Teaching Environmental Chemistry on the Web

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The Faculty of Science and the Faculty of Agricultural and Natural Resource Sciences at the University of Adelaide have been involved in a joint project on the use of the World Wide Web for the delivery of teaching resources to science and agricultural students. The Faculty of Science has established Adelaide Science Online (ASO) as a multi-faceted approach to the delivery of information to both staff and students within the Faculty, including teaching materials, research opportunities and the minutes and agenda for meetings as well as general administrative data. The facility has a full time manager and uses *Lotus Notes* as the database with a *Domino* server responsible for the storage and delivery of the material. This article will not cover the research and administrative facilities which are considerable in their own right but rather discuss our experience in designing and delivering a new course in Environmental Chemistry with the express intention that it be flexible in terms of the mode of presentation and that it be readily available to students both on and off campus.

Environmental Chemistry II is a second year subject that is taken by a wide variety of students. It is part of the Environmental Science Degree offered by the Faculties of Agricultural and Natural Resource Sciences and Science, as well as being available to Science students in general as one of their second year choices. Non-science students may also undertake the subject so long as they have the required prerequisite, which is a standard full year, first year chemistry subject. Since potential students can come from a number of Faculties and courses, timetabling for the subject was a major issue. In addition, students in the Faculty of Agricultural and Natural Resource Sciences have to divide their time between two campus settings and this can be difficult. Thus it was deemed essential that the course material be available for students to access in their own time.

Planning for the course commenced in a typical manner with the three academic staff who were to teach the subject having a series of preliminary meetings to discuss the aims and objectives, then deciding on broad areas of subject content. The next major discussion point concerned the necessity for a textbook. If the material was to be delivered by the World Wide Web was there a need for a formal textbook? Should the web presentation be encyclopaedic so that a textbook is unnecessary? This discussion was important because the aims and objectives for the course included statements such as: encouraging students to think critically; enhancing students problem solving ability; helping students gain an appreciation of scientific methodology; and encouraging professionalism. It was decided that a textbook was required as it encouraged students to read a slightly different version of the same material and thus enhanced their ability to coordinate information from a number of sources. Whether a textbook will always be used for this course will be assessed over the next few years as the web site is developed and feedback from students is obtained. Once the course content was finalised we then required a plan for the web site.

Rather than writing the course material and "dumping" it all into web pages, a series of planning discussions were held in which the reasons for using the World Wide Web for teaching *this particular subject* were considered. The initial rationale was ease of access for students who

could not physically be on campus. The discussions then proceeded with the importance of linking all the teaching and assessment material so that a student could make sense of the "bigger picture" of the subject, as well as individual pieces of information. Since the Faculty of Science was using *Lotus Notes* as the database for the delivery of some of its courses (ASO), this became the natural vehicle with which to deliver a new subject such as Environmental Chemistry II.

The first major item that had to be addressed was whether to use an open or closed site for the subject. What is the economic value of the intellectual potential of the teaching material? Should we share our resources with other tertiary institutions or make others pay for access? Who is likely to benefit from open or closed access to the material? The whole question of open access to information on the Internet will continue to be discussed and no doubt a variety of opinions will ensue. It was decided at this initial stage to restrict web access to students enrolled in the subject.

The front page was designed to be as simple as possible without the need for split screens and scrolling (Figure 1). The section headings were also kept to a minimum so that students did not have to remember complicated navigation terms. The term, course notes, was used instead of lectures in order to emphasise the fact that we were moving away from the traditional, passive, didactic lecture style and attempting a more interactive approach with students.

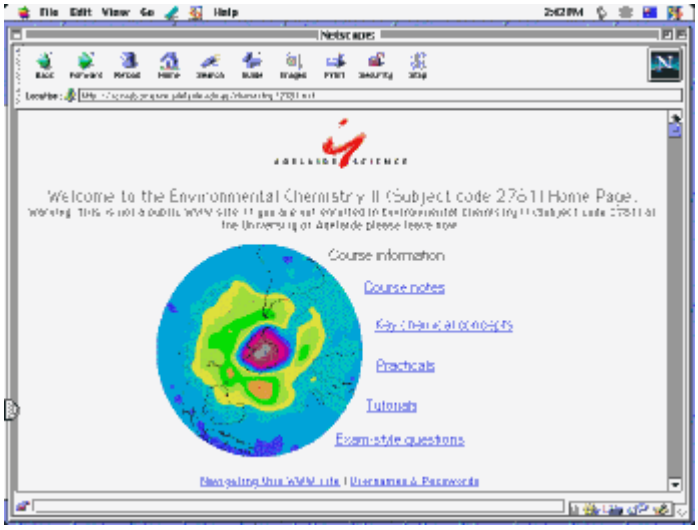

Figure 1.

The database approach to building the web site makes it easy to link the course notes to key concepts, practicals, tutorials and exam-style questions. These were the primary sections which we thought would be of concern to the students. Course information contained the usual housekeeping data as well as the aims, objectives and expectations for the subject. By combining all this material online both the staff and students have an opportunity to observe the relationships between different parts of the subject.

One idea, which we developed at the planning stage for the web site, was the notion that as the site was a database; selected information could be made available to students in other courses and subjects. Many of the concepts that are taught in chemistry are fundamental to many subjects and are dealt with in a repetitive manner by different teaching staff. We thus identified "key chemical concepts" and decided that for any subject we built in a web format that this heading should appear and that the information should be available for staff and students in different subjects. Concepts such as S_N1 and S_N2 are common to many chemistry subjects and rather than each staff member having to prepare individual course material it is more economical to prepare a single entry which is then made generally available. Within the web pages for these key chemical concepts the degree of complexity can be built up so that introductory students are not overwhelmed with detail that they do not need and advanced level students can be given a more rigorous treatment of the topic. This is another major advantage for the database approach to building web pages for course material. Students can use these pages for revision in any subject they are studying.

The next issue that was addressed was the number of levels available within the web site. Would students get lost down some mineshaft of information, never to see the light of day again? We thought that three levels were sufficient and that this would make it easier for students to either navigate in a linear sense or access the data in a format of their own choice (Figure 2). A set of standard navigation buttons was provided at the top and bottom of each page. Since the web site is actually a database rather than a sequence of web pages, the information contained in the database could be manipulated in various ways.

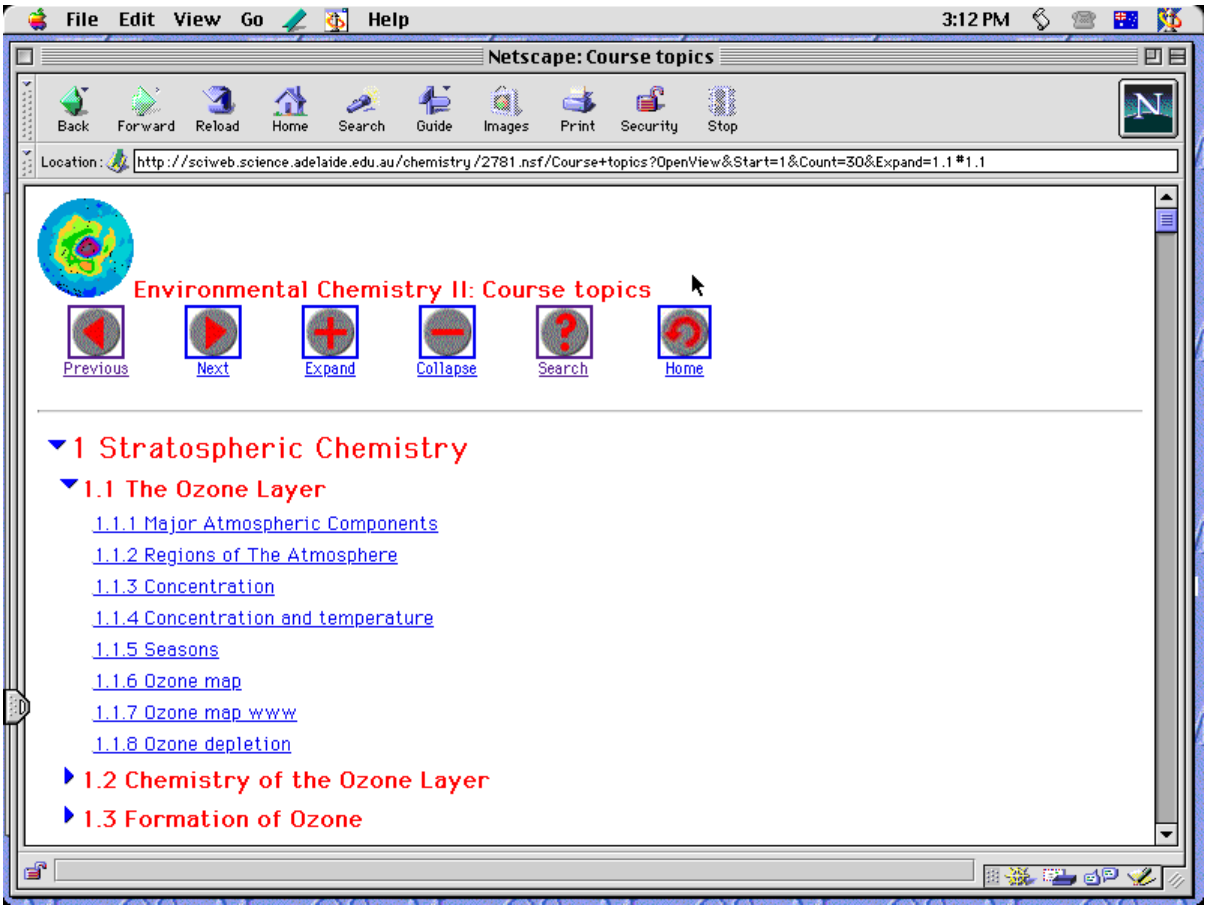

Figure 2.

The course material was assembled using a standard word processing application and chemical structure drawing package and then copied and pasted directly into *Lotus Notes*. Apart from minor formatting adjustments no further manipulation was required to build the web site. The ASO manager prepared the *Lotus Notes* template and page attributes and the teaching staff built the content of the pages. Since previous templates were available for us to review we could make changes to these so that the appearance and navigation aspects of the pages were simplified for students.

Another advantage to the database approach is the ability students have to undertake word searches and so compile their own databases (Figure 3). This effectively amounts to an individual web site with students organising the course material in a way that could be more suited to their individual learning behaviour. This is a concept we have only begun to explore, the idea that students can make sense of course material in alternative ways. Teaching staff may have a specific reason for presenting course material in a particular order and format but students may also find it advantageous to rearrange this material for their own unique learning path. Having access to an entire subject in a database format enables students to explore this possibility. We did not pursue this aspect this year but will in future years.

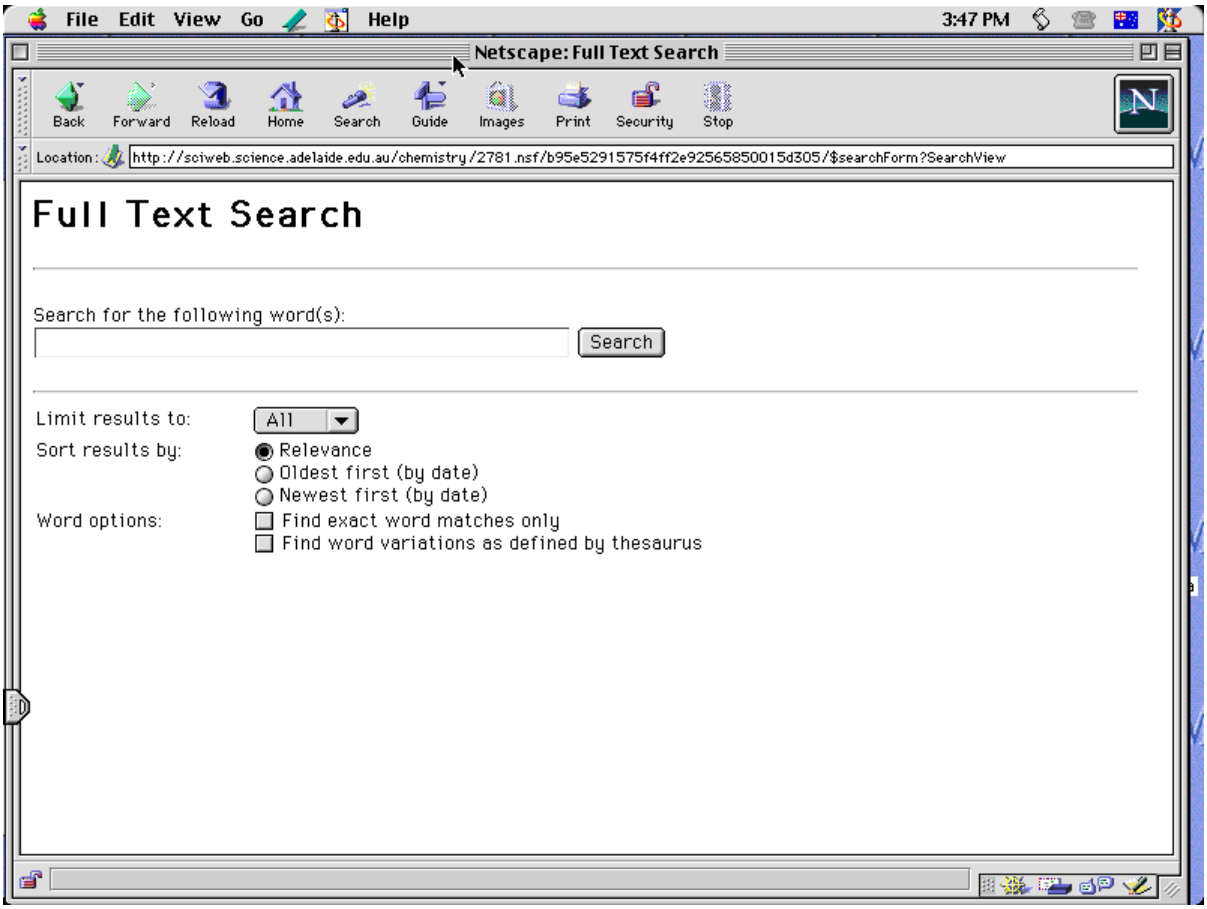

Figure 3.

An example of a search for the word 'nucleophile' is shown in Figure 4. The concept of a nucleophile is used in many chemistry subjects. The database approach would allow students to take a concept such as a nucleophile and see the broader context in which it is used. This is difficult to achieve in individual lectures where the teaching staff are often concerned with the details of one particular aspect of the subject. Since staff would have access to many of the subjects in the ASO database they could also do keyword searches for important concepts which they are using as part of their teaching and so investigate its importance in cognate areas. This has the potential for a more cooperative teaching approach amongst staff.

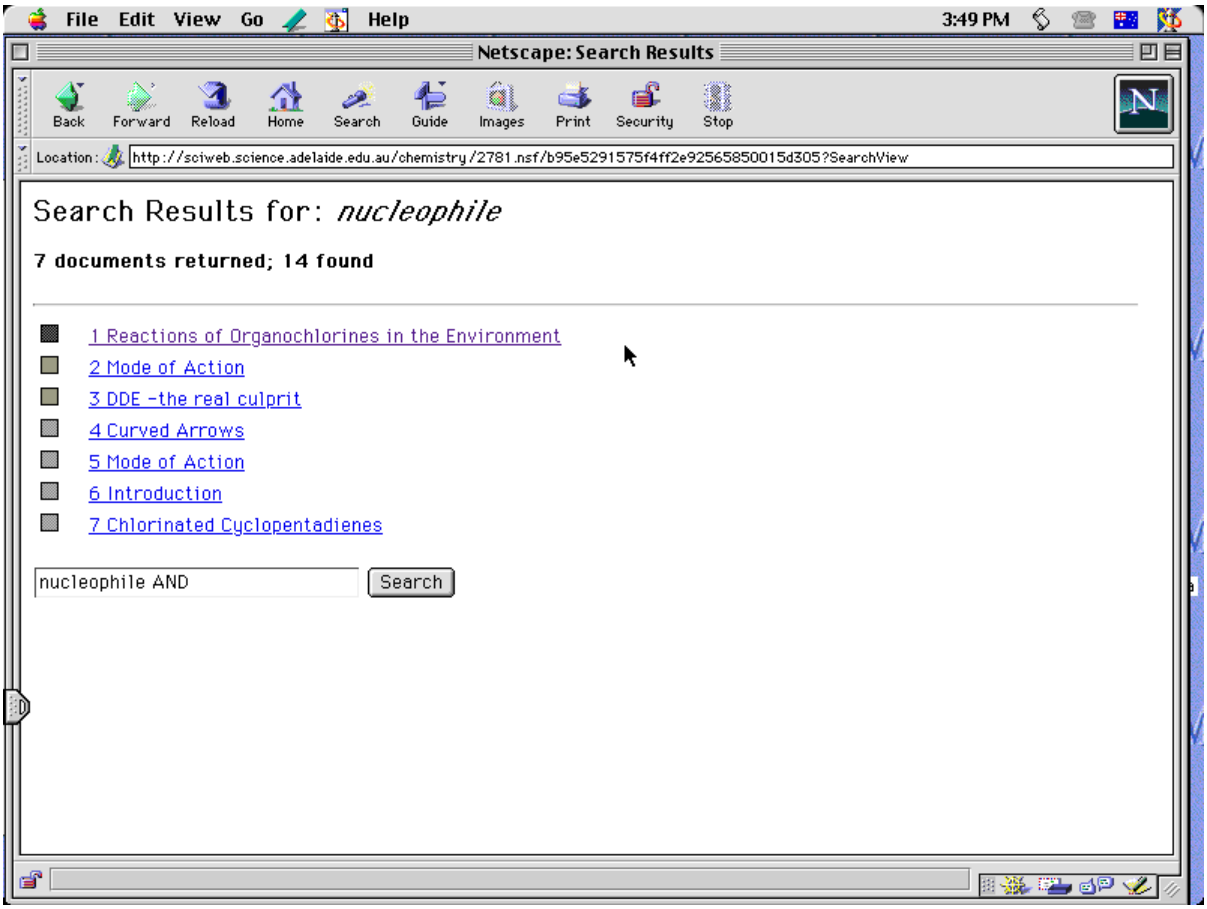

Figure 4.

There is a great deal of information available to students and staff on environmental chemistry on the World Wide Web. We have only just begun to embed URLs into the course content for students. Students can be overwhelmed with too much information and we will have to be careful not to overload them with unnecessary, peripheral material. Staff must always be mindful of the aims and objectives for the course and define clearly for students what is essential material required for the subject and what are additional resources provided for individual investigation. It would be a pity not to provide avenues for students who are motivated to pursue a concept or topic further as part of their own curiosity driven learning.

Although all the course content was available on the web site, traditional lectures and tutorials were still used to present the material. This included traditional overhead projector slides and using the web site directly as an on-line teaching resource. All of the students copied the web pages before the lectures and used these to annotate during the face-to-face lecture sessions. One issue that rapidly became obvious after discussions with the students was the wide variation in prior knowledge amongst students on using web browsers and copying material from the web. We had naively assumed that most students "surfed" the web regularly and so had a basic understanding of web protocol. Simple issues like students copying web pages directly from the

web browser can be quite wasteful because of the headers and footers which accompany each page and the fact that font sizes can be set for visualisation rather than printing. Many students did not realise that the font size could be changed on the browser. This highlighted the need for a training session with students on how to use the web browser efficiently. It is often more convenient to copy the text and diagrams to a word processor and format the content at a later stage than print directly from the original web page. This also highlighted the fact that many students did not realise that graphics in web pages needed to be copied separately from the text. When this subject is presented next year we will set aside time for a training session so that students can make efficient use of their time.

Lecturing directly from the web page was used for one section of the course material. The actual web site was projected onto a screen in the lecture theatre and the material discussed. One of the disadvantages of using the site directly for this particular section was the volume of material on each of the web pages. Even though the material was not read verbatim but concepts highlighted and mainly graphics used, students indicated they felt overwhelmed when seeing too much information on the screen in the lecture situation. This was to be expected. We are now designing the web pages so that a page of information is summarised in a single screen size (much like an overhead projector slide) on the top of each page and this is presented to the students in the lecture situation. We anticipate that students will then download and copy the main contents of the web page for further reflection and in depth consideration at a later time. This format will also serve as a useful summary of key concepts for both teaching staff and students.

No technical difficulties were encountered in lecturing directly from the web site but as a back up in case the site was not available the material was cached onto the hard drive of the portable computer used for the presentation so that continuity of format could be maintained. Detailed tutorial answers were available from the web site but this did not replace the normal contact time with students for reviewing questions.

Student feedback on this format for course presentation was generally favourable. Some of the concerns expressed by students have been discussed in the above text and we have been able to address them as the course progressed or will introduce the necessary changes next year. The students and teaching staff are in the early stages of realising the potential of web pages in a database format and as we all become more familiar and comfortable with the technology we will all benefit from its use. We are looking forward to presenting this subject again next year and hope to make better use of the facilities and resources we now have at our fingertips.

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