



## Energy Studies and the Art of Going Online

Chris Lund<sup>1</sup>, Philip Jennings<sup>1</sup>, Simone Volet<sup>2</sup>, Allison Brown<sup>3</sup> and Romana Pospisil<sup>3</sup>

clund@murdoch.edu.au

<sup>1</sup>:Australian Cooperative Research Centre for Renewable Energy, <sup>2</sup>:School of Education and <sup>3</sup>:Teaching and Learning Centre, Murdoch University

### Abstract

*Offering interactive, multimedia courses via the Internet or CDROM is seen as one of the most promising ways of achieving the goals of cost effective, flexible, global education in a more competitive local and international student market. One of the major questions that still has to be answered, however, is whether interactive, online instructional methods can only be used to supplement traditional teaching practises, or whether they can effectively replace or even improve on them. This paper describes our experience in the design and development, so far, of the core units of a Postgraduate Diploma in Energy Studies to be offered by Murdoch University in the on-line delivery mode. This includes a discussion of some of the pedagogical and teaching/learning issues that needed to be addressed in developing such things as a common Web Browser interface and the way material is presented in an online, interactive mode. Some ideas of "What Works and Why", are given based on an evaluation of student attitudes to one of these units that has already been offered in dual mode.*

### Background

The Australian Cooperative Research Centre for Renewable Energy (ACRE), hosted by Murdoch University in Perth, seeks to meet the increasing local and world wide need for more tertiary trained scientists, engineers and policy makers with the knowledge and skills needed to develop and implement renewable and efficient energy systems and policies [Jennings, 1996]. It is doing this by developing, in conjunction with Murdoch University, a range of internationally focussed, online (Internet, CDROM, or both) University courses in renewable energy technology, energy policy, energy efficiency and greenhouse issues. This includes a number of units (courses) in several disciplines at the University undergraduate and postgraduate level that will be available for both internal (on campus) and external (off campus) study. The target market is undergraduate HECS based students and full-fee paying postgraduate students, both within Australia and internationally.

There are currently five coursework units that form the basis of the postgraduate and undergraduate programs in Energy Studies. These are Energy in Society, Energy Management, Energy Systems, Energy Policy and Energy Economics. Four of these have been offered in both internal (on campus) and external (print based) mode for the last five years. Commencing in 1997 ACRE, in conjunction with Murdoch University, has begun to convert all of these units from print-based format to online units. Three of the Energy Studies units, Energy in Society, Energy Policy and Energy Systems are being developed and trialed this year. Demonstration versions can be viewed at the ACRE Website <http://wwwphys.murdoch.edu.au/acre/> under the Renewable Energy Education section, or through the Murdoch Teaching and Learning site at <http://cleo.murdoch.edu.au/> under Educational Technologies. This paper will describe the development of these three units, so far, from print based to online. It also includes some of their features, and a number of observations about "what works", what doesn't and why.

# Why online?

The Energy Studies units offered by ACRE and Murdoch have a diverse target student market and students can come from a wide range of backgrounds and have a wide range of requirements. The types of students include undergraduates, postgraduates, school leavers, mature age students, professional development students, students from developing countries, Australian students and international students. They are widely spread geographically, with some studying on campus, while others like interstate or overseas students, can only study externally. Any Energy Studies unit offering therefore needs to be developed in such a way that it can be used by all of the different types of students in a similar way and this leads to a number of considerations concerning their presentation and delivery. One of the ways to make the units available and relevant to the widest possible audience is by developing a range of internationally focussed units, which are available online.

Despite some reservations as to whether online presentation will be able to replace conventional teaching methods [Godfrey, 1996] there are a number of reasons for offering the units online:

- The potential to reach a greater number of students because the units can be completed via the Internet, from CDROM, or both without students ever having to come onto the campus.
- The convenience for students of being able to study at their own pace in the comfort of their own surroundings means online presentation is particularly suited to professional development and part-time students.
- The ability to use World Wide Web sites that are continually updated means that it is easier to keep information in the units up to date and relevant as well as introduce material from a wider group of sources, especially in an international framework.
- The ability to introduce interactive multimedia and simulation into the units via CDROM or the Internet means that a greater range of teaching options are available and the learning experience of the student can be enriched beyond that normally available from conventional print based material.
- Email and online discussion groups enable significantly faster and more convenient student-student and student-teacher interaction, submission and marking of assignments and help with problems, especially for geographically isolated external students.
- The units are generally easier for the academic and the educational institution to maintain and administer as new relevant material can be added to the unit Website or can be posted on the online discussion group or email listserver and it will be automatically available to all the students.

It is in the light of the diverse and geographically widespread target student market, and the inherent advantages of online offering, such as those outlined above, that the Energy Studies units are being developed and offered as online based units. The definition of "online" used here is that given by [Atkinson, 1996], which defines online units in the following way, '*Units classified as available online give online access to a full study guide, including the unit's teaching and learning activities, assignments, and online readings. Instructional designs may be drawn from a wide variety of models to suit the unit's curriculum, and the unit may use a range of other kinds of resources such as classroom teaching and text books, in accordance with its mode of study being "distance education" or "on campus"*'. ♦ The Energy Studies units will be offered online in this way from 1998 internally at Murdoch University, and externally via Murdoch Online and other education providers such as Engineering Education Australia.

## Design Philosophy

To enable the unit material to be offered in the same way to as wide a range of students as possible the online units should have a common interface and format that could be used effectively by both internal and external students. The design of the interface and delivery format also had to account for students having different amounts of Internet access. In the light of these requirements the approach taken was to design the online/multimedia material so that it was accessed via a World Wide Web Browser such as Netscape Navigator. The unit online and multimedia material can then be provided in a number of ways, by a local area network (internal students), by an active Internet link to the university's World Wide Web server, from CDROM, or a mixture of both the last two (external students). This enables access by a wide range of students as all they need to complete the unit is to have access to a suitable computer with a CDROM drive and that is capable of running an appropriate Web browser. Although active Internet access and email are preferable, enabling access to a larger amount of "enrichment" material and tutor or peer contact, they are not essential for completion of the unit. Only one version of the unit material needs to be developed and all students can access the essential core material in the same way, whether it is via an Internet link or from CDROM.

The instructional design aim of the Energy Studies online units was to provide a rich learning experience in a personalised supportive framework, while at the same time promoting self-discipline and requiring students to take a more active approach to their learning. The pedagogical underpinning of this approach and implications for instructional design, student learning support and evaluation will be discussed in more detail by Allison Brown [Brown and Thompson, 1997] in another paper at this conference. Only a brief outline of the philosophy and approach will be given here.

Laurillard [1993] and Jonassen et al [1993] argue that knowledge is constructed through the active participation of the learner in trying to arrive at and articulate their own personal understandings of new ideas and concepts. Megarry [1989:50] argues that giving the learner more autonomy in choosing how to interact with the information base makes for more effective learning. Simply providing information, or even access to it is not enough. Students also need to be able to collaborate in the learning process and this is the feature that is most commonly missing in many current online courses. Harasim [1990:43] describes peer interaction amongst students as a critical variable in learning. Learners therefore need opportunities to reflect on the new material, discuss their tentative understandings with others, and actively search for more information to throw light on areas of interest or difficulty and build conceptual connections to their existing knowledge base.

By using a hypertext approach to present information the learners can choose for themselves which pathway they want to explore, and in doing so, discover new links for themselves which they are asked to share. It also enables students to self-pace, either exploring issues about a topic of interest more deeply, or spending less time on concepts that are already understood. Computer mediated communications systems, offer a potentially rich social learning environment that can support and facilitate active learning collaboration. This is especially true for external students who are normally isolated from one another and do not have the same face-to-face interaction enjoyed by on campus students. Students in this environment are no longer "passive learners attempting to mimic what they see and hear from the expert teacher" [Berge & Collins, 1995, p6], but more active participants in the construction of knowledge and meaning.

### Interface Design

The challenge in the interface design was to help students navigate through a rich information environment and to help them to intellectually engage with and develop a critical perspective on the material available to them. An interface design sensitive to learner needs was needed which would link all the elements in a coherent, meaningful and helpful way for the students. The ultimate usefulness of hypertext and computer mediated communications depend on an appropriate interface design to enable trouble free and easy access to these features [Nelson et al., 1996]. The interface design must provide ease of navigation, a sense of human interaction, and helpfulness and responsiveness to the needs of learners studying in an information rich, self-directed medium. Learners need to feel confident that they know where they are at any one point in the course and that they can easily make contact with others as the need arises.

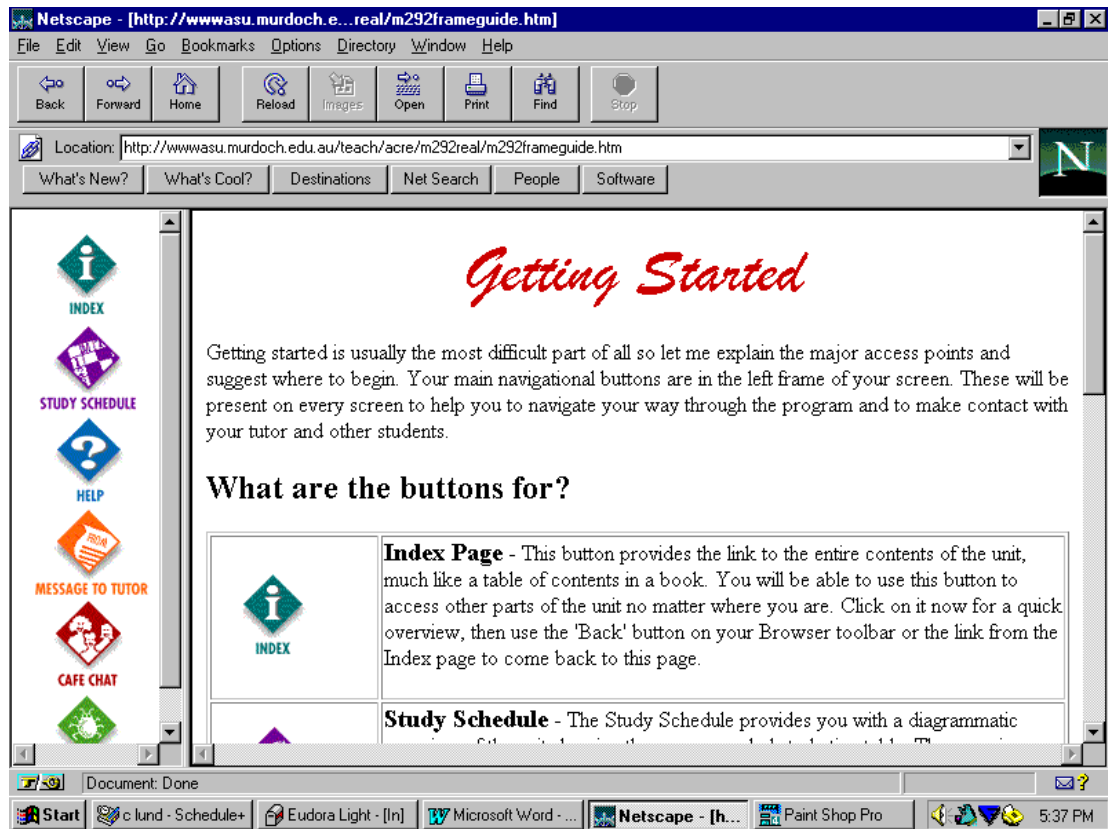











Figure 1 - The first page of the online unit Energy in Society as seen using the Netscape Browser.

 INDEX	<b>Index Page</b> - This button provides the link to the entire contents of the unit, much like a table of contents in a book. You will be able to use this button to access other parts of the unit no matter where you are. Click on it now for a quick overview, then use the 'Back' button on your Browser toolbar or the link from the Index page to come back to this page.
 STUDY SCHEDULE	<b>Study Schedule</b> - The Study Schedule provides you with a diagrammatic overview of the unit showing the recommended study timetable. The <u>organiser</u> includes links to the individual topics and reminders of when assignments are due. Preview it now, print it out, then return to the screen.
 HELP	<b>Help Page</b> - Takes you to a page that explains what each of the buttons do if you need help anywhere in one of the other unit pages.
 MESSAGE TO TUTOR	<b>Message to your Tutor</b> - If you are having any difficulties in the unit or you want to ask any questions, you will be able to contact your tutor through this link. If you click on this button an automated email message will appear for you to type in your message and send it. Your tutor will negotiate response times with you.
 CAFE CHAT	<b>Cafechat</b> - This button will link you to all of the other students (and the tutor/course coordinator) in the unit through a Web based, blackboard type discussion list. You will be prompted to 'Have your say' in suggested activities in the Study Guide.
 BUG REPORT	<b>Bugreport</b> - If you come across any sections of this online unit that don't quite 'work' for you or you find any technical bugs, use this link to report it. Your feedback is very welcome and will be used to improve the unit.

**Figure 2 - The initial Getting Started screen, showing what each of the index buttons means in order to give an idea of some of the features of the interface and the contents of the online unit.**

With these specifications in mind, the interface was designed in a frame format with a navigation bar as a fixed constant in the left-hand table, and a larger scrollable right hand frame containing the hyperlinked topics. The navigation bar appears on every screen in the same place, no matter which hyperlinks (whether these are local or external) the student chooses to follow in the right hand frame. Thus the common problem of getting lost in the hypertext web is overcome with the fixed navigation bar. Figure one shows a typical example of the interface to all the online energy studies units as viewed using Netscape Navigator.

Figure 2, from the initial Getting Started screen, shows what each of the navigation bar buttons mean and also gives an idea of some of the features of the interface and the online unit. The Index Button on the navigation bar allows students to navigate their way throughout the entire unit. They can access an entire overview of the unit, including organisational and administrative information and check on their progress through the unit with the Study Schedule Button. The study schedule helps students to develop an appropriate timetable for study and helps them to stay on track. Should students have particular learning problems that can't be resolved through the discussion list with their classmates, they are able to contact their tutor at any time, through the email Tutor Button. Any email sent to the tutor is private. The tutor email facility helps to establish a learning environment that is helpful, responsive and most importantly, human. The inclusion of the tutor on the navigation bar helps to remind students that they have not been "abandoned".

Collaborative learning is supported in the unit by the inclusion of a "Discussion List" facility, the 'Cafchat'. The discussion list is fully automated for ease of use and all members of the online class can receive all the messages posted there. As the discussion list provides a written transcript of the online discussion, it can build into a further rich resource, a collaboratively built knowledge base about the topics being discussed. Webb [1989], in a message map analysis of interaction patterns in discussion lists, found that students do respond to the messages of others, adding on and building to the ideas proposed. The Discussion List facility is also located on the navigation bar to give prominence to its importance to learning in the unit and to enable learners to access it no matter where they are in the topics.

Netscape - [http://www.asu.murdoch.e...real/m292frameguide.htm]

File Edit View Go Bookmarks Options Directory Window Help

Back Forward Home Reload Images Open Print Find Stop

Location: http://www.asu.murdoch.edu.au/teach/acre/m292real/m292frameguide.htm

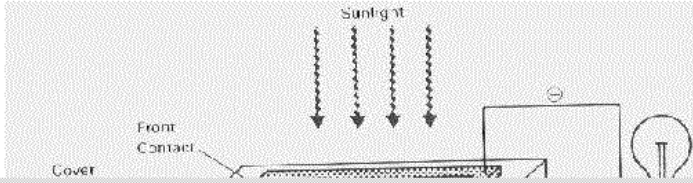
What's New? What's Cool? Destinations Net Search People Software

## M292 Lecture Notes

### Lecture 15 - Solar Cells

#### What is a solar cell?

- Solar cells are devices which convert sunlight directly into electric power. They are often called photovoltaic devices.
- The basic solar cell is a 2-layer device of *p*-type and *n*-type silicon.
- When the sunlight falls on it free electrons are produced. These travel through an external circuit and do work.



The diagram illustrates a solar cell. Sunlight is shown as three vertical arrows pointing down onto a rectangular cell. The cell has a 'Cover' on top and a 'Front Contact' on the left side. A wire connects the front contact to a light bulb, which is shown as a simple circle with a filament inside. The entire setup is on a textured surface.

Document: Done

Netscape - [http://www.asu.murdoch.e...real/m292frameguide.htm]

File Edit View Go Bookmarks Options Directory Window Help

Back Forward Home Reload Images Open Print Find Stop

Location: http://www.asu.murdoch.edu.au/teach/acre/m292real/m292frameguide.htm

What's New? What's Cool? Destinations Net Search People Software

Below is a list of Energy and Society related Web sites that I have found so far. As I find more I will add them so stay tuned and check this page every so often to see what has been added.

If you know of any good sites that are not on this list please [email](#) me and let me know where they are and what they contain. You could also use the [cafechat](#) facility to post them for other students to see the information as well.

#### Associations - Organizations

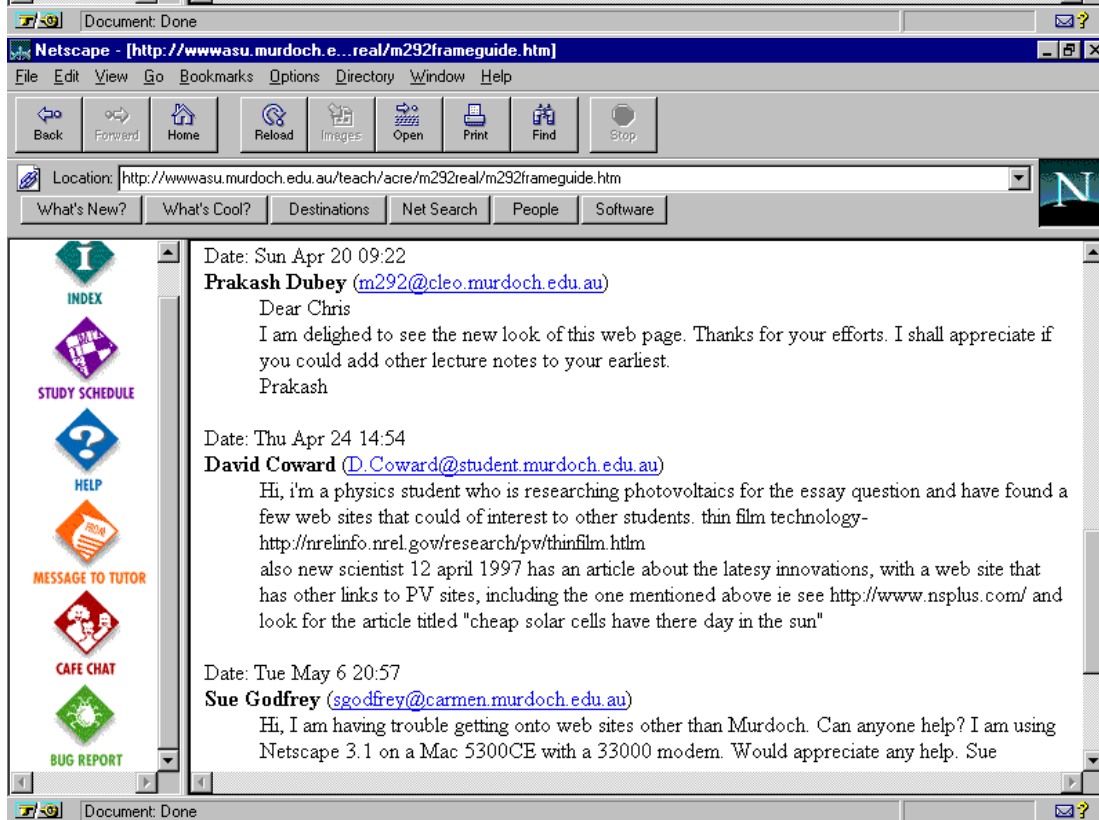
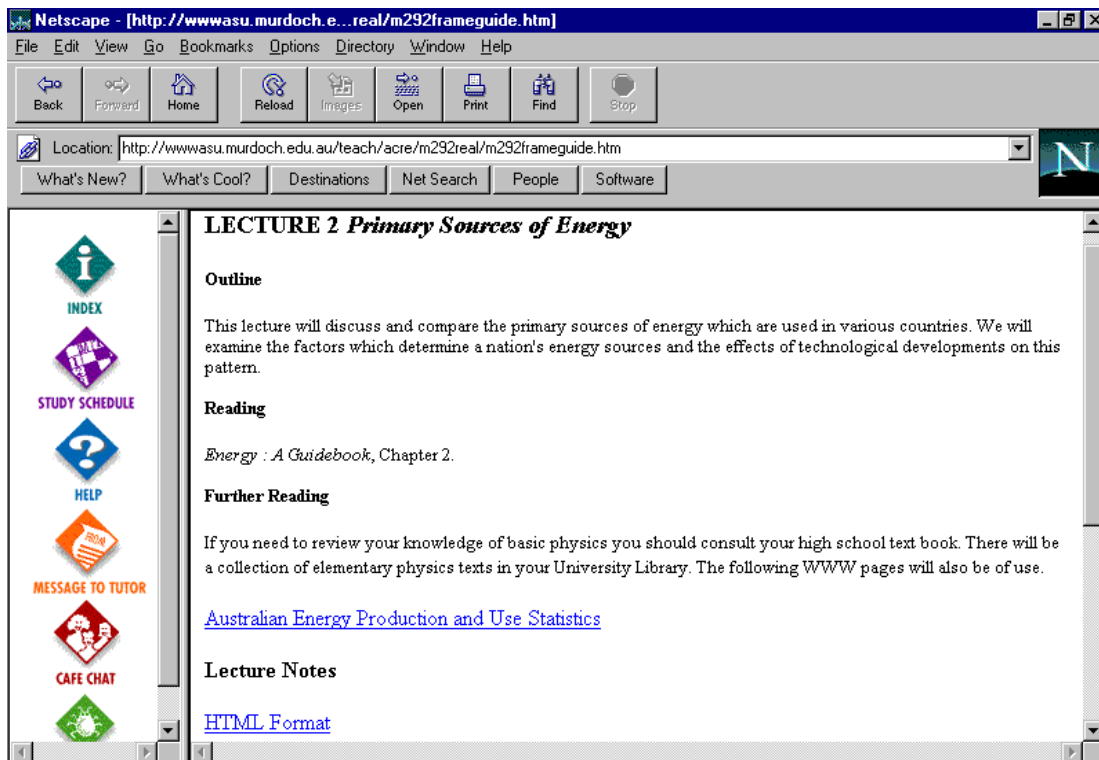
[American Hydrogen Association](#)  
Contains a lot of useful information on the Hydrogen Economy and the Use of Hydrogen as a renewable energy source. Also contains a number of useful facts about hydrogen and fuel cells etc.

[American Wind Energy Association](#)  
Contains lot of useful information on Wind Energy - including a Most Frequently Asked Questions File. Also contains a list of useful wind energy publications and links to other useful wind energy Web sites.

[Ground Source Heat Pump Association](#)

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**Figure 3 - Examples of some of the pages from the online energy studies units. Clockwise from the top, an example of a topic/lecture page, an example of a set of lecture notes in HTML format, some examples of comments entered on the Café chat and an example of the Useful Links page.**

Both trouble shooting and formative evaluation of the course is facilitated by Bug Report in the navigation bar. Through this facility students are encouraged to make comments on any aspect of the course - the usefulness of the learning activities, the appropriateness of the assessment, the usefulness of the readings, any technical problems with the site and access to it, at the immediate time the point occurs to them. The feedback in this online format goes directly to the unit coordinator and means that problems can be rectified during the current delivery of the unit rather than in subsequent courses as is the case with printed course materials.



Figure 3 shows examples of some of these features implemented in Energy in Society. Figure 3 shows an example of a topic/lecture page outlining the aim of the lecture, the reading from the text book, additional reading and Internet sites and the availability of the lecture notes in HTML format. It also shows an example of such a set of lecture notes in HTML format, including diagrams, some examples of comments entered on the Café chat for Energy in Society and the Useful Links page which has Internet links to enable further research on various topics in the unit.

## Online Offering Of *Energy In Society* - What Worked, What Didn't and Why.

The Energy Studies units were run in dual mode first, that is both conventional/print based and online, to gain student feedback and remove any problems before offering in fully online mode. Energy in Society was offered internally and externally in dual mode in first semester 1997. The students had access to both modes and could choose how much use they made of each. The online mode of presentation of the unit was reviewed at the end of the semester. Two other units, Energy Policy and Energy Management are being run in dual mode in second semester and will be assessed at the end of 1997. It is planned that from 1998 all three of the developed units will be offered in online mode only. The feedback and lessons from the dual mode offering of Energy in Society in semester one will now be discussed to give an insight into "What Works and Why" and what didn't work.

Energy in Society runs for one semester and is the foundation unit for all of the Energy Studies units that follow. Its content includes a review of the sources, uses and consequences of energy use in human society, including patterns of consumption, energy conversion technology, environmental and social impacts, alternative sources, energy conservation and options for future energy supplies. The online version of the unit contained all the features and components described in section 4.4 including multimedia lecture notes, organisational matters, email links to tutors, the Café chat and links to other useful sites. Because the online materials/facilities were developed progressively throughout the semester they were only made available to students via the Internet (or the Department LAN) and were not available via CDROM. Students were able to choose which mode they wanted to utilise throughout the semester, conventional (internal)/print based (external) and online, or a mixture of both. All internal students (and some external) were able to access the online materials/facilities using on campus computing facilities.

In semester One 1997, the unit M292 Energy in Society had 20 students, 7 internal and 13 external. During the second last week of teaching, the students were requested to complete a questionnaire by one of the authors who was not known to the students and had not been involved in the development or teaching of the unit. Seventeen of the 20 students (85%) returned the questionnaire. The profile of these students was representative of the whole class. Although the sample was small, a number of observations can be made about what worked, what didn't, and why.

*Profile of Users and Non-users in M292.* Of the 17 students, 8 (47%) used the online materials/facilities (4 Males and 4 Females) and 9 (53%) did not. Interestingly, only 36% of male students used the online mode while 67% of female students used them. No significant differences in Users and Non-users overall time spent on the unit were noted. Students' (retrospective) ratings of their confidence in using computers and the Internet at the beginning of the semester are shown in Table 1. As could be expected, students who used the online mode tended to rate (retrospectively) themselves as more confident in the use of the Internet in general at the beginning of the course than those who did not use it.

	Used Internet (n=8)	Did not use Internet (n=9)
Use of computers	1.9 (0.6)	1.2 (0.4)
Use of Internet (in general)	1.4 (1.1)	0.8 (0.8)
Use of Internet for Energy in Society	0.8 (0.9)	0.5 (0.8)

The 9 Non-users gave the following reasons for not using the online materials:

- n=5 - No access
- n=3 - Lacked confidence (All were males, & all interested in the unit)
- n=2 - Did not know Internet materials were available
- n=1 - Did not think would be useful because lecture notes were not

available in time for the assignments

(Note: 2 students gave two reasons)

Based on the responses of the 8 students who used the online materials/facilities, access to the material was achieved in the following ways. Five students used the University facilities, 1 used community facilities and 2 used personal facilities.

These results indicate that the most significant factors as to whether students used the online facilities were access to adequate computing and Internet facilities, and students' initial level of confidence in using these new learning methods and technologies. The link between previous access to computers, and particularly the Internet in general, and students' level of confidence in studying and completing a unit in online mode for the first time suggests that lack of access to adequate Internet facilities may not be the only reason why students do not use online units. As more students have access and exposure to the Internet at a younger age, i.e. primary and secondary school, it can be expected that online teaching methods will become more attractive as students have greater confidence in using the Internet as a learning method. This will however take time and until then, there may be a significant number of students who have not had much previous experience of Internet facilities, especially external mature age students (i.e professional development) and students from developing countries. These students will not only need adequate access but will also require additional support in the form of initial learning skills programmes developed specifically for online units in order to develop the confidence and competence to learn effectively from online materials.

	Male (n=4) (beginning to end)	Female (n=4) (beginning to end)
Use of computers	2.0 (0.82) to 2.3 (0.50)	1.8 (0.50) to 2.3 (.50)
Use of Internet in general	2.0 (0.82) to 2.0 (0.82)	0.8 (0.96) to 2.3 (.50)
Use of Internet for Energy in Society	0.8 (0.96) to 2.3 (0.96)	0.8 (0.96) to 2.8 (.50)

*Learning online: Perceptions and practices of Users in M292.*

Table 2 shows usefulness ratings, broken down by gender, of their confidence in using computers and the Internet at the

beginning (retrospective) and end of the unit Energy in Society by those who did use the online facilities. Although the numbers are very small an interesting gender-related trend was noticed. The 4 female students who used the Internet tended to rate themselves (retrospectively) as less confident in using the Internet (in general) at the beginning of the unit than the 4 male students, but there was no difference between male and female students at the end of the unit. With regard to "use of computers" and "use of the Internet for Energy in Society", there was no indication of gender differences in confidence either at the beginning or at the end of the unit. Both male and female students, however, showed a significant increase in their perceived confidence in using the Internet for Energy in Society, between the beginning of semester and the end of semester when they had used it.

For those students who had overcome their initial access and confidence problems and used the online facilities the carefully designed hypertext interface and unit structure worked well. Rather than causing students to become discouraged in their ability to complete an online unit, as would be the case for a poorly designed and presented unit, the unit increased their confidence. These results suggest that a well-designed online unit can, particularly for first time users, increase students' level of confidence in learning with online materials. In the present study, there was also some evidence to suggest that a well-designed online unit may assist in overcoming some of the gender-related differences in confidence in using both the Internet in general and for studying online.

Table 3 specifies how students used the Internet facilities and their perceptions of the usefulness of each of those facilities. As can be seen in the table, the facilities most used were the lecture notes and these were also perceived as the most useful facilities. Students' comments revealed that their main reasons for finding lecture notes useful were that they had lecture clashes and the notes provided a back up if they could not go to lectures. Links to other sites was the next most used, as well as the next most useful facility. The next frequently used, and next usefulness rating, was for organisational matters and email. Least used was the Cafe chat, which was also rated as the least useful. It seemed that only one student made a contribution related to the content of the unit. In the questionnaire, that student raised the issue of how other students could be encouraged to participate more in interactive discussions.

These findings have to be interpreted in the light of the fact that the unit was run in dual mode, and not online mode only. Internal students also attended tutorial sessions on campus and both internal and external students also had access to printed material. Consequently, these results give only an indication of which online facilities were most useful in a dual mode presentation. Online lecture notes worked well because, according to the students, they provided information in a more flexible way, and at a time that suited them. The links to other sites facility also were appreciated, giving students access to up-to-date and relevant source material from a wider group of sources, especially international ones, than was available from conventional print based material.

	Number of students using facility	Mean usefulness rating (out of 4) (s.d)
Organisational matters	5 out of 8	3.0 (1.0)
Email	5 out of 8	3.0 (1.0)
Cafe chat	3 out of 8	2.3 (1.5)

The online facility that worked the least well was the Caf chat, and this may suggest that students are not comfortable with using computer-



			mediated peer-peer communication.
Lecture notes	8 out of 8	3.3 (1.2)	Discussion groups have the potential to offer a rich social learning
Links to other sites	7 out of 8	3.1 (0.7)	

environment that can support and facilitate active learning collaboration. This is especially true for external students who are normally isolated from one another and do not have the same face-to-face interaction enjoyed by on campus students. The lack of participation in online discussion groups has also been noticed in the two Energy Studies units running in dual mode in second semester and this is in line with what has been noticed by some of the authors in other online units. One reason for this is that online discussion may need to be integrated within the course itself, where students are encouraged, or at times directed, to contribute on topics they are studying or on projects they are undertaking, much like participating in conventional face-to-face tutorials. The Cafe Chat in these courses was not integrated in this way and therefore its perceived usefulness to students may have been lost. If online discussion groups are to work, then students need to be trained in how to use them effectively and shown the enhanced learning environment they can provide. It has been suggested that assessing students' contributions to online discussion groups, in the same way as internal tutorial participation is assessed, may significantly increase participation. An even more critical task, however, may be to initiate and sustain topics for discussions that students find worthwhile and learning enhancing.

In conclusion, some of the inherent advantages of online delivery, such as increased flexibility (Lecture notes) and access to a larger more up-to-date international information base (Useful links) were identified by students in this study. The lack of use of the Cafe chat, however, will need further attention, if external students are to gain deeper understanding through collaboration and peer interaction. In 1998 the three Energy Studies units developed so far will be offered both internally and externally in online mode only rather than print based or dual mode. This will enable a more realistic analysis of whether online instructional methods can effectively replace or even improve on traditional teaching practises.

## Conclusions

We have been able to successfully develop a number of online Energy Studies units which are suitable for offering in both internal and external mode. This has included the successful design of a hypertext interface based on sound pedagogical principles and an understanding of the different approach needed to learning online. One of these units has been trialed by offering it in dual mode in 1997 and this has given useful feedback as to "What Works and Why". A number of observations and conclusions have been made about "the art of going online" from this experience.

- If an online unit is to lead to effective teaching and learning then careful consideration needs to be given to the instructional design of the unit and to the new student learning supports that are required of this delivery mode.
- An online unit must have an interface that provides ease of navigation, a sense of human interaction, and helpfulness and responsiveness to the needs of learners studying in an information rich, self-directed medium.
- A well-designed online unit can increase student confidence and effectiveness in learning online, especially for subsequent units.
- Evidence suggests that a well-designed online unit may assist in overcoming gender-related differences in confidence in both studying online and using the Internet in general.
- For online units to be effective students must have adequate access to Internet or computing (CDROM) facilities and feel confident in using them. Those students who have not studied using the online mode before should have access to support and training in how to use all the components of an online unit before taking the course in order to raise their confidence and effectiveness in studying online.
- Some initial training may be required to familiarise students with the benefits of interactive, online learning, especially computer mediated communications systems such as online discussion groups.

It was not possible from offering the units in dual mode to answer the question of whether interactive, online instructional methods can only be used to supplement traditional teaching practises, or whether they can replace or even improve on them. Running the Energy Studies units developed so far in fully online mode only will test this.

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