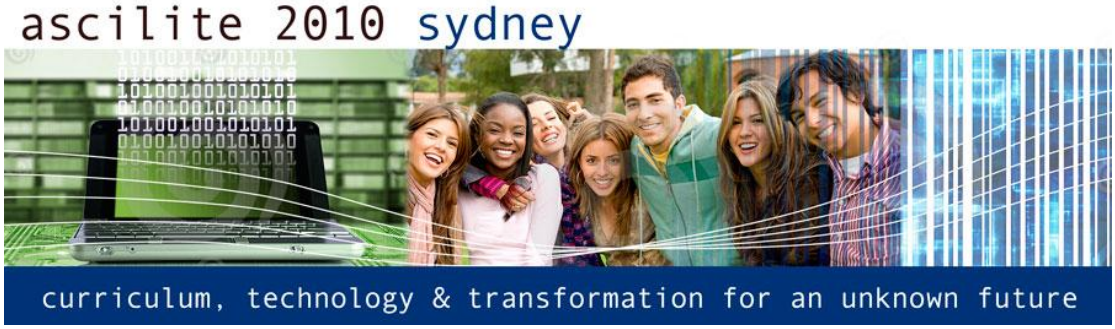

Transforming the teaching of report writing in science and engineering through an integrated online learning environment, WRiSE (Write Reports in Science and Engineering)

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This paper describes an ALTC (Australian Learning and Teaching Council) funded project, which addresses the development of students' report writing skills in science and engineering across the undergraduate years. The WRiSE project grew out of concerns about student performance in written assessments, as well as the need to improve graduate writing emphasised by employers and government. The project approach involved a collaborative team across two institutions. The team comprised language and learning specialists and discipline staff who developed learning materials and technical and eLearning specialists who converted these into online materials. Development followed a feedback spiral, which also involved student users. WRiSE is an integrated, freely available, student centred, online learning environment for report writing in nine discipline areas within science and engineering. In each discipline area, interactive learning materials have been developed to address both the product and process of report writing, as well as the concepts and content behind the reports students have to write. WRiSE is designed to meet the needs of students from diverse backgrounds who have had varying writing experiences as it can be accessed according to student needs. Evaluation of WRiSE has been positive in the areas of user friendliness and improved understanding and confidence in report writing. Those students who used WRiSE have attained significantly higher grades in their reports than students who did not use WRiSE.

Keywords: report writing, science, engineering, online learning, student diversity

Background and rationale

In Australia and elsewhere, science and engineering students often struggle with written assessment tasks; many have elected to study these disciplines precisely because they perceive them as relatively 'writing free'. However, academics and employers require highly developed written communication skills in students and graduates. Deficiencies in this area are of ongoing concern in the science and engineering professions and are deemed to be of critical importance for future employability (AC Nielson Research Services, 2000; Commonwealth of Australia, 2002; 2007). Teaching writing skills is still considered a low priority within science and engineering curricula and presents faculty staff, many of whom are from non-English speaking backgrounds (NESB), with a number of challenges such as the

ability to devise appropriate writing tasks, to provide scaffolding and guidelines for these, to articulate how they assess student writing, and to provide timely, relevant and appropriate feedback on writing to bring about improvements. An additional challenge is the diversity of the student cohort with large numbers of NESB students, both local and international. These challenges occur in the context of the knowledge revolution, which means that students have to be even more skilled in the reading and writing of their disciplines. The volume, variety and complexity of texts that students need to engage with and produce means that the kind of literacy they need to master does not only encompass writing but also multiple literacy practices or multiliteracies (New London Group, 1996; Cope and Kalantzis, 2000; Unsworth 2001).

Although concerns about the writing of engineering and science students are not new as attested by the large and varied literature on successful interventions to address this issue (for example, Oakley, Connery & Allen, 1999; Walker, 1999; Jensen & Fischer, 2005; Craig, Lerner & Poe, 2008), today's increasingly diverse cohort of students and staff present new challenges, especially in the linguistically and cognitively demanding domain of written communication. Yet science and engineering curricula offer limited opportunities for teaching written communication in a systematic and developmental way over the undergraduate years. In the contested space of these curricula, new technologies can offer learning opportunities to support students in developing their writing within the context of their discipline.

Technologies associated with online learning or eLearning approaches are now widely used to support the development of students' writing in a flexible and accessible way. Students can use the materials at their own pace and according to their needs. Most of these resources however, remain online versions of print based materials (for example, Winckel, Hart, Behrend & Kokkinn, 2002). Although they offer sound advice and guidelines, they do not allow students to actively engage with the learning modules through exercises, nor can they give feedback.

Other online programs offer a degree of interactivity using the computer-based medium to provide on-screen examples and exercises that target writing. (http://www.dlsweb.rmit.edu.au/lsu/content/2_AssessmentTasks/assess_tuts/reports_LL/index.html and http://unilearning.uow.edu.au/main.html). However, although these programs use authentic examples from a variety of disciplines, they are not situated within a specific disciplinary course curriculum and therefore the programs remain largely generic in their approach. Some online programs have recognised the importance of targeting a specific discipline context (Clerehan, Turnbull, Moore, Brown & Tuovinen, 2003; Drury, O'Carroll & Langrish, 2005) and have embedded online resources in discipline curricula and assessment tasks (Wingate & Dreiss, 2009) while maintaining a balance between the development of generic skills and discipline-based skills (Strauss, Goodfellow & Puxley, 2009). These online resources do go some way towards meeting students writing needs in different discipline contexts, but they do not provide resources across discipline boundaries and across the undergraduate years. This means that the transitions students need to make in their written communication are not well supported, nor is their understanding of the similarities and differences in written communication within and across disciplinary boundaries. One online learning environment which aimed to address these issues is the WRiSE project. http://www.usyd.edu.au/learningcentre/wrise/

The WRiSE project was funded by the ALTC and brought together two institutions: the University of Sydney and the University of New South Wales. Collaboration involved language and learning specialists from both Learning Centres and staff from nine discipline areas as well as technical and eLearning specialists from the School of Biological Sciences at Sydney University.

The project created an online learning environment to foster awareness of and skills in writing a common genre in the sciences and engineering, the report. The WRiSE site is an integrated, freely available, student centred, transdisciplinary, online learning environment for report writing in a range of disciplines and levels within science and engineering (*Biology, Molecular Biology year 2 and year 3, Chemistry, Microbiology, Physiology, Chemical Engineering, Civil Engineering, Mining Engineering*, Figure 1). WRiSE is designed to provide writing support in a strategic manner to an increasingly diverse student body, so that students can access it according to their varied needs. WRiSE also offers student writers new ways of engaging in writing tasks designed to enhance and make explicit their awareness of writing. For subject specialists, who are often ill-equipped to teach writing

the site provides new opportunities for communicating with their students and supports staff in devising contextualized, guided writing tasks that allow for a developmental approach to writing.

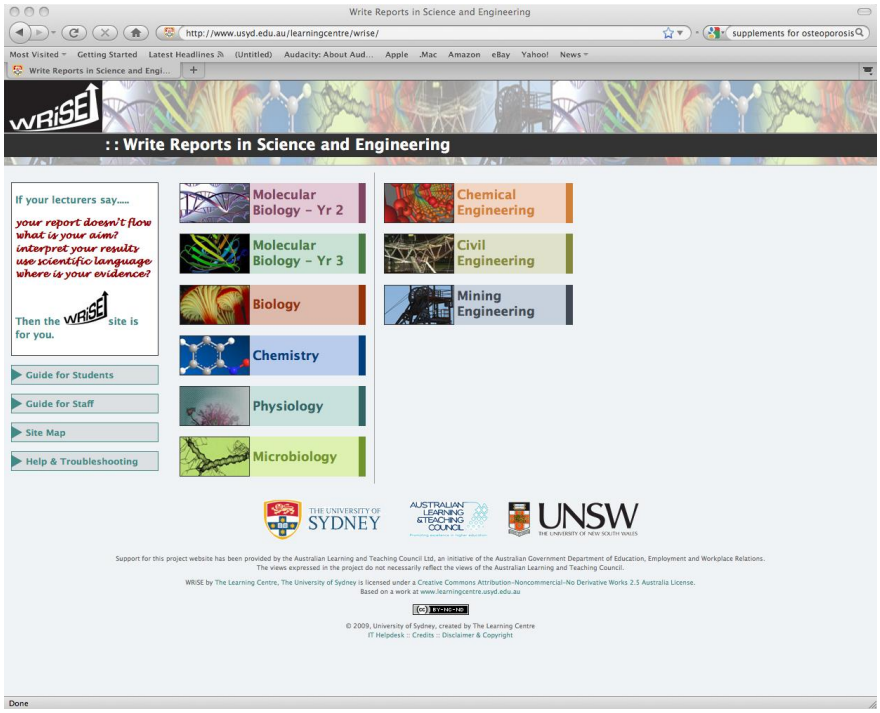

Figure 1: Screen shot of the home page for the WRiSE site
http://www.usyd.edu.au/learningcentre/wrise/

Approach and methodology

The approach adopted in the creation of WRiSE brought together a project team with a wide range of experience and knowledge. Subject area specialists from the nine discipline areas created content to support student understanding of concepts in their discipline and language and learning specialists created content to help with understanding the structure and language of reports in these disciplines. Students contributed their voices to the website to comment in particular on the process of report writing and on a report they had written. Discipline staff also added their commentary on the students' report as well as their expectations of the report assignment. Technical and eLearning specialists transformed this content into interactive online learning materials brought together in a seamless online environment. This collaborative process followed a design, development, feedback cycle to ensure that the website was meeting the needs of students and staff.

The methodology consisted of 2 main phases covering a 36 month period and involving administration, collection and analysis of sample student reports, content development and design, technical development, implementation, evaluation and dissemination (Figure 3).

The WRiSE concept

The design concept for WRiSE has been informed by a model of learning which emphasises the students' prior learning, their perception of the learning goals and their motivation and interaction with the learning materials and environment. It is complemented by a teaching approach that allows students to engage in an interaction with the educational media, (Prosser and Trigwell, 1999; Laurillard 2002). This interaction needs to be supported by more explicit guidance and structuring of tasks for effective learning to take place. The theoretical model of language adopted is based on Systemic Functional Linguistics (Halliday, 1985; Martin 1994) and a "genre-based" approach to writing pedagogy, which emphasises the influence of the context and social purpose on text structures, rather than decontextualised "rules" (Cope and Kalantzis, 1993; Martin 1999). This theoretical model is widely used in researching and teaching academic literacy in Australian Universities and elsewhere (Jones,

2004) and was used as the basis for the conceptual development of the earlier online report writing modules which were brought into the WRiSE site (Drury, 2004).

The WRiSE design addresses both the product and process of report writing in a particular discipline area. In this way it supports students in their understanding of discipline content relevant to reports they are writing for assessment. There is thus a strong incentive for students to engage with the online learning materials on the site, as the content is highly relevant to students' current needs (Boud & Prosser, 2002). These two aspects of the site are reflected in its design, which features a *Help with Report Writing* space and a *Help with Understanding Content* space for each discipline area (Figure 2 and Figure 3).

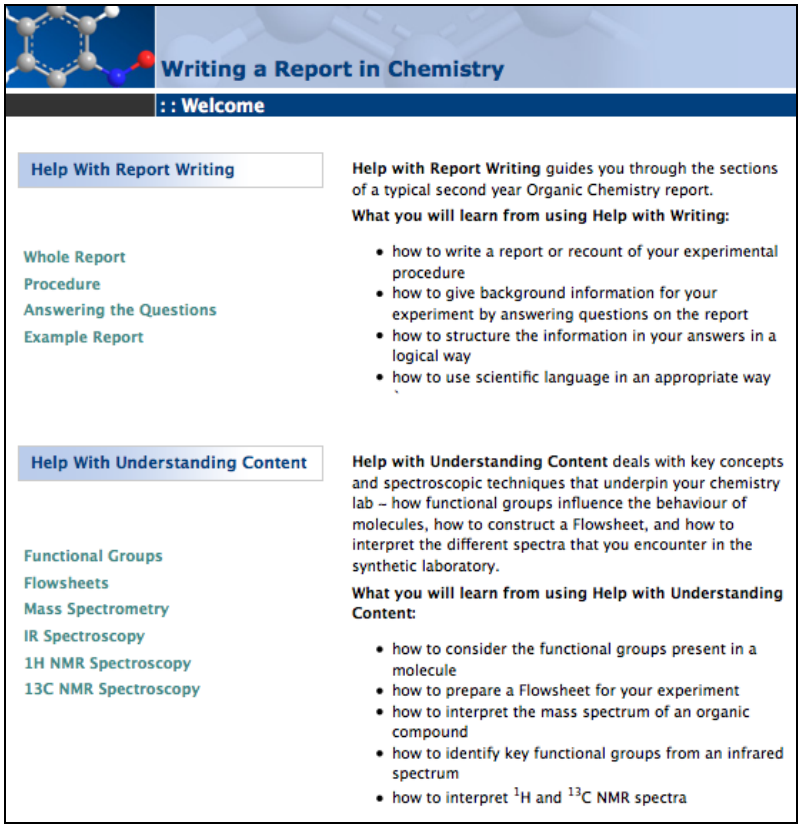

Figure 2: Screen shot of home page for Chemistry

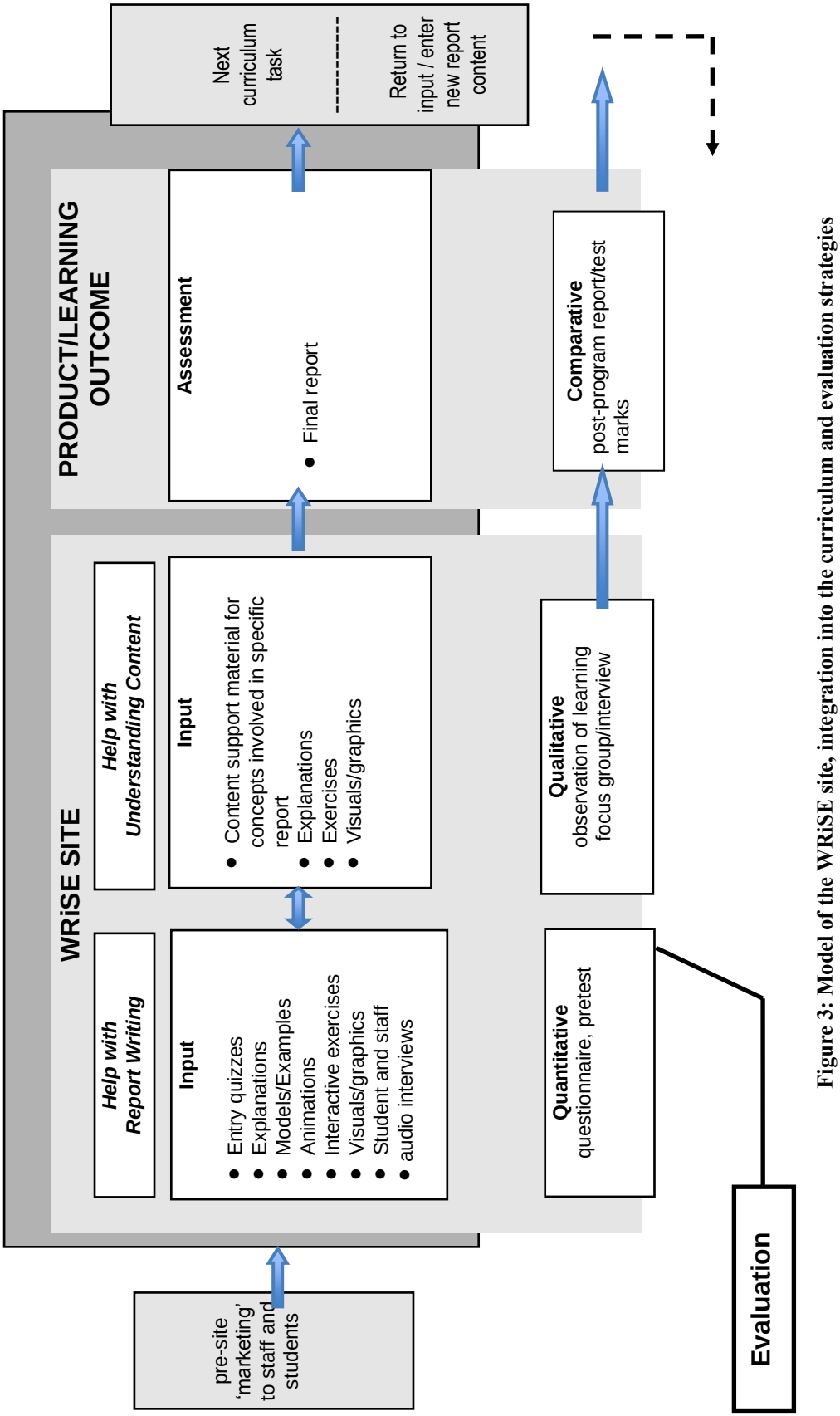

Figure 3: Model of the WRiSE site, integration into the curriculum and evaluation strategies

The Report Writing space consists of 3 areas. The first area focuses on the report as a textual product and makes explicit the content, structure and language of the report in each of the particular disciplines through highlighted and annotated examples of student reports, interactive and animated explanations and interactive exercises with feedback (Figure 4). It includes self-testing quizzes which students can use on entry to each section of a report module so that they can assess what they already know about report writing in that discipline area. The second area provides a student's perspective on the process of writing a specific report through an edited audio interview with a volunteer student. Interviews are from a selection of discipline areas to clarify the specific requirements of each. Interviews are accompanied by visuals to create a more personal interaction. The third area provides the lecturer's perspective on the student's report from that discipline area and also more details on the expectations about writing in the discipline. This information is also provided through an audio and visual medium and clarifies the disciplinary context (Figure 2).

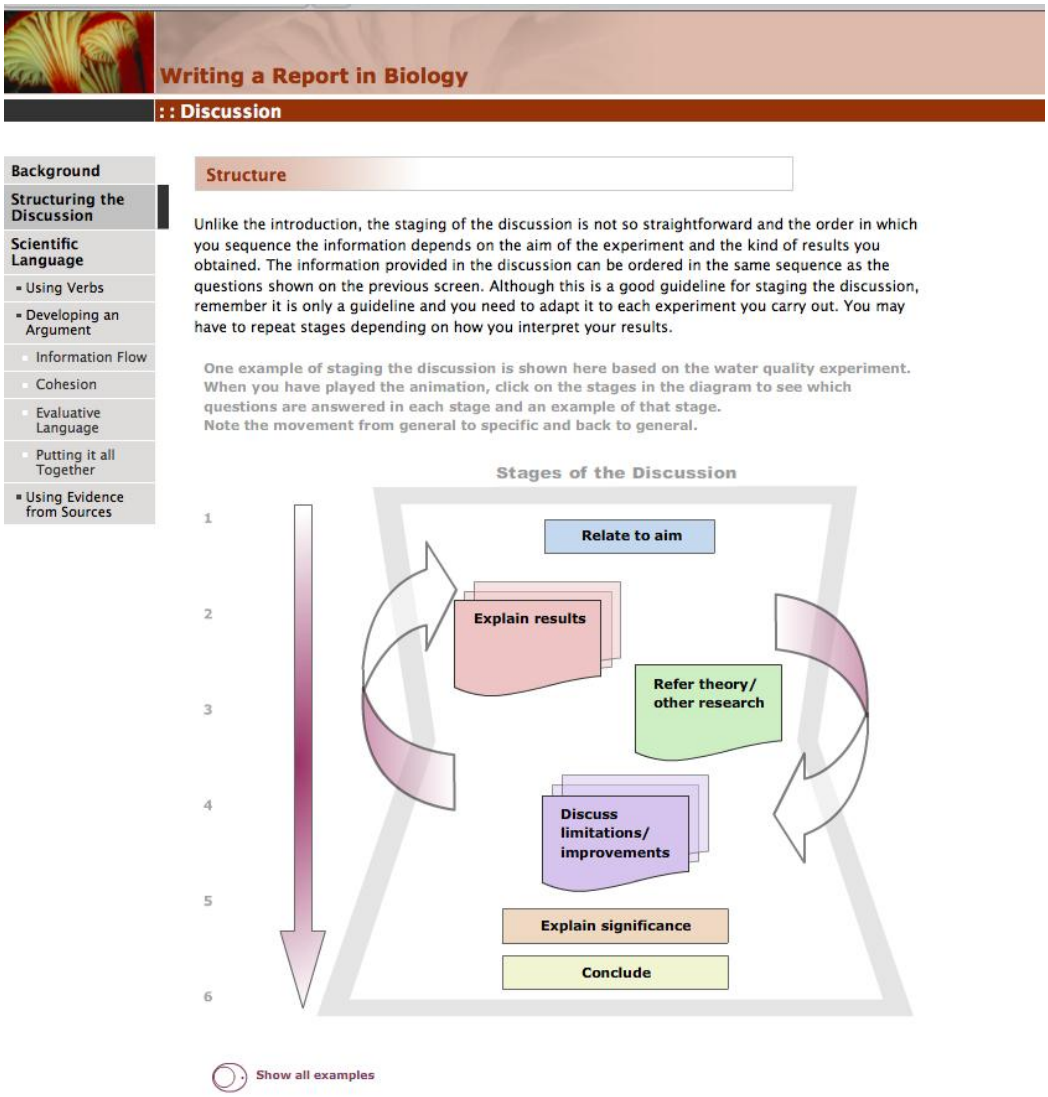

Figure 4: Screen shot of animated diagram to illustrate a typical discussion stage of a laboratory report in Biology

The *Help with Understanding Content* space is where lecturers upload information and create interactive exercises on a particular assignment topic or a particular concept in their discipline (Figure 5). They can refer students to this space and further recommend other areas in the *Help with Report Writing* space for them to visit. In this way, the site is customized to specific contexts and specific assessment tasks and feedback on these tasks.

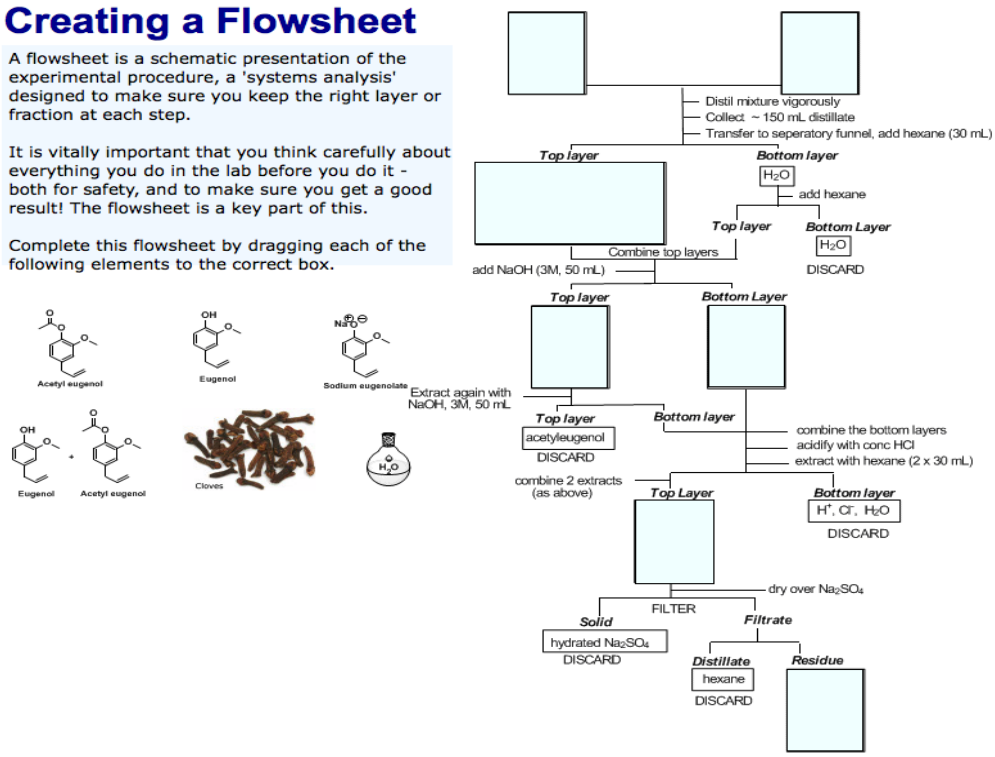

Figure 5: Screen shot of an exercise in the Help with Understanding Content area of the Chemistry module

Project evaluation

An extensive evaluation of the WRiSE site was carried out across both institutions in semester 1, 2009 using questionnaires and focus groups (1 in University of Sydney and 1 in UNSW). Numbers in the focus groups were very small (< 5) but the comments were useful. Both students and staff and all disciplines were surveyed. Tracking data were also collected. Tracking data showed strong site usage over first semester with approximately 1000 unique visitors and 60,000 pages/screens viewed. Visitors peaked in mid May reflecting due dates for report assignments. Of the 442 students who completed questionnaires in both institutions, 261 (59%) used the site – 189 (University of Sydney) and 72 (UNSW).

Those students who used the site were asked to complete an extended questionnaire that assessed their usage of the site, their evaluation of the user-interface, and the perceived effect that it had on their report writing skills. The majority of users had an in depth approach to using the site, visiting it on a number of occasions and spending at least an hour on the site. Overall, they rated WRiSE highly in all areas. They reported improved understanding of the structure and language of reports through their interactions with the site and increased confidence in their report writing skills. In addition, their understanding of content in their discipline improved as well as their confidence in knowing what content to put in their report.

More specifically, students were asked to evaluate aspects of each module: *Help with Report Writing* and *Help with Understanding Content* using a likert scale that ranged from 1, which indicated "Strongly agree", to 5, which indicated "Strongly disagree". In the *Help with Report Writing* module, the diagrams, animations, example reports, exercises and feedback on exercises helped them to understand the report structure and the kinds of language appropriate for a report. In the *Help with Understanding Content* module, the results indicate that students agreed that the feedback on the exercises helped them understand the correct answer and helped them identify what content is necessary for their report. Overall, these results indicate that most students thought that both modules had a positive impact on their report writing skills (Figure 6).

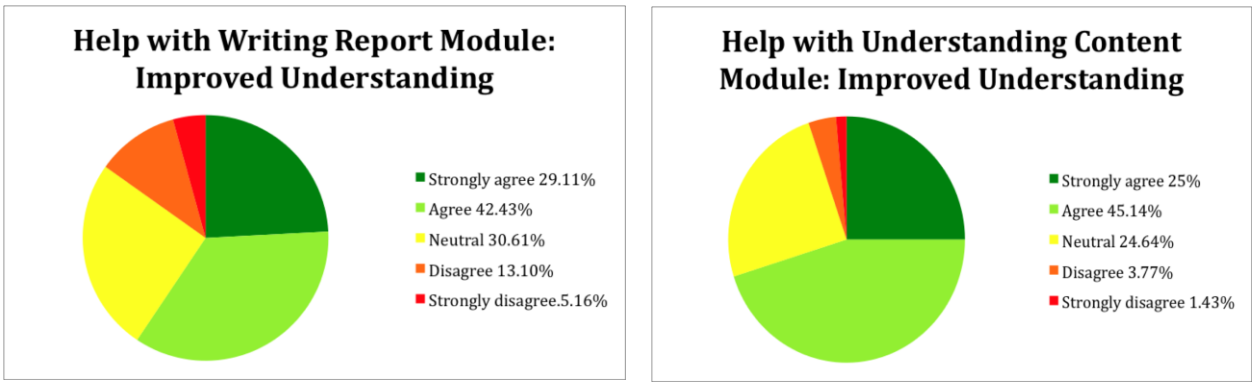

Figure 6: Participants assessment of their improved understanding of report writing after using the modules

Focus group quotes support this finding:

> Those examples or the example and then the structure next to it, I think was great,
>
> Seeing those different colours is what helped me the most and, yep, I did change it. I wrote mine and then went to this site and looked at it and then went back and changed it.

When asked if the modules had led to students being more confident in their report writing, the agreement was less positive although the majority of students still felt their confidence had improved (Figure 7).

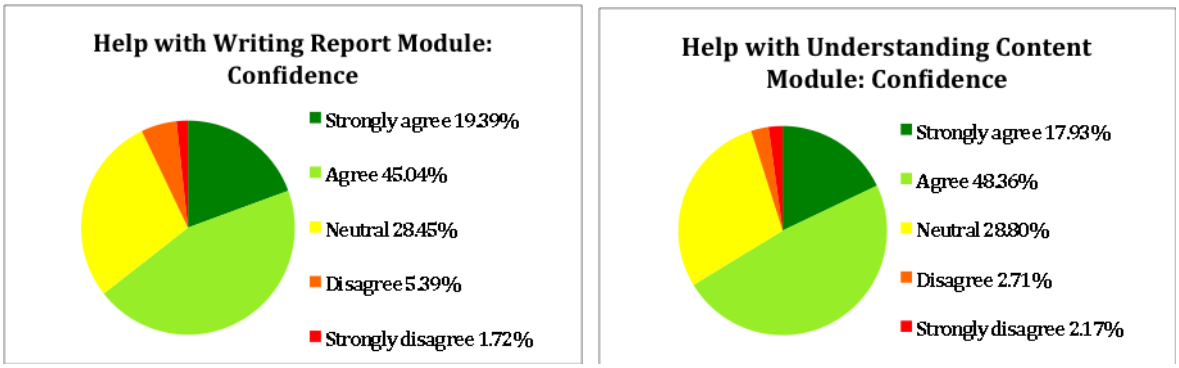

Figure 7: Participants assessment of their improved confidence in report writing after using the modules

Examples of positive focus group comments in this area are:

> I feel more comfortable at following structure
>
> I can explain myself clearly and am able to identify mistakes and correct.

Of the 41% who did not use the site, most reported that they did not know about it. This is despite the fact that it was strongly promoted by discipline staff during the implementation stage of this project. It may be the case that students are overwhelmed with 'resources' as one lecturer in the project commented:

> Students are faced with a huge range of materials, each for specific purposes without clear guidelines as to which should be used for what purpose. I think we need better integration of all learning resources. I suspect we now have too many digital resources for the unit. Thus I need to develop a guide to resources, including the WRiSE site.

In general, users and non-users did not differ in terms of demographic characteristics, language background, confidence in writing, past writing experience and skill in writing different parts of a report. However, the user group tended to have written longer academic texts than the non-users.

The staff survey was sent to all 14 discipline lecturers (10 in University of Sydney and 4 at UNSW) and 4 responses were received. Throughout the project, however, discipline staff were providing ongoing informal feedback on the design and content of the report writing modules. Staff were surveyed on the project processes and outcomes, sustainability and lessons learned. The responses indicated that most staff were satisfied with the project processes and outcomes both for their students and for themselves. Their comments reinforced this view:

> I feel we definitely have a well-designed pedagogically sound website. Informal feedback from PhD demonstrators who mark the reports indicate meaningful improvements in student report writing skills. In response to the question "Have you noticed an improvement in student lab reports?" their comments include "Yes!!! by far"
>
> There have been some significant improvements in student report writing in some areas particularly in the area of report structure and writing style

Staff also commented on the development of new working relationships and collaborative links across and within Universities.

Project outcomes

Despite this favourable evaluation of WRiSE, however, the most important question is whether it makes a difference to writing performance as measured by report marks. In general, users gained better marks than non-users, although differences were not significant except in one instance, Molecular Biology, 2nd year (Table 1).

Table 1: Mean Report Marks (%) for Each School, by website use

		Did you use the website	
Discipline		**No**	**Yes**
Biology	M	65.38	69.75
	SD	10.85	15.12
	N	16	28
Molecular Biology 2nd Year	M	80.02	88.77*
	SD	11.78	7.47
	N	27	16
Molecular Biology 3rd Year	M	81.48	74.81
	SD	15.80	11.99
	N	3	41
Chemical Engineering	M	66.31	70.40
	SD	7.65	9.52
	N	28	26
Chemistry	M	78.53	82.63
	SD	7.38	7.30
	N	23	19
Mining Engineering	M	61.80	69.26
	SD	17.29	12.38
	N	5	19
Microbiology	M	75.39	76.99
	SD	18.86	15.18
	N	36	38
Civil Engineering	M	51.33	58.64
	SD	13.08	21.01
	N	6	17

*denotes $p<.05$

When marks were pooled across disciplines, however, on average, report marks of those who used the website were significantly higher that those who did not ($t(306)=-3.02$, $p=.01$). Therefore it appears that using the website had a consistent positive impact on report marks across different disciplines. Since the user group tended to have written longer academic texts compared to non-users, further statistical analysis was carried out to control for this variable. This analysis upheld the conclusion that using the website helped students to improve their report marks.

Discussion and conclusion

We have built a website that supports students in their report writing tasks in the sciences and engineering and which has been shown to improve students' performance in report writing. The influence of eLearning interventions on any academic performance is usually not so clear in the short term (Peat & Franklin, 2003; Oliver, 2008). Since it is freely available to all students and staff, users from all educational backgrounds and all locations can easily use the site and we have had positive feedback from as far away as Argentina and China.

The overall design has aimed to be student-centred, incorporating example student reports, student voices and a range of different disciplines and experimental and field examples to simulate the university context that students experience. The site also has the additional advantage of including staff voices and the examples and exercises designed by academic staff help to make explicit their expectations for writing and understanding concepts in their discipline. Another strength of the site is the theoretical underpinning of the language, discipline and learning concepts and as such it represents a beginning in mapping the genres of the undergraduate years across science and engineering disciplines, working towards specifying learning outcomes in terms of written communication.

Despite this success, ongoing implementation strategies are crucial to students engaging in the modules and learning from them. If implementation merely involves inserting a link into a unit of study on the Learning Management System, then students will most likely fail to take advantage of the site. If however, the site is embedded in the unit of study and introduced in a tutorial or lecture session where students can actually work through some of the explanations and exercises, higher usage of the site will then occur (Wingate, 2009). Additionally, if content relevant to students' current assessments is introduced into the *Help with Understanding Content* space on the site, this is further motivation for engaging with the learning materials. The question remains whether high levels of usage result in improved transfer of skills and knowledge to new learning situations. In other words, how transformative of student's disciplinary literacies are their interactions with the site? Related to this is how this transfer may be occurring and what kind of interactions with the site promote transfer. Such exciting questions remain for future research.

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