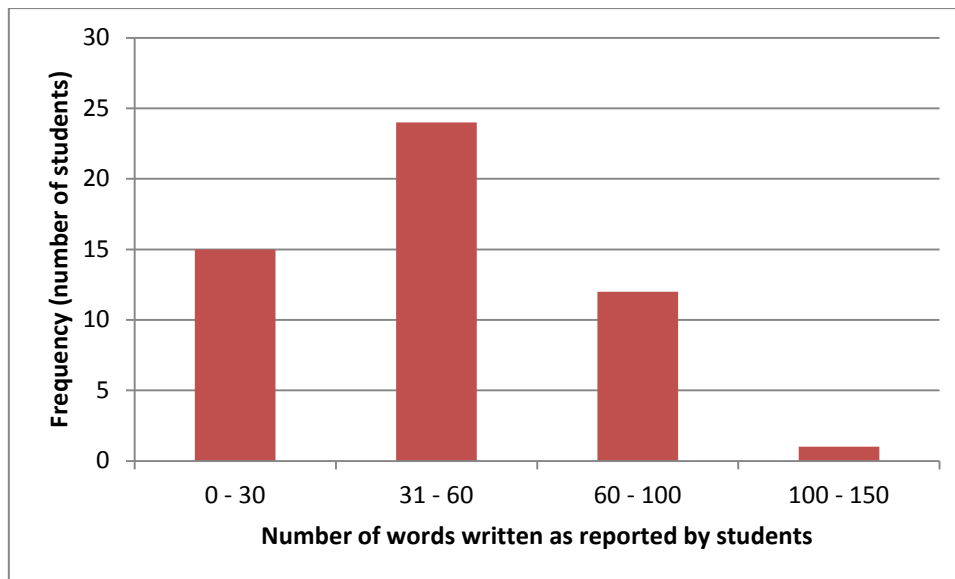
Figure 2 – Reported number of words written by students during 'free-writing' exercise. 58 responses were received, 6 students did not specify a value.

Various reasons were given in the 'other' category relating to tiredness and reflecting on what the ethical considerations were for the particular project in question, along with several flippant answers.

The implications of the exercise were twofold – first the students were forced to consider the ethical aspects of their project – an area which is often badly reported and where students do not reflect on adequately. Professional conduct and adherence to ethical standards is a significant issue for professional engineers, particularly those seeking accreditation such as Chartered Engineer status (Engineering Council 2014). Secondly the activity also gave students the opportunity to reflect on the difficulty involved in writing in a technical manner without planning.

The next part of the session encouraged students to think about how they plan their writing. A vote was held where the students were asked to identify which approach from the list given most closely mirrors that they have taken. The options provided were:

- Start on page one and write linearly until the document is finished
- Write all the headings first then fill in the content beneath
- Decide what the chapters will be and what each should contain then write each one in turn

In addition to the given options the students were given the opportunity to enter their own free text responses. The results obtained are shown in figure 3 below.
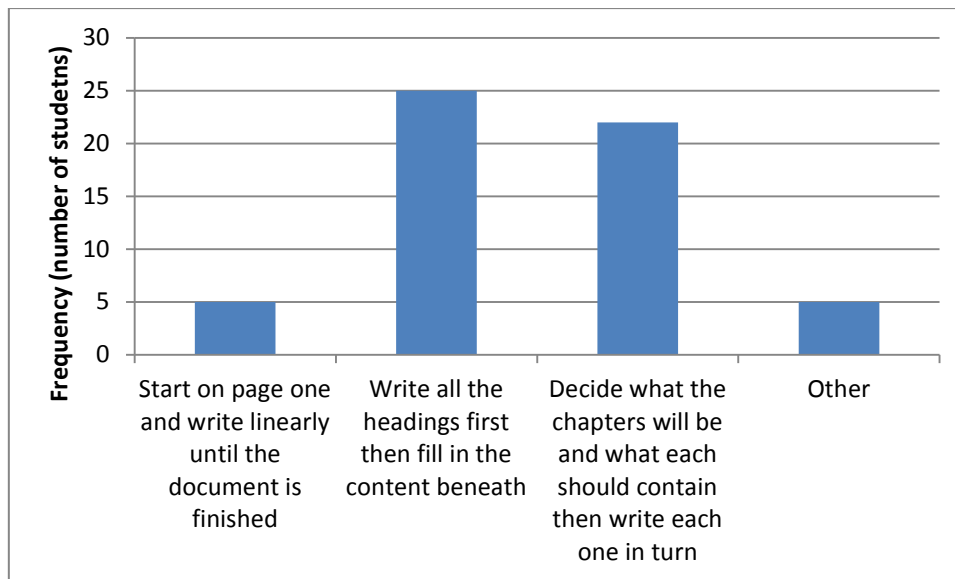
Figure 3 – Results of poll on approaches to writing. 59 Responses were received.

The free text responses entered included various responses which related to approaches which combined elements of two of the categories above or which related to a writing process which mirrored the week by week activities of the student which could result in a 'logbook' type report rather than a structured, technical document. It is hoped that this process would have encouraged students to start to think about the writing process and consider how they would commence their writing.

The final exercise carried out in the session involved the students being presented with four paragraphs of text and being asked first to submit, via Socrative, the flaws they identified and secondly, to vote on which of the submitted flaws they felt most relevant.

The four paragraphs of text used were those provided by the LearnHigher website (2012) and cover a range of topics. In each case the students correctly identified the failings and problems with the text they were presented with. In addition to the positive contributions a small number of comments were received questioning the relevance of the activity to Engineering. While this additionally appears to be a negative outcome, which was quite probably the intention of those particular students, this was used to start a positive conversation with the entire class identifying the generic and transferable skills whose transfer was the objective of the session. Other authors have observed that the perceived relevance of activities to the programme of study can affect student opinions of the value of the activity (Gider et al 2012).

Evaluation

In order to evaluate the students' perceptions of the classroom sessions associated with the project module the students were provided with the opportunity to provide anonymous written feedback. The comments received included:

- The interactive elements of the lecture sessions using the Socrative app were well received and considered to be thought provoking. The positive response to interactive activities aligns with the experiences reported by Gider et al (2012).
- The length of the lecture classes (2 hours) was considered to be too long by many students, reflecting accepted wisdom regarding the attention span of students (Horgan 1999, p21)
- Many students commented positively on the amount of advice given to students. A number of students requested more explicit instructions on report content, and even on what should go in individual subsections of reports, despite being told that this level of details was individual to each student and should be discussed in supervisory meetings indicating that further work is needed to ensure this message is both heard and understood by students.

The third and final point above suggests a lack of confidence on the part of students in terms of their own judgement, mirroring the results of other practitioners who have developed interventions aiming to improve academic writing where the involvement of the instructor is favoured by the student (see, for example, the work by Cilliers, 2012).

In general it can thus be seen that the sessions were well regarded, and while areas for future development of the module have been identified, the success of this approach means it will be repeated in coming years.

Conclusions

The proposed approach has been demonstrated to engage students in a degree of reflection on their writing both through the degree of positive engagement evidenced in the responses during the online activity and through the positive feedback obtained.

Assessing the impact of the activities on the quality of the students' final reports is a more difficult goal. In order to achieve a more complete understanding of the degree of success achieved, the final marks for the project will be investigated from cohorts before and after the intervention. However such an analysis relies on the assumption that the ability of the students who participated was statistically similar to that of the 'control' group prior to the intervention described here. What is clear from the feedback and from informal discussions with students after the sessions, is that confidence levels prior to embarking on the substantive part of the report writing has been increased, without providing students with an "off the shelf" solution for the report. This in itself is a positive outcome and means the sessions have achieved their intended outcomes.

References

Cilliers, C.B. (2012) Student Perception of Academic Writing Skills Activities in a Tradiational Programming Course. *Computers and Education.* 58(4), 1028-1041.

Gieder, F., Likar, B., Kern, T. and Miklavcic, D. (2012). Implementation of a Multidisciplinary Professional Skills Course at an Electrical Engineering School. *IEEE Transactions on Eduacation,* 55, 332-340.

Engineering Council (2014) UK-SPEC: UK Standard for Professional Engineering Competence. Third Edition. Available at http://www.engc.org.uk/engcdocuments/internet/Website/UK-SPEC%20third%20edition%20%281%29.pdf (accessed 15 April 2015)

Engineering Council (2014a) Accreditation of Higher Education Programmes (AHEP). Available at http://www.engc.org.uk/ahep.aspx (accessed 24th February 2016)

Exley, K. (1999) Key Aspects of Teaching and Learning in Science and Engineering, in Fry, H., Ketteridge, S. and Marshall, S. (Eds), *A Handbook for Teaching and Learning in Higher Education*. London: Kogan Page.

Horgan, J. (1999) Lecturing for Learning, in Fry, H., Ketteridge, S. and Marshall, S. (Eds), *A Handbook for Teaching and Learning in Higher Education*. London: Kogan Page.

Johnson et al http://www.learnhigher.ac.uk/writing-for-university/academic-writing/academic-writing-with-free-writing/ (accessed 8th May 2015)

LearnHigher (2012) http://www.learnhigher.ac.uk/writing-for-university/academic-writing/academic-writing-for-reports/ (accessed 8th May 2015)

Mort, P., Drury, H., Calvo, R.A., Skinner, I., McEwan, A., Levy, D., Molina, M.G. and Mitrajit, R. (2012). An Online Engineering Centre for Engineering Students. *Proceedings of the 8th International CDIO Conference*. Queensland University of Technology, Brisbane.

Skinner, I. and Mort, P. (2009) Embedding Academic Literacy Support Within the Electrical Engineering Curriculum: A Case Study. *IEEE Transactions on Education,* 52(4), 547-554.

Socrative (2015) Available at http://www.socrative.com/ (accessed 20th April 2015)