

## Improving report writing for undergraduate students in engineering through an online learning environment: the case of second year civil engineering

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***Abstract:** This paper addresses the ongoing concerns about the discrepancy between engineering students' communication skills and those identified as necessary by government and professional bodies. Although written communication skills are critical for engineering graduates, many students find writing difficult and consider it a low priority, an attitude often reinforced within engineering curricula. Rising to this challenge, a collaborative project between writing specialists, discipline staff and technical and eLearning specialists across two institutions created an online learning environment (WRiSE: Write reports in science and engineering) to improve undergraduate students' report writing skills in science and engineering. Using the case of second year civil engineering students, this paper reports on the design, development, implementation and evaluation of the report writing module in this discipline. Although student performance improved for those students using the module, issues remain about whether students can transfer their online learning to new writing contexts.*

### Background

Report writing remains a challenge for many engineering students whatever their background. Yet communication skills - both oral and written - are highly valued in engineering graduates and are essential for career progression (Tenopir & King 2004; King 2008). However with increasing diversity in the higher education student cohort, the issue of students' competency in writing has been highlighted. In this context, universities and engineering faculty are under increasing pressure from government, professional bodies and employers to address this issue (Commonwealth of Australia 2007; Nair & Patil, 2008).

The literature contains a wealth of information on successful approaches for improving engineering students' written communication in different higher education context. Most interventions concern integrating communication skills into engineering curricula or providing technical communication courses within engineering curricula (Ford and Riley, 2003; Lord, 2009). Collaboration between discipline lecturers and writing specialists forms the basis of many interventions (Oakley, Connery and Allen, 1999; Yalvac, Smith, Troy and Hirsch, 2007; Craig, Lerner and Poe, 2008). Other approaches emphasise making assessment tasks and criteria more explicit, providing more realistic, work-related writing tasks, offering a draft/feedback cycle for submission of written assignments and clarifying learning outcomes for writing for engineering students (Boyd and Hassett, 2000; Plumb and Scott, 2002; Chirwa, 2007; Yalvac, Smith, Troy and Hirsch, 2007; Flateby and Fehr, 2008). Some of these approaches have also been reported in civil engineering curricula (Wilkinson, 2005; Patton, 2008; Rhoulac and Crenshaw, 2006) Interventions draw on a number of pedagogical approaches such as situated learning or activity based learning, constructivist and knowledge transformation frameworks

and genre based pedagogies (Walker, 2000; Paretto, 2008; Lord, 2009). The literature also emphasises the importance of writing for the development of scientific and technical thinking.

However, online or eLearning approaches for improving engineering students report writing skills have not been reported so widely. Such environments offer students a flexible approach to learning as materials can be accessed at their own pace and according to their varied needs. Although a number of online programs support engineering students with advice and guidelines for report writing (for example, Winckel, Hart, Behrend & Kokkinn, 2002) and some provide students with authentic examples and interactive exercises (Clerehan, Turnbull, Moore, Brown and Tuovinen, 2003; Drury, O'Carroll and Langrish, 2005), they are not closely aligned with specific discipline course curriculum and therefore remain largely generic in approach.

The approach outlined in this paper has used the affordances of an online learning environment to support the development of students' report writing skills in nine discipline areas in science and engineering across the undergraduate years, including a module to address the needs of students writing reports in second year civil engineering. These discipline based modules not only support students in understanding the structure and language of reports but also the process of writing their reports. In addition, learning activities to help students understand the concepts associated with the content of the particular report they are writing are included in each discipline module. In this way, the modules have been embedded within discipline curricula and designed from a student perspective with relevant and motivating content. The development of this site, WRiSE (Write reports in science and engineering) was funded by an ALTC (Australian Learning and Teaching Council) grant and involved collaboration across two institutions. The site is freely available at <http://www.usyd.edu.au/learningcentre/wrise/>

Using the example of the civil engineering module, this paper will report on the approach and methodology used in the project, provide evidence of successful outcomes, highlight benefits and issues and provide reflection and recommendations for the future.

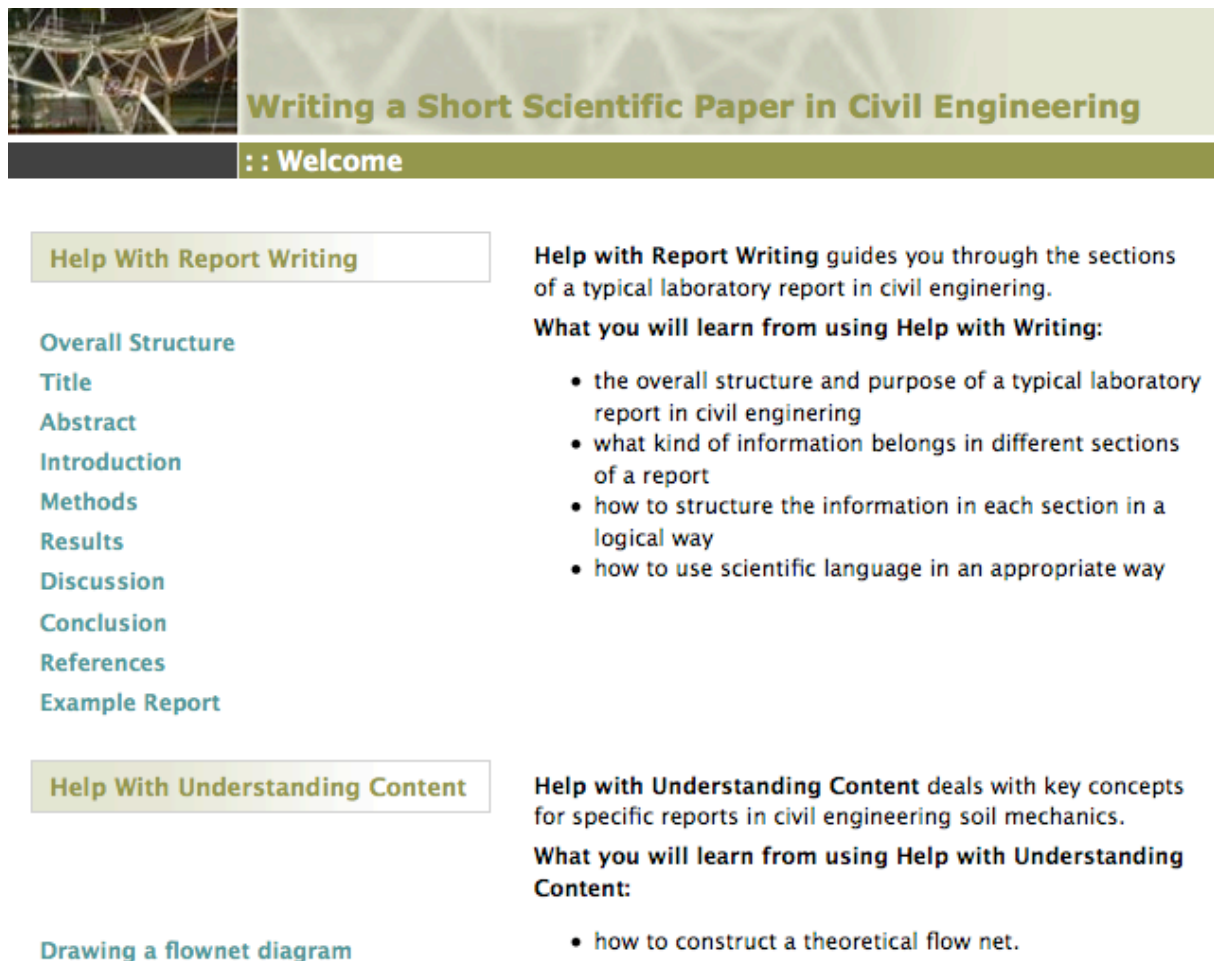
## **Approach and Method**

The project followed a team-based approach involving students and staff from civil engineering, language and learning specialists and technical and eLearning specialists. In the first phase of development, the discipline lecturer created interactive materials to target difficult concepts and content behind the report students would be writing in their second semester course in soil mechanics. Language and learning specialists created learning materials to address the structure and language of a typical civil engineering report based on their analysis of a corpus of student reports from civil engineering. Both students and staff provided audio interviews for the site. Students commented on the process of report writing and the difficulties they encountered and staff explained their expectations of students' report writing, student difficulties and how to improve. Technical and eLearning specialists converted learning materials into online modules. This collaborative method followed a design, development feedback cycle within a set timeline with agreed milestones. In the implementation phase, the discipline lecturer introduced the site to students during the lead up to their laboratory report assignment. Students were shown extracts from different parts of the online program and information on how to access the site through a link on their course unit learning management site. This phase was followed by formal and informal evaluations.

## **Design**

The design of each discipline module is based on a model of learning which takes into consideration students prior writing experiences, their current perceptions and approaches and their interaction with the learning environment designed to support their written assignments (Prosser and Trigwell, 1999; Laurillard 2002). The online approach to teaching writing is supported by a sound theory of language (Systemic Functional Linguistics after Halliday, 1985; Martin, 1992) and a genre based pedagogy which emphasises the influence of context and purpose on text structures (Cope and Kalantzis, 1993; Martin 1999). This approach is widely used to teach writing at university, in both face-to-face and online situations (Jones, 2004; Drury, 2004). Following genre based pedagogy, the online design makes explicit both the product and process of report writing through structured and scaffolded

learning tasks embedded within the context of the discipline unit of study. At the same time, students can access learning modules to help them understand the content of the experiment they are writing about. In this way both language and content are brought together. This design concept can be seen in the welcome screen for the civil engineering module (Figure 1).



**Figure 1: Screen shot of the homepage for the civil engineering module**

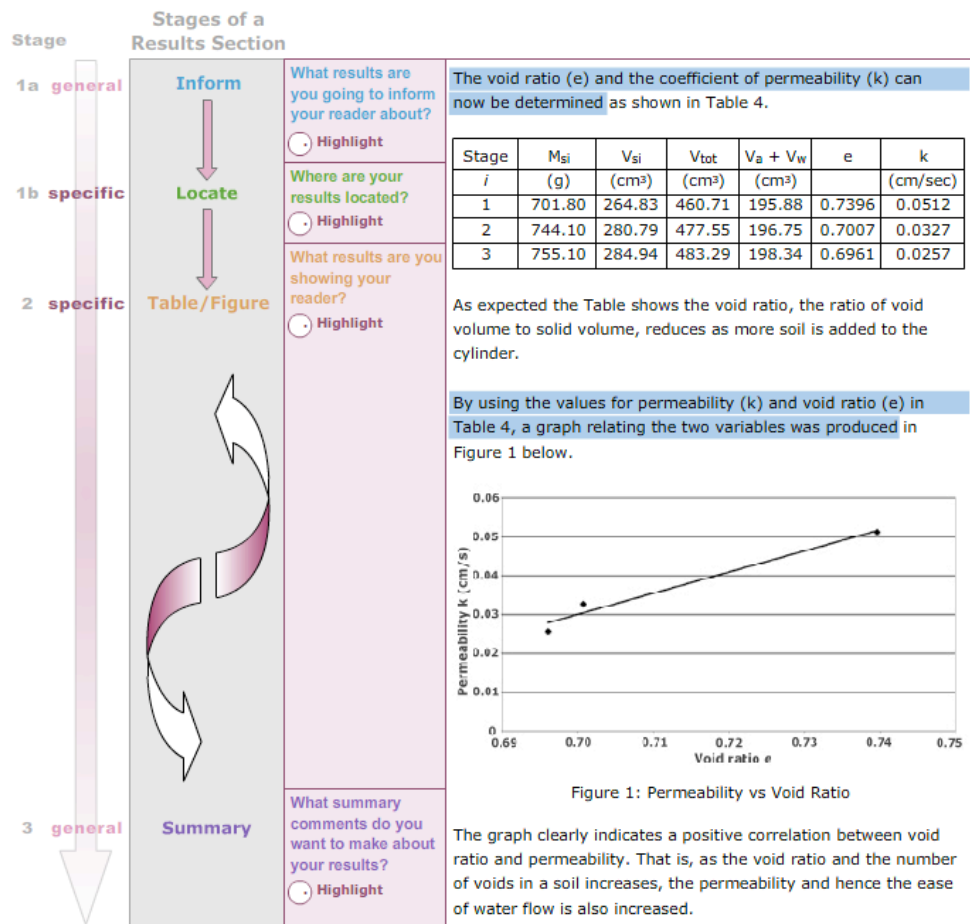
The **Help with Report Writing** area provides students with interactive and animated explanations and exercises with feedback to make explicit the structure and language of each section of a typical laboratory report in civil engineering. Authentic student examples for each report section are highlighted and annotated as the basis for providing an explanation of the structural stages and language features (Figure 2). Students can also undertake self-testing quizzes on entry to each section to find out what they already know about writing that particular section.

**Writing a Short Scientific Paper in Civil Engineering**  
**:: Results**

- Background & Entry Quiz
- Structuring the Results
  - Stage 1
  - Stage 2 Tables
  - Stage 2 Figures
  - Stage 3
- Scientific Language

**Structure**

Here is a diagram of the typical stages of a results section. Click on the **stage links** in the diagram to see which questions are answered in each stage. Click on the **highlight link** to see an example of each stage of the results sections of a student's report. Note the movement from general to specific and back to general. Depending on the number of results you want to report, and the number of Tables and Figures you want to show, Stages 1, 2 and 3 may be repeated.



**Figure 2: Screen shot of animated and highlighted diagram to illustrate the structure of the results section of a civil engineering laboratory report**

The **Help with Understanding Content** area provides students with interactive exercises and feedback on difficult aspects of the report they are currently writing, in this case, constructing a theoretical flow net (Figure 3). Discipline lecturers can add to this part of the site through using Question Tools software (<http://www.questiontools.com/>). Workshops were provided for lecturers during the project so that they could use the software and create this part of the site.

**Question 2**  
 If the tunnel lining is permeable water will flow into the tunnel and the tunnel must be kept dry by pumping. To draw a flow net we must start with a scaled diagram of the problem. The diagram at the top is the original version. The three below it are scaled diagrams of the artificial island. Which is correct? A, B, C, none of them?

Diagram A?  
 Diagram B?  
 Diagram C?  
 None?

flownet\_q2

Figure 3: Screen shot of an exercise to help students draw flow net diagrams

## Outcomes, Benefits and Issues

The whole website was extensively evaluated after implementation. Civil engineering students who had used the module were asked to complete questionnaires on their past writing experiences, the user friendliness of the module, their pathways and the sections they had accessed and their perceptions of how the module had improved their understanding and confidence. Open-ended questions asked students whether they had changed the way they wrote, whether the module had helped to improve their report writing and what was most and least helpful. Although numbers completing and returning the questionnaire were small (n=17 users, n=6 non-users), informal evaluations carried out during laboratory sessions indicated that the majority of students had in fact used the module and were overwhelmingly positive about it. Tracking data also support extensive use of the civil engineering module: the homepage received 565 visits during the first semester of implementation with 6591 pageviews in total. Overall, 442 students across all discipline areas and across both institutions completed questionnaires and of these 261 (59%) used the site.

Figure 4 and 5 below indicate how civil engineering students rated their improved understanding and confidence through interactions with the civil engineering module compared with all students' ratings of the site.

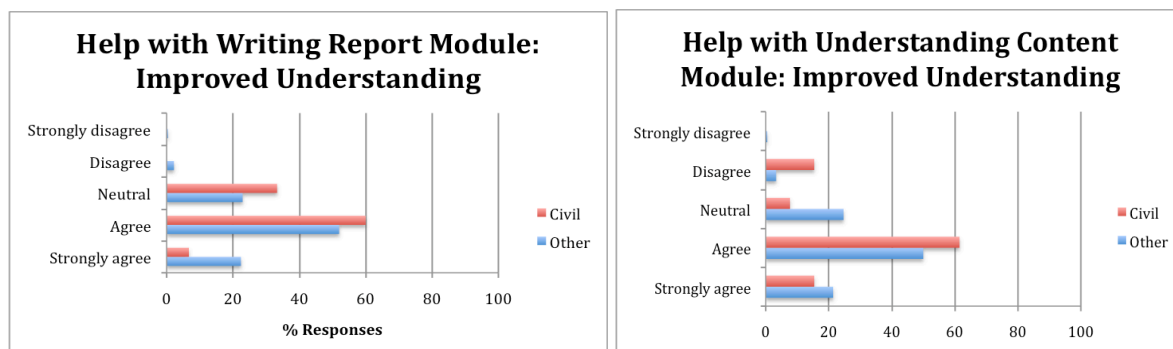
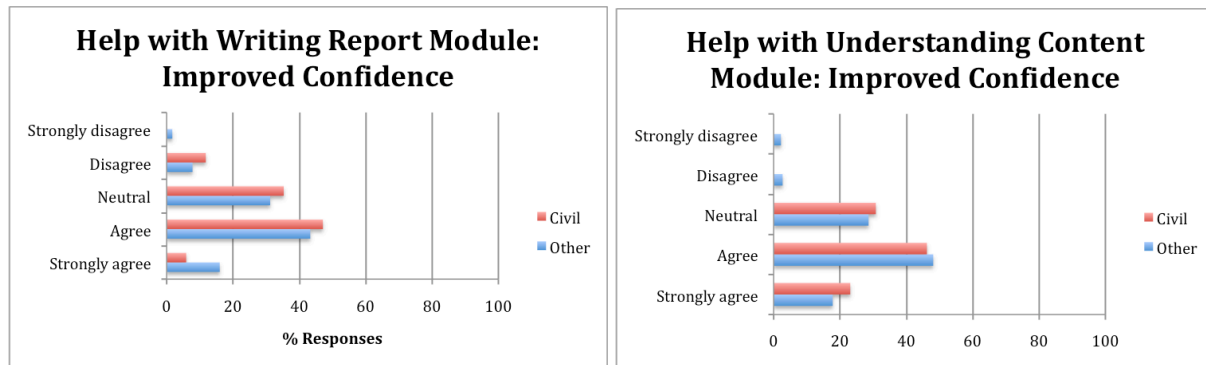


Figure 4: Civil engineering students assessment of their improved understanding compared with all student ratings.



**Figure 5: Civil engineering students assessment of their improved confidence compared with all student ratings.**

As can be seen, the majority of civil engineering student users agreed or strongly agreed about their improved understanding and confidence in both report writing and understanding of discipline content related to report writing, at times more strongly than students in other discipline areas.

Performance data also indicated that civil engineering students who used the site gained higher average report marks (mean=58.64) than those who did not (mean=51.33). This trend was repeated across other discipline areas and, on average, report marks of those who used the site were significantly higher than those who did not ( $t(306)=-3.02, p=.01$ ). Since the user and non user groups displayed similar demographic and language characteristics and reported comparable past writing experiences, it can be concluded that the website helped students to improve their performance in report writing.

Staff involved in the project have also reported benefits not only in terms of improved student report writing but also in the sharing of expertise, knowledge and skills among team members and the creation of collegial links across and within institutions. The civil engineering lecturer commented on the improvement standard of report writing when students engaged with the report writing module compared with previous years when students received general advice on report writing.

Despite these benefits and the evident success of the online learning environment in improving students' report writing, a number of issues remain. The majority of students who reported not using the website said they did not know about it and this was despite the fact that it was strongly promoted by discipline staff throughout the implementation phase. It may be the case that students are overwhelmed by the variety and number of online resources available to them as one lecturer commented '*students are faced with a huge range of materials, ... without clear guidelines as to which should be used for what purpose ...we need better integration of learning resources*'. Also as Figures 4 and 5 show, some students were either neutral or disagreed about the benefits of the module. Some of the open ended comments from civil engineering students indicated areas of dissatisfaction or confusion '*quizzes were a waste of time*'; '*the content should be much simpler*'; '*the module helped me improve my report writing but there were ambiguities with knowing what was expected*' and '*the site was particularly helpful for me as my report was on flow tanks, might not be so helpful for other areas*'. Students also wanted more practice, more examples and more feedback on their report writing and may not have engaged with the site due to the low weighting given to the report (10%).

## Reflection and Recommendations

Although we have reported on the development of a successful online learning environment for improving students' report writing skills in a second year civil engineering course, writing skills need to be further developed throughout the undergraduate years in an integrated and systematic way. This means that the written genres of the undergraduate years as well as learning outcomes in terms of writing for civil engineering students need to be specified. This is indeed a challenge for engineering faculty and curricula.

As we have shown online approaches can offer a way of providing support for student writing but to be successful, they must be integrated and aligned with curriculum content and assessments. In this

way, students will be highly motivated to engage with the online learning resources, In addition, implementation practices need to be proactive so that students are introduced to the learning materials in laboratory sessions or lectures and they do not merely remain as a link within a learning management system. In this case, although civil engineering students claimed they were using the website, in fact, the early reports submitted did not show any improvement and it was only when the lecturer emphasised the importance and relevance of the learning module in a lecture that students used the website '*this appeared to make a dramatic difference as after that I received many excellent reports where clearly students had engaged with the website*'. Ultimately students will need to transfer what they are learning online to new report writing contexts and if and how this occurs remain areas for further research.

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Drury *et al.*, Improving report writing for undergraduate students in engineering through an online learning environment: the case of second year civil engineering

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