Developing and Teaching the Renewable Energy Web Course

Independent Master's Thesis Project
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Abstract

Web delivery is the latest trend for distance education courses. This report follows the design, development, and teaching of a Renewable Energy web course offered in the fall of 2004 at New Mexico Tech. The keys to successfully completing this project were preparation, planning, and organization of resources and time. Preparation for this project included completing classes in web development and design, instructional writing, and technical editing. Planning involved developing an effective design for the web site and for the class assignments and deciding how to evaluate and grade the students. Both course content and pedagogy had to be planned and formatted specifically for web delivery. Since web course material has to be able to stand alone, the content had to be self-explanatory, clearly written, and thorough but concise. Assignments for the class also had to be designed for students to complete independently, with instructions that were very clear. This project shows that creating a course website requires more time than preparing traditional lecture material. Creating the course web site while also teaching the class made both tasks more difficult. The web course required more up-front time than does a traditional course. Instead of preparing lecture material and spending time with students regularly in a classroom, the web site is prepared ahead of time and the students review the courseware at their own pace and schedule. The web format allows students to absorb the material more completely and retain the information more effectively, but this relies on the students' own motivation and self-discipline. The thoroughness of the content and the dynamic nature of the well-designed web site encouraged students to learn the information. Student-instructor interaction during the web class was accomplished through the use of email, the discussion board, virtual office hours, and field trips. The quality of the student-instructor communications accomplished using email and the discussion board were actually richer than those the instructor had experienced in traditional classes. Student feedback indicates a very

positive response to the amount of interaction achieved and to the online course format. The quality of some aspects of both the students' and the instructor's experience was improved over their traditional course experiences. Twenty-eight teachers in New Mexico Tech's Master of Science Teaching Program took the web course - three times the number who had taken it the previous year as a traditional class. The increase in registrants was due to the web format. A well-designed web course is also a very worthwhile investment, as the course can be used many times without repeating most of the effort required for creating the initial web site. Overall, the Renewable Energy web course was well designed and very effective. Preparing this web course was challenging, but in the process, effective ways of designing, creating, and teaching web courses were learned. The conclusions and recommendations included in this report will help prospective web-course designers and instructors when developing online courses.

I. Introduction

This document describes my master's thesis project - developing and teaching an online course for the Master of Science Teaching (MST) program at the New Mexico Institute of Mining and Technology (NMT). I am the first graduate student at NMT to create a distance education course for a thesis project, and the first to combine Technical Communication with Geology. During my Master of Science (MS) degree program at NMT, I had an opportunity to teach the same Renewable Energy course in both a traditional classroom format (Summer 2003) and a distance education format (Fall 2004). These experiences afforded me the chance to compare teaching and preparing course material from two perspectives.

Developing, creating, and teaching the online course was quite different than the traditional face-to-face courses I have taught. Preparing the course material for a lecture class can be done in a short time. The presentation is augmented with the live lecture and questions can be addressed as they arise. A lecturer can adjust the presentation while it is being delivered. However, the instructor must deliver the material at a pace that the students can assimilate the information. The instructor must also maintain the focus of the lecture.

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Online course material must be sufficient to convey the information without further explanation. Unlike a lecture class, preparing material for a web course takes much more time. Preparing an online course is somewhat analogous to writing a textbook. The material must be complete. Students must be able to get all of the information from the course material. Therefore the preparation of online course material is much more complex and challenging.

The extra effort required to develop an online course is offset by the quality of the learning experience for the students. Students have the opportunity to absorb more information because the information is more complete and they can pick out what they don't know and skip the parts they do know. Content must be well thought out and clearly presented because it is the sole source of information. One of the biggest advantages of online courses is that students have complete control over the pace of their learning. The thoroughness of online course material along with the ability to pace learning allows students to absorb the information more efficiently.

II. Distance Education Background

Distance education has been around for decades. It can be described as "the delivery of education in which the instructor and students are not in the same classroom"[1].

Brief History

The goal of educators has remained the same throughout history, to educate students. Education is also a business, and as with any business one of the primary goals is to deliver its product to the largest market in the most cost effective way. As technology has advanced, the distribution of information has become more efficient as well as more cost effective, expanding the market for educational institutions.

For over 100 years, educational institutions have recognized the need to reach out to students beyond the classroom. Originally called "correspondence courses", in the oldest versions the educational material and the student's responses were delivered by mail. The material was mostly limited to non-accredited courses. Art courses, watch and gun repair certification, or even a high school diploma equivalent were popular subjects. For

example, after seeing an advertisement in a magazine for a sign-painting correspondence course, I took it when was in junior high school. One of the limiting factors in these early courses was that they did not involve any direct instructor-student interaction.

After television became common in homes, it was used for delivering course material. While this method still lacked direct instructor-student interaction, it greatly improved the quality of distance education. So much so that TV courses were the first to be offered as accredited courses. TV stations, including the Public Broadcasting Service, still commonly deliver courses to students in this way. While this was a vast improvement over correspondence course, producing course material in a television studio is expensive.

Later, the use of private intercampus video networks and video taping of lecture courses became popular methods of course delivery. As video technology came down in price, this method reduced costs and allowed courses to be produced and delivered on campus. The use of intercampus networks allowed live interaction between the students and the instructor for the first time. However, while the cost of delivering course material had dropped, the distribution of such courses was still limited.

With the increased availability of Internet access and the development of the World Wide Web (WWW or the web), delivery of information became vastly less expensive. Suddenly, information could be transmitted quickly and inexpensively to anyone with an Internet connection virtually anywhere in the world. Originally, WWW content was limited to text and very simple graphics. As technology improved, the capacity to include elements such as audio and video streaming and live student-instructor interaction became possible. At the current level of technology, distance courses can match or even exceed the quality of traditional face-to-face courses.

The State of the Art

The latest trend in distance education is the delivery of courseware online using the Internet. The online delivery format gives both student and teacher greater flexibility. The course material can be delivered asynchronously. After the course material has been made available on the Internet, the student can review it at any time. This allows students

to each work at their own pace.   Online technology also allows immediate access to hundreds of thousands of other sources of information.   The online environment offers interactive elements that were previously unavailable in distance education. These elements help make online distance courses comparable in quality to traditional courses.

Delivering a course using online media has distinct advantages that are unavailable in traditional classrooms or with video formats. Perhaps the most profound of these advantages is the ability to embed hypertext right on course web pages.   Hypertext makes it possible to include links to any number of other sources of information or to move around easily within the course website.   This ability to move around between the Internet and the course content adds a myriad of options that gives web courses great flexibility. Students can immediately access references or related information, right from the course web pages, and then return to their place in the course.

Direct interaction between students and instructors was not feasible in distance education formats used prior to online delivery. Several features available for online courses allow student-teacher and student-student interaction. One feature that people are already familiar with is email which permits private as well as shared communication. While most of the instructor's course management time is devoted to email, much of the communication from the instructor is done in a broadcast format. Chat rooms and discussion boards are two forums in which all class participants can interact.

Chat rooms provide a forum in which class participants can interact synchronously about course material or personal subjects. This interaction allows participants to form interpersonal relationships with each other and the instructor. The ability to have live communication brings a quality of interaction previously unavailable with distance courses. This format generates a sense of community within the class and facilitates collaboration.

Another excellent interactive feature available for online courses is the discussion board. Discussion boards allow groups to exchange ideas about particular topics in a forum that is long term and asynchronous. Students can add thoughts to the thread of discussion even weeks later and everyone can view them and respond at any time. One of the

greatest values of the discussion board to is that it immediately gives the instructor a way to monitor how well students are absorbing the course content.

Discussion boards, chat rooms, and email add the capacity to retain a text record of the information exchanged, giving the dialog persistence. Unlike class notes, both the instructor and the students have access to these transcripts. Furthermore, text searches can be performed on transcript content. This illustrates some of the capabilities that are unique to the online format.

Multimedia components like video and audio are delivered in two ways, by downloading or streaming. Video streaming is transmission of video content over a network. The lecture is transmitted through the instructor's computer via a web cam while the students watch from other locations. Like the transcripts from discussion boards and chat rooms, live audio and video components can be recorded and then downloaded for later review.

Online distance courses often utilize virtual field trips because of the difficulty of assembling students to attend traditional field trips. A virtual field trip includes some version of an annotated slide show with additional web elements. Video virtual field trips are also becoming popular but they require more sophisticated equipment to create and deliver. However, virtual field trips can be an effective substitute for real ones if they are well put together and will complement the rest of the courseware.

Technological advances continue to catalyze the evolution of distance education. Traditional instructors can be resistant to new directions, preferring to stick with the familiar. However, the online elements discussed here can add new dimensions even to traditional courses. Chat rooms, email, and discussion boards are being used increasingly to transform courses into what are being called hybrid distance courses. As the demand for purely online courses increases, more and more educators will applaud their distinct advantages and see that they far outweigh the disadvantages. Online courses are the wave of the future that will help make the best benefits of higher education available to increasingly more students.

Implementation of online courseware

Just as Microsoft PowerPoint (PPT) is a tool used to create presentations for traditional lecture courses, there is a class of application programs designed to create material for electronic delivery formats. When these tools are used to create course material for electronic delivery, the product is called courseware. Courseware consists of a website when the course is delivered online. Web course authors can choose from several versions of these tools for creating or delivering their courseware.

Several design tools are marketed that are used to produce courseware. Some of these tools can be used to both design and deliver courseware. *WebCT* is an example of such a dual-purpose web course development tool. However, WebCT is a better delivery platform than it is a website construction tool. Despite this, WebCT offers a suite of tools that do work well, such as user authentication, chat rooms, discussion boards, email, calendar, and test administration. Courseware delivery systems also have ways to track student usage, helpful for monitoring student participation. Many of these features were used successfully for the Renewable Energy class. Course management tools can add useful features to an online course, but they must be included in the planning and structure of the course to be truly effective.

The Renewable Energy online courseware was developed using *Dreamweaver* and *Fireworks* as the tools for website development and WebCT as the web server and delivery platform. Macromedia markets several levels of web development tools, (i.e. Dreamweaver and Firework*s*) that can be used for creating websites. These tools build and edit sophisticated HTML-based websites much more efficiently than WebCT does. Courseware authors can take advantage of the best features of web development tools to develop their site.

Assignments and tests for online courses require a different strategy than they do for traditional courses. Extra consideration and planning should go into the assignments used for online courses. The assignments must be explained very clearly and thoroughly and be capable of being completed with little supervision. Assignments can be designed for collaborative or independent efforts. With the excellent electronic communication

and information exchange tools available for the Internet, collaborative projects are especially good choices for online assignments.

However, assignments should still be designed for electronic delivery and explained very clearly. If students are given options for an assignment, the instructor would do well to have students write and submit written proposals for how they plan to implement the instructions. Unclear instructions lead to insufficient assignment fulfillment, which cannot be blamed on students.

Technological and supervisory limitations must be taken into account when planning assignments and tests for online courses. A distinct advantage of the online environment is the ability to grade tests electronically and inform students of their grades immediately. Because tests must be designed so that they can be administered unsupervised or the instructor must arrange for them to be proctored, test preparation for online courses is particularly challenging.

The management of online courses can be easier if the instructor makes use of online tools like email, calendars, and discussion boards. These tools are available with some web course delivery systems or directly through the Internet with "open-source" (free) software or online services. Use of these tools should be planned as part of the course structure as they control the amount and type of interaction with the students.

Instructors of traditional courses often plan their course structure vaguely, or even as the semester goes along, and it works well enough. On the contrary, online courses require good up-front planning and courseware structured specifically for web delivery. Assignments, tests, and field trips must be specifically structured for distance students. Contrary to having diminished quality, the online environment enhances the educational experience. The implementation of online courses may require more planning and organization than traditional courses, but the rewards they offer outweigh the extra effort. The careful planning and structuring required for an online course could well improve courses of traditional format as well.

III. Project Considerations

The initial consideration a prospective distance course author should make is whether or not they have the skills needed to complete the project. Specialized technological skills, teaching skills, and time are required. Web course authors need to be aware of what these skills are and the extent of expertise they will need.

Another consideration is that web course content authors must be familiar with their subject matter in a different way than they have had to be for traditional teaching. As I learned while doing this project, I had to learn much more detail and a broader perspective about renewable energy to make the kind of website I wanted.

The technological aspects necessary include web development and web design skills. Particular types of teaching skills facilitate the creation of effective distance courseware. These include the ability to explain well with focused intent and being very organized and thorough. Another important consideration is the time commitment. The challenge comes from combining the technology and the teaching skills and devoting enough time to develop the course.

Web course authors must be adept with web development software and online course design. When contemplating creating a website, prospective authors must choose the right tools and become familiar enough with the programs to use them effectively. Making a complex course web site could require some working up to it. Like most projects, knowing what you are getting into and preparing for it increases the possibility of a successful outcome.

Expertise needed

Instructors unfamiliar with computer program usage or the online environment should not consider doing an online course development project until they gain that knowledge. Even if instructors are good at planning and teaching traditional courses, they may not be suited for creating and teaching online courses. I studied web development programs and processes and online course design elements for two semesters and made several simple websites before attempting to create the Renewable Energy website. Online course

development requires special skills in addition to those associated with traditional pedagogy.

Creating online course content requires the author to have a more thorough level of expertise on the subject. Web developers are experts on building web pages but usually they are not experts on course content. Professors are experts in their subjects but rarely have experience making websites. An educator who is also a web developer is a rarity. I had an advantage in completing this project because I have studied both renewable energy and web development in addition to teaching traditional classes for many years.

Some instructors have created personal web pages or syllabus pages, but usually they have not constructed the hundreds of pages and complex structure that make up a comprehensive web course. Creating an online course requires two experts - one to create the content and another to create the web pages, especially if the instructor does not have web development skills or the time to learn them. This observation is supported by research in the field, "The development of content must be in the hands of the expert, the delivery of content demands a different expert"[2]. If the prospective web course developer doesn't have web development skills or the time to learn them, seeking the help of a web developer may be a viable option.

Development time commitment

Preparing course material takes a certain amount of thoughtful consideration and planning regardless of the subject. The amount of time required to prepare course material varies with the format, the subject, and the delivery method. The more complete and autonomous the material needs to be, the longer it will take to create and the more skill required. The resulting product will reflect the extra effort though, and provide the opportunity for students to learn more from the course.

One of the most time consuming steps is gathering resources. The web course author is not limited to using just the information available in the textbook, but can gather content and information from countless sources. Resources must be gathered with a conscious effort, making sure the style and level of the information is consistent with the rest of the material to be used in the course. The author must also be sure that any content used is

accurate and can be adequately documented. Picking out just the right material to use on your website is challenging.

Integral elements of online course material are the embedded website links to supplemental information. Selecting the best links to send students to for more information is also time consuming. Many sites are unfocused, too detailed, inaccurate, or have distracting ads. Choosing the sources requires finding information that is appropriate, effective, pertinent, and for which the source can be documented. Once the content is located and collected, another challenge comes from knowing how to organize references and content, optimize graphics, and create effective web pages from the information.

Constructing the actual web site requires several months. Once the design is chosen and the templates created, writing content for the course must be accomplished. The development of content can happen fairly smoothly if the resources are gathered and organized and the website's structure has been well planned. Because content for online courses must be very thorough, it takes more time to write.

The inclusion of images and other graphics greatly enhances web course content. The time required to locate and prepare the graphical elements must be included in the planning. Graphics used in websites should be optimized (reduce the file size) to shorten the length of time for the image to appear on the user's screen. Optimization requires limiting the file size by reducing the resolution and/or the image size, something that isn't necessary for graphics used in print or PPT presentations.

After the web site is complete, the author must proofread the content and validate all of the links. Validation is an important process and must be done. Each link, internal and external, must be checked to make sure the intended target is reached by clicking on the link. Another responsibility of the web developer is to check how the website appears in all of the browsers that students could use to view the course. The website should be opened in several web browsers (i.e. Internet Explorer, Netscape, Mozilla, Safari, etc.) to ensure it is properly rendered.

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In my experience, once the content is gathered and organized, making each web page takes from 2 to 5 hours, sometimes more, including optimizing and integrating graphics. Making a typical PPT slide for a lecture class only takes about 30 minutes to an hour because it usually consists of summary information. Preparing a week's worth of material for web delivery takes about 2 to 3 times longer than preparing a week's worth of material for in class delivery. See Table 1 for estimations for how long I spent on different course elements for different course formats. Fortunately, the next time the web course is offered, only the site validation and course management time commitments will be required.

One of the reasons online content takes so much longer is because the information is much more detailed. A PPT slide must be explained every time it is viewed. A well-made web page never needs to be further explained. The extra time that is put into making an effective web page is the very thing that makes web pages such effective courseware.

Table 1. A comparison of the time required to prepare materials and how long I needed to prepare materials for the various course formats.

Task	Traditional 16 week course		Summer 2 week course		Distance Course 16 week	
	~time spent-hours	~when needed-weeks ahead	~ time spent-hours	~when needed weeks ahead	~time spent-hours	~when needed-weeks ahead
*Course description	0	6	3	6	3	24
*Syllabus	5	0	5	0	30	24
*Grading Structure	2	0	2	0	3	12
*Assignments	6	0	3	0	18	12
*Course Structure	5	0	4	0	48	3
**Field Trips	6	1	6	2	6	3
***Learn/review Course Material	10	0.5	15	1	36	3
***Presentation Material	8-Apr	0	24	0	40-60	2

*These numbers are approximate values, and refer to the whole course

**These numbers are approximate values, and refer to one single day field trip

***These numbers are approximate values, and refer to a week's worth of material

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Organizing time while teaching

Once the website is completed, course management requires another whole set of time commitments. The instructor must allow sufficient time for the administrative requirements of teaching a web course. Due to the ease and convenience of electronic communication, students tend to interact more with the instructor. Personal interaction between the student and the instructor is not limited to "office hours". Another factor that seems to encourage more student-teacher interaction is the private nature of email. Some students that hesitate to approach face-to-face are more comfortable with email because they can compose their thoughts and review them before sending the message. These advantages of electronic communication facilitate more student-teacher interaction than which commonly occurs in traditional classes.

Once the class starts, most of the time the instructor devotes is taken up with course management. Some of the administrative responsibilities will be similar to those for traditional classes and will take about the same amount of time. For distance classes, routine contact with the students is done electronically. Most of the instructor's time is spent on emails, with additional time spent dealing with the discussion board, chat, and any other interactive features they are using for the course. Even though email may be used for traditional courses, a lot more email traffic occurs during online courses. However, the greater time commitment required for email when teaching an online course actually catalyzes more personal communication than often happens in face-to-face classes.

During the semester, it became necessary to organize my time differently in order to teach the course while also making modules. On top of creating web pages, I had to plan and grade assignments, answer emails, hold office hours, and plan field trips. Between 10-12 hours building web pages and answering up to two-dozen emails, this made for very long days. However, after the first few weeks of the semester, I found a rhythm and was making even better modules because of learning to organize my time and energy.

Dealing with email averaged an hour to an hour and a half a day. The heaviest email traffic occurred during the first month and the last two weeks of the semester and right before the field trips. Planning field trips took up to 6 or even 8 hours a week during the

weeks that I arranged them. The field trips took up whole days out of five of the weeks during the semester because I had to attend all of them.

Because building the course web site is so time consuming, the best plan is to have all the web pages completed before starting to teach the course, so that is my recommendation to prospective web course authors. Online course developers must be prepared to spend the time necessary to produce web pages, but then they will have a superior course that can be used over and over again.

Development Environment

A web development environment consists of the equipment and software used to create web pages. The development process must also consider the delivery infrastructure that will be used for the online course. Throughout the process of developing the website, the design and a detailed plan for implementing it must be kept in mind. Good course development also considers the specific audience for the course. However, choosing the tools that will be used to construct the course website is the first step.

Websites are constructed within one of several web development environments. The simplest technology for web development is a text editor used to manually write Hypertext Markup Language (HTML) code. HTML is the fundamental language used to build web pages. Hand coding requires an intimate familiarity with HTML and how to use it.   In the past, writing HTML code manually was the only way to create web pages. In addition, a web browser is required to view the resulting web page, ensuring that the code is correct. This type of web development is tedious because of its complexity. Hand coding is still used for creating HTML, but this technique is limited to special circumstances. New tools are now available for web development that provide a visual environment for constructing web pages, eliminating the requirement of knowing HTML.

Once the WYSIWYG (What You See Is What You Get) tools evolved, web development was no longer restricted to nerdular programmers. WYSIWYG applications automatically build the HTML code as the author designs the visual elements of the web page in a layout window, similar to making a PPT slide. Such tools allow the web developer to view a rendering of the page as it is being built. The code is built

simultaneously by the program and can be viewed at the same time. Web authors no longer have to be familiar with manual coding to build web pages. Web development is now more widely available to everyone, including industrious educators. Several WYSIWYG-style web development applications have evolved to fill the market. Dreamweaver remains one of the best WYSIWYG-style web development programs available today.

Recently web development systems aimed at the distance education market have become available. These content management environments have taken the development process a step farther by trying to simplify it more. WebCT is one of these systems that provide pre-made web site layouts and course management tools. However, the WebCT product is a content management framework and delivery system that is meant to be customized for the specific school. The customization requires the skills of a professional web developer. Because the WebCT system had not been customized at NMT when I started this project, it was not an attractive option to use as a development tool.

Websites made within the WebCT environment may only be delivered with WebCT, making them "non-portable". Furthermore, the sites may not even be compatible with other school's WebCT systems because of differences in their customization. The selling point for WebCT and similar systems is that they are "easy to use". However, I found WebCT is not easy to use if the developer wants a professional looking web site.

If you want a professional looking site, use a professional web development tool like Dreamweaver. Developers can do everything that is needed in HTML easily using such a tool. Additionally, Dreamweaver has built-in libraries of dynamic elements, like Flash buttons and Javascript code snippets. Without being a programmer, educators can develop some very sophisticated web sites using Dreamweaver.

Dreamweaver is chosen over systems like WebCT because it has more power, flexibility, and control over the development while providing an environment that is more intuitive. Websites built with Dreamweaver retain their portability and also allow the addition of more advanced options like database integration and code libraries, if and when the developer is ready to try them.

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An important part of any web development environment is a tool to manipulate graphics and prepare them for web delivery. Images, charts, graphs, photographs, and any other graphical elements that will be incorporated into the web pages must first be processed. An important part of the process of preparing graphics for web use is called optimization. Most computer monitors display everything at 72 dpi (dots per inch). Using graphics at higher resolutions just increases the length of time they take to appear on the screen. Similarly, using graphics that are larger in size than they will appear on the screen also increases loading time. Optimization is the process that lowers the file size of graphical elements while still preserving their quality. Macromedia offers an image manipulation application called Fireworks that includes optimization capabilities and directly interfaces with Dreamweaver.

The last development environment factor that needs to be considered is how the course will be delivered. Several online delivery systems are available. Web servers can be used to deliver course websites over the Internet. Additional programs can be added to control access to the course material or to supply interactive features. Message boards, chat rooms, email, streaming audio or video, and discussion boards are some of the features that can be added to online courses using software readily available at little or no cost. Some course management systems, like WebCT, also act as web servers. Packages like WebCT contain built-in course management tools like email, calendar, chat rooms, and discussion boards. Developers have flexibility in how they implement these features for their course. For instance, the Renewable Energy course used the log-in, discussion board, email, and web server features of WebCT, but used Dreamweaver to construct the website. I used the best features of two different sources because it resulted in a better end product.

When undertaking a web course development project, there are several important considerations, and each web course author must make choices appropriate to their situation. Prospective course authors must first contemplate whether or not they have the expertise required, and if so, do they have the time necessary to complete the project. If the authors have the expertise and time, they must then choose the best web development

environment and delivery infrastructure. They must also allow time to become familiar enough with the applications to be able to use them.

IV. Course Development

Once the author has chosen the course format, the development tools, and made a commitment to spend the necessary time, the project can begin. The process of developing an online course also requires a detailed plan and a clear vision of what the end product will be. The plan starts with knowing who the students will be, what subject and scope the course will cover, and how the web site will be structured. The course is then designed and produced with all of this in mind.

Identify audience and define student requirements

The first issue that must be addressed when implementing a web course development project is identifying the target audience[3]. The course must be planned specifically to fit the needs and the resources of the prospective students. Understanding the target audience will help identify and characterize some of the fundamental design constraints that the course must meet. The formal process used to identify the target audience is the audience analysis. An audience analysis includes such information as:

- What are the profiles for the anticipated students?
- What type of equipment will they use to access the course material?
- What network connection speed will the students have?

Students who do well in distance courses are self-motivated and can pace learning well. They make space in their schedules and spend the time necessary to view and absorb the content of the course independently, they stay aware of assignments and deadlines, and interact with the instructor by email or phone if they have questions or need more help. Making the course content and structure work well independently is one of the biggest challenges facing web authors.

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Aspects of the students' profiles that could affect course planning include: their level of education and whether they will have mixed backgrounds; whether any of the students are handicapped and if so, in what way; whether any of the students have previously taken distance courses; where they live; and any other information that is relevant. The audience analysis is perhaps the most important initial factor to consider when designing a web course. The audience and what equipment they will be using narrows down some design choices.

One of the key concepts in web course design is the relationship between the student requirements and the technology that will be needed. The course must be designed so that it will work with the equipment that will be used to deliver it and receive it. The author must plan the course so that it is directed at the specific audience, and then notify the students ahead of time what they are required to do and how much time they should expect to need to spend. Let them know what equipment they will need as well. And then design the course so it fits these specifications.

The author must identify the audience and define the minimum kinds of computer systems they should be using, what browsers they should have, and what speed their connection to the Internet must be. Each student will be required to have access to equipment and facilities suited to receiving the course material. A web browser program such as Microsoft's Internet Explorer or Netscape's Communicator is all that is required in the way of application software to view the course website. Courses with video or audio elements require a 56K or faster Internet connection. If any students will be using 28.8 K or 33.3 K modems, the course should not include any video or audio elements.

Students who do well in web courses

Students that respond well to web courses are self-motivated and independent learners. Erika G. Feulner explains this phenomenon: "The key to learning over distance and using a screen is the motivation for self-study."[4] Distance students must choose when and how much to interact with the course material instead of having a regularly scheduled time and place to attend classes. Students that take distance courses are usually motivated by not having to attend regular classes in the first place. The teachers in the

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MST program are also motivated by the flexibility of being able to view the web site any time they want to, as much as they want to, at a pace that worked best for each of them. All of these options are only available with online courses like mine. Teachers are often inherently self-disciplined and find distance courses easier to fit into their schedules, they are ideal candidates for web course students.

Research similar projects

Prospective course authors should look at other web courses that are similar to the one they are planning to teach online in order to get ideas. Before embarking on developing a web course, research the options by looking at other web courses and web sites designs, reading about other web course developers' experiences[5], and reviewing the options for course delivery. Informed decisions up front can save much time and aggravation. The server that will deliver the web course must be considered when planning – the site must be written in a language the server recognizes. Talk to the computer department and find out what server they use to deliver web courses to the Internet and which languages it recognizes. Plan your web course accordingly. Drawing on other authors' experiences can help avoid making similar mistakes and save them time by adopting methods that worked well for other authors.

Suitability of course

The prospective course developer must first decide if the course is suitable for distance delivery. Some courses are more suitable for distance delivery than others. For example, interactive courses such as hands-on laboratory classes may be better taught in person unless each student will be issued a set of samples to work with. Lecture courses are usually better choices for distance delivery. Contemplate the nature of the course you want to develop before undertaking a web course development project.

Scope of course

Planning the scope of a course includes making sure that the courseware will cover all the material that the instructor wants to include in their course at the level that is required. This necessitates organizing and planning the course structure and content before

beginning the project while always keeping the intended audience in mind. One of the ways to end up with an unsuccessful web course is to forget who the intended audience is while making it. Another pitfall is going into the development stage without a well-organized plan for the course and a good site design. Having a good idea of exactly what the course will include reduces wasted effort.

Make a plan for course design

When planning a website, site design is one of the most important considerations. Most of the decisions made in this initial phase of developing a website establish the foundation upon which the entire website and the course is built. The structure and usability of the resulting website must be thought out and considered early in the design process. A well-designed web site should be attractive, functional, and intuitively usable. This list of design elements contribute (or not) to the usability of the Renewable Energy course web site, and they should be considered carefully when planning any online course:

- The page layout, starting with hand-drawn sketches. Planning the site well from the start is tantamount to having the construction go smoothly.
- The visual elements that will be included, like the school logo, a defining banner, which font(s) to use. On computer screens, some fonts are easier to read than others.
- The non-editable regions (elements common to all pages throughout the site), which are places allotted for navigation bars, copyright, logo, banner, etc.
- The editable regions (elements that vary from page to page). These are areas allotted for course content, last updated date, module titles, module specific navigation buttons, etc.
- Organization of the site, such as determining how and where to incorporate the syllabus, grading and assignment parameters, field trip dates and requirements, virtual field trips, and administrative pages.
- The navigation system, including where the navigation bars will be and if they will be horizontal or vertical, how many buttons they will contain, and how they

> will be linked. The Renewable Energy course navigation system required both vertical and horizontal sets of navigation buttons.

- The scope of the website, such as how many modules the course will consist of, the size of the modules, and the structure and navigation system that will be used.

The design stage of the website involves these careful considerations and a lot of planning, starting with a hand sketch or some other mock up of what the site will look like. This "plan" will be used to layout the templates and navigation for the site. The next step in developing a course for web delivery is implementing the plan and creating the items listed above, most of which face-to-face instructors do not have to think about.

If the website is well designed, the course structure is intuitive and easy to use. The information will flow logically from page to page and module to module, and there will be coherence in the entire site. In a coherent course web site, the content will be presented at a consistent level and pace so that the intended students can absorb the information in a reasonable length of time.

In addition, if the assignments are well thought out and timed right, the students will be able to keep up with them comfortably.   Finally, the structure of the course should include elements that provide adequate opportunities for instructor-student and student-student interaction, like discussion boards, email, field trips, chat, whiteboards, etc. All of these elements should be accounted for in a well-thought-out site development plan.

Style design

Choosing styles for the elements of the web site is the next step in the process. The style parameters must be chosen before making templates for the site. The font type and size used in the site should be a web-compatible font (only a few fonts are recognized by the majority of web browsers) that is attractive in the design and easily readable at the size most of the text will be on the pages. The same goes for the color scheme. A limited number of colors – known as web-safe colors – will be rendered the same in most web browsers. In addition, the background and text colors should have high contrast. An excellent discussion of colors, backgrounds, fonts, and how they affect web design is available in Robin Williams excellent book *Web Design Workshop* from Peachpit Press[6].

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Choosing an unattractive color scheme or font sizes and type that are difficult to read makes for an ugly website. Using elements like unusual fonts and colors that are not compatible with common web browsers eliminates some of the audience. Look up "ugly websites" on Google, there are several websites featuring examples of unattractive and/or ineffective web sites. If you are uncertain about what look at some bad web site examples so you don't make poor choices for your site. Either way, once the style choices are made, page layout can follow. Then the templates for the site can be made and finally, the web pages themselves are made from the templates. Backtracking to change the styles after course web pages are being made is very awkward and causes more problems than it is worth. So be sure about the style choices before going on to the next step.

Page layout

Planning the layout of the course web pages is much easier if the author knows what they want. If the final product is still uncertain, then the author can look for ideas in other websites. At this point in the process the author commits to the size of the web pages for the site. Most web sites are 800 pixels wide by 600 pixels high – a rectangular space about 11" wide X 8" tall on a typical computer screen). Lay out the design so it looks good in a space like a sheet of paper turned 90 degrees. This is a common minimum computer screen size, and the largest page size that allows sufficient room for a digestible chunk of content on a page without the user having to scroll to see all the content.

Decide where to put navigation, footer, banner, and all the other template elements. Then see if enough space is allowed for content. You may need to choose between several layouts, start with the one that looks like it will work best and then modify that one because it is closer to what is wanted, and will require less radical changes. Experiment until it looks and feels right. An important consideration is leaving enough space for the course content. The author should find the best fit between the amount of content to be included per page and the size of the pages. If the static elements such as the school logo and navigation buttons take up too much room on the page, the amount of content per page will be too limited.

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Another consideration is that some web design choices are impractical and should be avoided. Keep in mind that layout strategy for web pages is fundamentally different than what works in print. Positioning a navigation bar at the bottom of the page or on the extreme right-hand side of the page makes it hard to find and somewhat less accessible. Try out the navigation on several websites and model after something that is easy to see and that works well.

When laying out the page, adding elements to the sketch made while designing can be helpful. Designate areas for navigation, school logo, any "branding" course imagery, and general information (i.e. copyright information may be in the footer). These elements will not change from one page to the next. The template will define these areas so they will be preset and protected when the web pages are made. The template will also set up areas for content that will be different from page to page.

Template design

Once the design elements have been chosen, the next step in the process is to implement the design plan by building templates for the site. Templates are used in web site development to establish style choices and to impose coherence on the site. During the process of creating the master template, the colors, fonts, and navigation bars in the design plan are tried and modified if necessary. Choosing the final design should be completed before the templates are used to generate web pages. Making changes to the templates after starting to make web pages is awkward and can create a lot of extra work and aggravation. Problems within a template will be propagated to every web page created from that template, and may lead to undue difficulties.

The main template for a site defines the common and page specific regions of each web page. The templates for the individual site sections are then made from this main template. Once the templates are made, it is time to add course content to the web pages.

Content Creation

Content on web pages should be in easily digestible chunks. "Lessons for the design of online learning environments demonstrate that students are likely to prefer visual

representation and chunking of course content."[7] Pages that require scrolling down to view introduce a choppiness that prevents flow when reading course material. A better style is to break up the content so only related content, including images, fits within a single page size area. The content of a web course needs to be at a consistent level and format and be very organized and flow well, more like a textbook than lecture material is usually. A face-to-face course can be more disjointed and still work well because the professor can fill in any missing pieces spontaneously.

Even after teaching a course face-to-face, creating content on the subject for a similar web course may require further research. Remember that the information in online courseware must be able to "stand alone" as the instructor will not be present when the student reads it. Therefore, the content must be very thorough and be very well explained and illustrated. On the other hand, the content should fit on the pages of the site, so it needs to be concise.

Gathering content for an online course requires looking at many web pages, articles, and books for possible content to use. Only content, both graphical and textual, that will fit in with the course material should be gathered. In the process of learning more about the subject, gather material for the web pages, especially graphical content like photographs, charts, and graphs. The material on the Renewable Energy web course pages contains a mixture of content that I wrote and quotes from web references, articles, and the course textbook.

The content must be gathered in digital form and organized so it can be easily accessed as course web pages are constructed. Furthermore, the placement of content is important for web pages, especially graphics, considering both their size and how they relate to the text on the page. Online course developers must consider that every graphic, including the photographs for the virtual field trips, must be optimized for web use and then be well explained and adequately referenced. Graphics used for lecture classes are seldom documented or adequately explained on PPT slides as the instructor talks about them instead.

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Assignments

Assignments that work well for a distance class are different than those that work for traditional classes. They must be explained clearly and thoroughly in the course website. Assignments should be capable of being independently completed by students within the prescribed time. Just like when planning a web site, a very important consideration when planning assignments is the audience. All assignments should be tailored for the specific students that will be taking the class. Additionally, completed assignments should be easy for the instructor to evaluate.

Tests

Testing in the online environment requires a very different strategy. In a traditional classroom, the instructor is there to administer and monitor tests. On the contrary, online tests must be designed to be unsupervised or they will require proctoring in a synchronous environment for their administration. A proctor can be set up and the test administered in a central location such as a library.

Creating tests that work well in the online environment without proctoring is both challenging and time consuming. The questions must be well thought out and very clear as to what the instructor wants. Test formats like multiple choice, true/false, or matching can be good choices for distance administration. Moreover, these types of tests can be graded electronically and students can receive their grades immediately. Even so, problems that arise when tests are unsupervised must still be dealt with, such as time limits and the possibility of cheating.

Some successful online tests take the form of "thought" questions that allow the students to use their books and Internet resources to complete. However, such tests can be complex and require extra time and skill to prepare and grade as they cannot be graded electronically. A viable alternative is to plan web course assignments that can be used for evaluating students and not to give any tests, which is what I did for the Renewable Energy web course.

Grading

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The requirements and grading system for online courses (and for all courses, for that matter) should be set up before the class starts. Students should be informed of what they will be required to do and what the grades will be based on right up front. This information is usually transmitted on the course syllabus or during the first lecture for traditional classes. Web courses can be even more specific with the grading information and include it on the web pages for easy referral.

For the Renewable Energy web course, the breakdown of grading and the assignments for the class were included in the administrative pages that were posted several months before the semester started. This allows students the opportunity to know how they will be graded and what they will be expected to do before signing up for the course. This option is not usually available for traditional courses.

One of the advantages of using a course WebCT is that it keeps track of how many times each student accesses the website and the discussion board and also records their replies to the discussion topics. WebCT does not break this participation down specifically by week, just gives total numbers of times each student accesses the course website and the number of times they post to the discussion board. Such information can still be used to help evaluate students – a distinct advantage when teaching an online course. For the Renewable Energy web course, I was able to tabulate student participation from the WebCT discussion board and site access statistics and use that data to calculate participation grades for the students.

Accountability

Instructor accountability is much different for web courses than it is for live lecture materials. I think instructors are more accountable for content in online courseware than they are for traditional lecture material. In traditional classes, students very seldom question the content of lectures or where it came from. Documentation for sources is usually not even mentioned in traditional course material. Because creating a course website is actually a form of publishing, different "rules" apply. The content on course web pages has to be accurate and well documented. All graphics, text quotes, and

reference sources are carefully documented in the Renewable Energy course website, as they should be in any course web site.

Validation

One of the more time-consuming but important aspects of developing a website is the validation process. This process involves checking all of the navigation links within the website - between the pages and sections, as well as external links to any references given on the pages and at the end of each module. Validation requires a couple of steps. The site should be uploaded to the server to make sure the internal links work, the images have been uploaded, and the pages look OK. Web course designers must allow time for adequate validation of their site. Every time the course will be offered, the author or instructor must validate the external site links again, and remove or replace any broken links.

Class Management Tools

When developing an online course, which online management tools to utilize, if any, is a consideration. These tools offer some viable replacements for traditional classroom interaction, and some of them are only available in the online environment. Interactive tools include email, discussion boards, chat rooms, forums, and whiteboards. Tools are also available that can help keep track of student participation, deliver and grade tests, maintain a class calendar, and allow students to create their own web sites.

If these tools will be used with a course, they must be included in the course plan and incorporated purposefully. Many of them require additional time commitments from the instructor. These include answering emails or monitoring chats and discussion boards. Incorporating these tools in a course includes committing to spending the time to manage them. However, these tools can add elements to an online course that are very helpful for both the instructor and the students, so they should be considered when designing online courses.

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Guidelines and Recommendations

This section delineates some guidelines and recommendations for prospective online course authors. I learned these things during the process of creating the Renewable Energy website for this project. These guidelines are all things that I would definitely have benefited from knowing before I started this project. My goal is that they will help others save time and aggravation and therefore be able to make better web courses.

- Have a detailed plan for the web site design and structure, as well as for the development of the site.
- Plan the whole structure of the course before you even start gathering and preparing the material or building web pages, both the navigation for the site and the scope of it. Being organized about assembling research material and constructing the site will save a lot of time and help make the final website organized too.
- Choose and learn the web development programs you will be using very well before trying to make your web pages, or have somebody that is both familiar with web development and the course content make the web site for you.
- Don't try to make web pages for a course while teaching it. Finish preparing your course material before the class starts.
- Make sure your material can stand alone, without more explanation, as you won't be there to answer questions.
- PPT slides do not convert to web pages very well. Use them for an outline for the site and then explain everything completely but clearly and concisely on the web pages. If using graphics from a PPT presentation, optimize them and add indicators like arrows or circles in order to direct students' attention.
- Utilize the ability to create hyperlinks to other web pages, references, additional information, or larger versions of images.
- Document your sources accurately on web pages even if you normally don't for live presentations.
- If other graduate students want to make an online course for their thesis project, they should work on the web course project while taking the support courses, i.e.

work on the web page design and structure while taking the web development courses, work on content while taking the writing courses, and so on. That way the web course is being built during the learning process.

V. Developing the Renewable Energy Web Course: A Case Study

Section V summarizes the development of the Renewable Energy web course using the processes described in Section IV. Included here are the reasons why this project was chosen for my thesis and how the project evolved into a web course, the course development process, and time estimate for completing the phases. The experiences of teaching the course and the pedagogical implications of the methods I used are summarized in Section VI.

Project background

This project was initiated in order to fulfill the thesis requirements for my Master of Science degree at NMT. Since I had already done a research project for my first MS thesis, I decided I would do an independent project for this MS thesis. My committee and I decided that I should use my new TC and web development skills in combination with my teaching experience and create a distance education course. We chose the Renewable Energy course offered as a short course in the summer of 2003 to adapt to distance format for several reasons.

- The subject is timely and is also relevant to New Mexico's current science education curriculum requirements.
- I was already familiar with renewable energy from co-creating and co-teaching the course the previous year.
- The MST program committee was very pleased with the choice to use the Renewable Energy class for the project, because they would then be able to offer the course during regular semesters and not just in the summer semesters. Consequently, many more of their teachers would be able to take the class.
- The Renewable Energy online course is the only course offered through the MST program that can be used to full fill any of their four requirement categories

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(Math/Computer/Economics/Business, Physics/Chemistry, Geology/Biology, or Engineering), therefore that option would now be available to many more of their students.

- I feel very strongly about the importance of teaching about the energy crisis and about ways to live differently. One of my goals is for the teachers to in turn teach their students responsibility about energy use.

Course History

Dr. David Norman (professor of geochemistry and my academic advisor) and I created the Renewable Energy course for the MST program at NMT. Dr. Norman and I co-taught the original traditional version of the course in the Summer 2003 semester. The idea was to teach the MST students about renewable energy and the current energy situation so that they in turn would be able to teach their own students about energy economics and options. We assembled all of the course material and planned the field trips in three weeks. Dr. Norman put together one-third of the lectures, PPT presentations, and field trips, while I prepared the remainder. I started creating the online course in May 2004 and taught it in the Fall 2004 semester. The original class consisted of ten teachers - nine from throughout NM and one from Durango, Mexico. The online class consisted of 28 NM teachers. The Renewable Energy course was the first distance course at NMT to be delivered entirely online without video streaming or taping.

Preparation for this project

In order to prepare for making this web course, I took two web-development courses offered through the Technical Communication program at NMT. In these classes, I learned web design and site development using Dreamweaver, Fireworks, and HTML. Through building simple course project web sites and by making the initial pages of the Renewable Energy site for my final projects I gained practical experience. During that year, I also read many articles about distance education courseware and delivery methods. I drew on all of these experiences to put the Renewable Energy website together. For designing the pedagogical methods and course structure I relied on the distance education articles, my traditional course teaching experiences, and instinct.

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Audience for the Renewable Energy Web Course

The MST program is designed for teachers to earn their Master's degrees in science teaching. The MST program curriculum includes graduate level courses in all of the sciences. The Renewable Energy course is very attractive to its intended audience - teachers who do not want to interrupt their lives and careers to go back to school to earn their master's degrees.

Because teachers are usually inherently independent and self-motivated learners, they do well in distance learning environments, especially if the course material is well designed and self-explanatory. I think that the Renewable Energy course was especially suited for its audience – NM science teachers.

Student requirements

The MST program at NMT has established minimum equipment requirements for taking distance classes. In addition, I specified specific requirements for the Renewable Energy web course. In order to take the course, students were required to:

- have a copy of the textbook (*Turning The Corner: Energy Solutions For the 21st Century* published by the Alternative Energy Institute).
- have use of a computer with access to the internet with connection speed of at least 28.8 Kbps, and a web browser compatible with WebCT.
- participate with the class and keep up with the assignments. The assignments and deadlines were clearly delineated in the syllabus.
- attend two out of the three class field trips to renewable energy sites in New Mexico. Students unable to attend field trips were to make arrangements at the beginning of the course so another activity or project could be assigned.

Scope of the course

The primary focus of the course is renewable energy, with an overview of non-renewable sources to round out the mix. Each module covers a different energy source, offering discussions of the history, current situation, future possibilities, aspects of the technology, economic and political factors, and the advantages and disadvantages of the particular

resource. The impending energy crisis and how we have gotten into the current situation is also included. The course is intended as an overview of the alternates to continuing to use mainly fossil fuels to generate our power and run our vehicles. Renewable alternatives covered include wind, solar, geothermal, biomass, hydropower, tides and ocean currents. Non-renewable sources discussed are fossil fuels and nuclear power. Even theoretical renewable energy sources like hydrogen fuel cells, nuclear fusion, and zero point energy are addressed.

In contrast, this web course is not intended as a renewable energy design or engineering course, nor does it cover in-depth technology. This course is also not intended for business people who want to learn all about the economics and politics of energy sources. I designed this course as an introduction for my intended audience of NM teachers. Whenever possible, examples of renewable energy sources and energy conservation methods available in NM were highlighted.

A picture of the conventional energy industry is covered so the students will understand the relationship between the burning of fossil fuels, global warming and the need for alternate fuels. The relationship between fossil fuel supplies and world economics and politics is also addressed. Energy conservation methods and the need for carbonless fuel sources are highlighted in the course. After completing the course, the teachers in the class were well aware of the seriousness of the energy crisis and which of the alternative ways of generating power are viable in what areas of the world. Hopefully my students are no longer taking energy sources for granted and are even now teaching their own students respect for the fragility of our energy future.

Structure of the course

The Renewable Energy web course consists of over 450 web pages. The material was divided into sixteen modules to correspond with the sixteen weeks in the semester. The modules range from 18 to 29 pages long with an average of 24 pages. The navigation system allows moving forward and backward between the pages of a module, but the other modules can only be reached by returning to the syllabus page. This allows the navigation to be functional even when the modules are not all available. After the first

three modules were released at the beginning of the semester, the remaining modules were released one a week.

Navigation

The navigation system for a course web site should be strategically placed and intuitive to use. All of the pages in a module and all of the administrative pages for the course can be easily reached by using the navigation buttons on the course pages. I was unable to include navigation between modules because the modules were not all completed when the class started. I may or may not add that option before the web course is taught again. Not releasing all of the modules at the beginning of the semester imposes instructor control over the pace of learning.

The planned design for the Renewable Energy web course required several navigation bars, one for accessing the modules, another for accessing the administrative pages of the course, and the third for accessing the subsections of the modules (the navigation bars are labeled in Figure 2 in this section). Module access is from the horizontal navigation bar across the top of the page. I chose to use the horizontal space for the 16 buttons to link to the 16 modules, because that many buttons would only fit the long way across the page. Once a module opens, this horizontal navigation bar switches to displaying links to the other pages in the subsection that is being viewed (compare the 16-button horizontal navigation bar in Figure 2 to the 4-button horizontal navigation bar in sample module page shown Figure 1. The 4 buttons correspond to the 4 pages in the History Section of Module 1). That left the vertical navigation bar for accessing the remainder of the internal links. Therefore, the administrative pages, virtual field trips, and module subsections are accessed from the vertical navigation bars on the left side of the page (see Figure 2). On the module pages, the main menu appears below the module subsection navigation bar so users can still access the syllabus, the course requirements, the grading system and assignments, the virtual field trips, and my contact information from any page.

Page layout

I designed the course to read like the pages of a book, so the pages needed to all be about the same length. I didn't want the students to have to scroll down to read. When the pages vary greatly in length necessitating scrolling, readers can lose continuity. In order to avoid scrolling, the length of individual pages was ultimately constrained by the height of users' screens. The challenge was to include enough information to cover a subject well and still fit it in the area of a web page.   The size of the Renewable Energy course pages is 800 pixels wide by 600 pixels high, which covers about 14" wide by 9" high on most computer screens (see Figure 2 for a typical web page from the course).

The length of the buttons in the vertical navigation bar defined how large the main content region could be, in this case 600 pixels wide by 400 pixels high, or about 2/3 of the web page. That is enough space for 300 to 400 words of Times point size 12 or about half a dozen paragraphs. Text on the course web pages is laid out in either one or two columns. On some course pages the content area is taken up entirely with maps or graphics, or the graphics may be interspersed amongst the text. In order to make the pages consistent in scope and length, the paragraphs needed to be concise. Any graphics included had to make a point, be well explained in captions, and be placed strategically placed within the text.

Style

For the basic color scheme, the Renewable Energy site uses earth tones because they are easy to look at for long periods of time (See Figure 2 for a view of a typical course page). I also wanted the students to think about the Earth while reading the course pages. The background for static regions is charcoal gray with white text and tan links. The regions for content are light gray with black text and purple external links. These colors offer excellent contrast for easy reading.

I chose Times New Roman as the font for the web site because it is very similar to the font that is commonly used for textbooks and students are used to seeing and associating Times with learning situations. The Times font family is also one of the few that is

recognized by all web browsers. Times also looks good over a range of font sizes and when bolded.

Figure 1. This is the page that opens when users select Syllabus in the main menu, which is the left-hand vertical navigation bar (Marked with an arrow). The 16 numbers in the horizontal navigation bar across the top (indicated with a Star) are the links to the modules. This image shows the main editable region in light gray - the content in this area changes from page to page (labeled Syllabus 2004 in this image). The non-editable regions have a charcoal gray background. The underlined purple words are external links, the tan and white underlined words on the left-hand side are internal links.

I positioned the NMT logo in the upper left-hand corner because that is the first place the eye is usually drawn to when viewing a web page. An attractive recognizable banner in the upper center and right-hand area of each page serves as an identifying image for the course. The banner depicts the Valles Caldera, an active geothermal area in northern NM, which we visited on one of the summer 2003 Renewable Energy field trips. Mike Smith constructed the banner from a series of photos I took on that trip. The NMT logo

and the banner are circled in figure 2. The copyright information, space for the module title, and the last-updated date were placed in the footer.
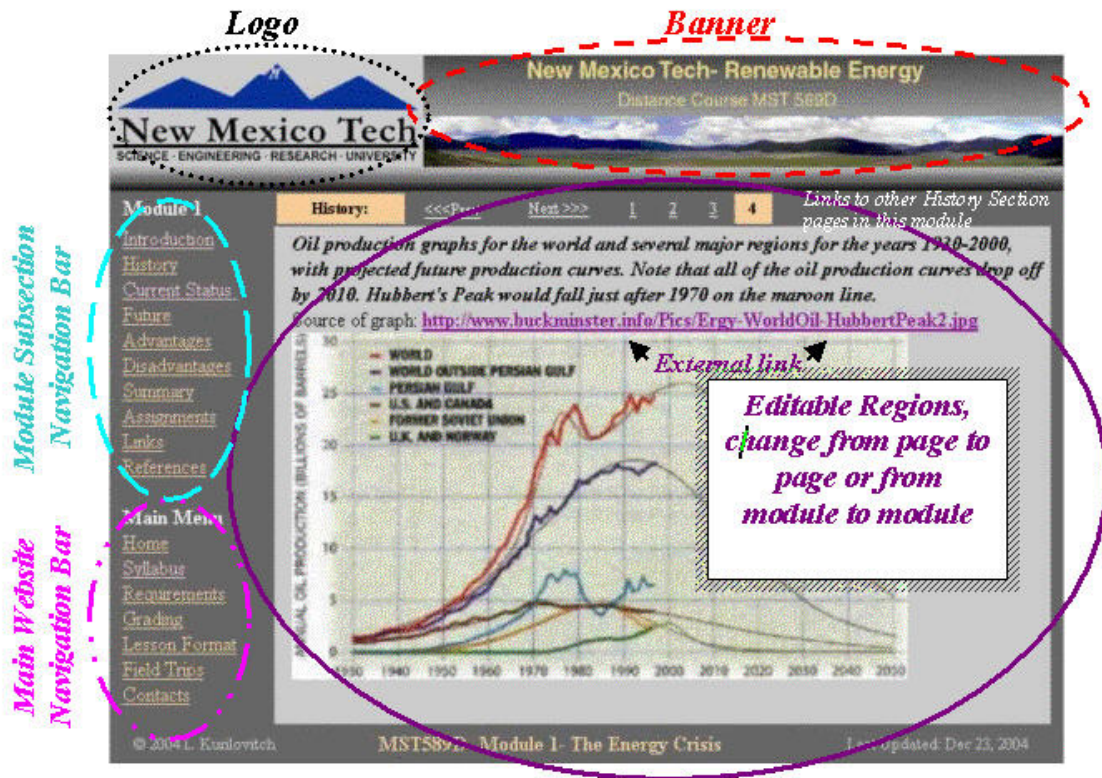

Figure 2. A typical web page within a module with the navigation bars circled and identified, the internal and external links labeled, the logo and banner circled, and the editable region circled. This example is page 4 of the History subsection in Module 1, the Energy Crisis, which contains a graph in the editable region.

The general layout and design of the Renewable Energy course worked well. The one thing that I would change for the next offering of the course is to make the navigation system simpler, so that the horizontal navigation buttons will link directly to the first page of the modules instead of going to the assignment pages first. The reason I didn't set it up that way in the first place, is because the modules were still being made when the class started, so the navigation had to be set up so the buttons only linked to the assignment pages in order to access the modules.

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Frequently Asked Questions

Originally not a planned part of the Renewable Energy website, the Frequently Asked Questions (FAQs) page was inspired by the number of questions that students asked over and over again. I wrote down these inquiries and created an FAQ page in the website. I sent an email to all students asking them to look first at the FAQs for answers. The web site FAQs was very helpful to both the students and myself. I also redirected questions about WebCT and the discussion board feature to the MST website as most of those questions are addressed there.

The FAQs helped eliminate some of the routine questions, but a number of students still wanted their questions answered personally. Perhaps they were the students who had never taken a distance course before. Before I teach the course again, I will expand and refine the FAQs to cover more of the questions that came up last time. Anyone planning a web course would do well to include an FAQ page in their site and to keep a list of questions they are asked often so they can update the list for the next year. In this way, FAQs will improve over time as new questions are added every semester.

Class management tools

For the Renewable Energy web course, the only add-on course management features of WebCT I utilized were the log-in, email, discussion board, and student participation statistics. These features worked well for this course and helped facilitate interaction with students and between students. These tools made teaching the class, communicating with students, and determining grades easier.

Because I did not want to utilize synchronous elements, I did not employ chat rooms for the online version of the Renewable Energy course. Several of my students gave feedback indicating that they would have liked to use the chat feature so they could interact directly with other students. I also did not use the calendar feature, but I think that would have saved me some time answering emails. The features that I will include next time I teach the web course are the chat room and the course calendar.

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Time Commitment

I spent about 50 hours creating web content per module, even after I really got the hang of making web pages. Once the semester started, I made a new module every week and posted it to WebCT at least a week before that module was scheduled on the syllabus. I wished many times that I had waited until the web pages were finished to teach the course, but my schedule did not allow that option.

Creating course material for online delivery can be incredibly time-consuming, as it requires a different level of completeness and special formatting for the web pages. Preparation for a traditional course takes me about 4-8 hours a week. Even if I am not as familiar with the material, it doesn't take me more than a day to prepare for a week of lectures, and preparation can be done weekly during the semester. Creating the 450 web pages for the Renewable Energy online course took me from 6-10 hours a day for over 4 months. Anyone contemplating creating a web course must consider that it will take more time and require more skills than preparing for live lectures.

Assignments

Each week, the students were required to view any virtual field trips, read the assigned pages in the textbook and that week's module, do the required outside web readings, and respond to a minimum of two topics on the discussion board. Each student was also required to write a minimum of two discussion topics for one of the weeks. Students were also required to keep detailed field trip logs on the two field trips they attended.

Since the students for the Renewable Energy class would all be science teachers, some of them with students of their own, I decided to design assignments especially for teachers. For their major assignments, I had originally required the students to complete a book report, show their class a renewable energy video, write a proposal for their final project, do a renewable energy presentation for their class, and complete a final report on their major project. After the class started, I changed the requirements so the students could pick two of these as their class projects and write proposals and final reports on them instead of having to do all of the original assignments. This gave the students more options and flexibility, especially since a couple of them were not teaching that semester.

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For the teachers who did have students of their own, I added some project ideas for them to choose from to try to get their own classrooms involved.

Many of the teachers came up with interesting project options that included their own students - several had speakers come in from NMSEA (New Mexico Solar Energy Association), PNM (Power New Mexico), and Positive Energy (a Santa Fe Solar Technology Company that sends out their employees to speak and do demonstrations). Others showed their students relevant Nova and Scientific American Frontiers episodes. Two teachers started recycling programs in their schools.

The assignment options were very popular with the teachers because they got to choose which projects they would do and because they could involve their own students. Another benefit of these assignments is that they encourage original work, limiting the possibility of plagiarism, which made these assignments much easier to grade.

Tests

I chose not to use tests for the Renewable Energy class but to get creative with the assignments. Tests were not necessary for this course because the assignments I developed kept them busy, required them to have learned the material, and gave me enough information to determine grades. In addition, one of my project goals was to include only asynchronous elements in my course, and most online test environments require synchronous elements. No one complained about not having tests as the students had plenty of other ways to earn grades, and many students dislike tests to begin with.

Grading

In addition to grading their two proposals and final project reports, I also graded their assigned discussion topic submissions and sent them feedback on their submitted topics. I was able to evaluate their participation in the discussions by reviewing their answers and using one of the course management features of WebCT that kept track of their participation statistics. I was also able to tabulate student participation for the discussion board by reviewing their replies and using that data to calculate participation grades for the students. They submitted project reports for their finals. Their midterm grades were

based on their proposals. I then used the formula I had included in the administrative pages of the course website to calculate their final grades.

Validation

Validation required from 3 to 6 hours for each module. The process of validation involves checking to make sure the internal and external links are functioning properly. In addition, after the site was uploaded, I had to look at all the web pages to make sure the images were present. If any images did not appear, they had to be uploaded to WebCT and the pages viewed again. Any links that did not work had to be repaired within Dreamweaver, the affected pages reloaded to WebCT, and then the links on those pages checked again. Every time the course is used in the future, the site will have to be validated again and any broken links removed or replaced.

Organization

One of the keys to successful web course development is organization, including organization of resources, information, time, and effort. Poor organization leads to repetition of tasks, continual editing, and even more time to complete the project. Once disorganization of content occurs, chances are the end product will also be disorganized and less effective.

Collecting text and graphic references while doing Internet research for the Renewable Energy modules necessitated developing a system for storing and keeping these resources well organized and accessible. During my research, information relevant to modules other than the one I was working on often surfaced. I developed a system of media folders to organize the information gathered for the website so that I could find it when I needed to use it later.   Consequently, having learned to apply such organizational skills will make any future web courses I undertake go much smoother.

In retrospect, preparation for the online course, including organization of time and resources, was much more involved than for traditional courses, both in making the initial course material before the semester and while teaching it.

Developing and Teaching the Renewable Energy Web Course

I also found that I had to organize my time differently in order to make modules while I was teaching the course. I had to find time to research the topic for each module and then create the web pages for that module. Each module covered the same aspects of a topic (Introduction, History, Current, Future, Advantages, Disadvantages, Summary), so I had to learn all of these well enough to describe them clearly and concisely for all of the topics. In addition, I had to attend to the administrative requirements for the course like answering emails, grading assignments, and planning field trips. After the first few weeks of teaching I found a rhythm and was making even better modules because I had learned to organize my time and energy.

Documentation

When I first started making the Renewable Energy web pages, I documented content minimally like I do for traditional classroom use. I included live links right on the pages to the sources of content, but did not originally use an endnote format as is done for articles written for print publication. After making several modules, my advisor suggested including more formal documentation. I researched other websites and style guides and found that documentation styles for website content is still in flux and no convention has been set for this relatively new media. I finally chose a version of the Chicago style and inserted a number in brackets at the end of the text line. The number links to the endnote references listed at the end of each module. I also listed the date that I accessed the website or the date the referenced website was published with each reference. Knowing just the URL of the reference isn't enough, if you don't know the date the page was accessed to create the web content, you can't always get back to the original page. Unlike references used in print, the links in the reference lists at the end of each module can take the reader directly to the sources. For documenting graphics, I still inserted external links immediately following the caption.

Virtual Field Trips

One of the advantages of online course delivery is the option to include virtual field trips. New Mexico has many Renewable Energy sites worth visiting, but many of them are too far for one-day field trips. Since the MST program director, Marisa Wolfe[8], encouraged

me to only plan one-day field trips for the online course participants, virtual field trips were the perfect solution for the more remote destinations. That way the class could still "visit" the facilities without actually traveling there.

Fortunately, during the summer 2003 course, we took several two-day and one three-day field trips and got to tour some sites in the far corners of the state, and I had taken many high-quality digital photographs. The Renewable Energy web course includes virtual field trips constructed using these photographs. These virtual field trips allow the students to "visit" the geothermal greenhouses at Lordsburg and Las Cruces, a coal mine and a coal-fired power plant near Gallup, the Wind Farm near House, and an off-grid solar home and hybrid car in Santa Fe. More virtual field trips can be added each year as we visit more sites and the Renewable Energy course evolves through time.

The program to display the virtual field trip images and captions was written by Mike Smith. This excellent program displays thumbnails that users can click on to view the full size images and descriptive captions. Students were able to view photographs and read about renewable energy sites beyond those that we visited during the 16-week class by viewing virtual field trips.

Traditional field trips

During the Fall 2004 Renewable Energy class, we made several traditional field trips as well. I required students to attend two of the five scheduled field trips. The dates for the trips were advertised with the course description that prospective students could view. I waited to arrange the field trip destinations until I knew where the majority of the students lived in the state. We visited an off-grid solar home and a home with a black-water processing system in Santa Fe, toured solar homes in Taos, attended the Solar Fiesta in Albuquerque, toured the Sacred Power manufacturing plant in Albuquerque, and visited the Southside Wastewater Treatment Plant in Albuquerque's South Valley. The field trips added excellent opportunities for personal interaction between the students and myself and between the students. Students kept detailed field trip logs, which were graded as part of their assignments. One of the reasons I assigned the logs was so that the

teachers could gather enough information to return to the renewable energy sites with their own students.

VI. Uniqueness of Communications in Online Courses

Teaching this web course required different strategies than those that I have used for traditional courses. Some of the differences were due to the Renewable Energy course being a distance course, and some were due to the web environment. I also developed some unique pedagogy for the web environment. Section V covered some of these adaptations related to web course design. This section will include some of the ways that I tailored class assignments and interaction for the web course. Here I have also summarized my observations about this experience. Teaching this course has refined my belief that online courses can be as effective, and in some respects more effective, than traditional courses.

On the other hand, I also found that I definitely would approach some aspects differently when the course is offered again. A list of the things I would do differently is included at the end of this section. I hope this information will assist other educators make pedagogical choices for their web course projects. Each time one of us creates and teaches a web course, we will learn more about the possibilities and pitfalls of this new teaching medium. I would have started out ahead of the game if I knew even some of this list before attempting this project. Sharing my experiences may benefit other educators contemplating creating or teaching a web course.

Content creation

Understanding the media that will be used for a course is the nature of doing good content design. Even though some style practices are shared in both print and online media, the unique qualities of the medium need to be considered when developing content. For instance, in order to hold student interest, a textbook should be a flowing narrative. If a textbook is scattered, students quickly lose interest. Conversely, video is a very dynamic medium. Students tend to lose interest in a video course very quickly if the content isn't dynamic. A lecture that is simply video taped is often droll and tedious to

view because it lacks the dynamic nature to which we have become accustomed in video media.   The key to creating effective courseware in any media is keeping the attention of the students.

A web medium requires a different approach than that used for other media. Web media combine a textual narrative with dynamic elements and an interactive environment. This characteristic of web media must be considered when creating online course content. Furthermore, like textbooks, the narrative must have flow. Students are accustomed to the ergonomics of flipping pages and digesting the information in a textbook. For online courseware, absorbing content should combine the ease of reading a book with a sense of dynamic interaction. In a live lecture, there is a sense of interaction that holds student attention. Video taped lectures tend to lose the student's attention because they do not have that dynamic element. If the content for a web course can hold the student's attention, it can be more effective than a live lecture. Dynamic elements combined with good content flow in a web course can hold student attention quite effectively. The nature of the experience the reader has when viewing online material needs to be a prime consideration.

Online content needs to be created with more purpose and structure than does traditional lecture material. Design element choices can diminish or contribute to the distractions of course web sites. Considering the ergonomics of a web site can help make a web course design easier to use. For example, the Renewable Energy web pages were designed so that students do not have to scroll either vertically or horizontally to read entire pages. Moving on to the next page requires a single mouse click, which doesn't require shifting the eyes or the attention. The ability to move dynamically through the material in the online medium keeps the students' attention so they are not bored with the content.

Another tactic that I used to hold student attention was to constrain topics to single pages. The ergonomic limitations I had chosen, i.e. no scrolling, limited the size of the content area on the pages. This served to compartmentalize the information and make the course content easier to digest. Formatting content so that it fit on individual pages was very challenging. Choosing a design that provided a limited space to present complete chunks

of information forced me to write in a very concise style. Within each module, the topics are very well defined and balanced.

Content in a textbook routinely flows over to the next page, splitting thoughts, sentences and even words. While this works in a textbook, fragmenting thoughts by continuing sentences onto another web page is particularly bad form for web design. If the amount of information on a particular topic needed more space, I would increase the information included for that topic, so it would occupy two full pages. Keeping the content concise and confined to single pages keeps the reader's attention from wandering and creates a simplicity that approaches that of reading a book. Another way to prevent distraction in a web course is to make sure that the content is well written, with impeccable grammar and style practices followed. Editing is definitely an important part of site development!

Graphics are particularly important to include in course content as they add a visual element that helps hold student attention. Graphics used to illustrate web content should be relevant and easy to explain, with arrows or circles added to direct students' attention to what they should notice in the graphic. Captions must be included that explain each photograph, chart, graph, or diagram included in the content. Graphics should be placed strategically within the content so that they appear after the subject that they illustrate has been mentioned in the text. Like other source material, graphic sources should be well documented on web pages.

Another way I used graphics was to fill in space on a page once I had said all that needed to be said about a subtopic. Rather than inserting information about a different topic, I filled in the extra space with a relevant graphic. This makes pages more esthetically and visually pleasing. In cases where it would be useful for the student to see a larger version of a graphic such as a map, I put a condensed version on the web page and provided a link to a more detailed version.

Including hypertext links directing students to more information about topics is another option I used to help keep web pages concise. External links to sources of additional information about module topics were commonly included on the Renewable Energy course web pages. I carefully reviewed the content for appropriate level, coverage, and relevance before I included these links. The option to explore outside of the assigned

course information gave the Renewable Energy course more depth without adding more bulk.

Together, all the design choices I made specified how to develop content for the Renewable Energy web course. All of the experiences of developing content for my web course are supported by this quote from Erica G. Feulner, "Presentation of content on a screen cannot rely on the lecture format of the three-dimensional classroom. …Texts on the screen have to be written in short paragraphs and engaging language to incite responses. The writer of screen texts has to strive for utmost clarity along with easy navigation and place links to references strategically. Visual effects - either in graphics or arrangement of text -are essential for stimulating the learner to explore."[9]

The presentation of my course content allows students to learn the material without distractions. The ergonomics preserve student attention, the graphics grab their attention, and the compartmented content holds their attention. Television documentary programs hold viewers attention very well but they cost hundreds of thousands of dollars to produce. Documentaries are therefore not practical for a university to create for course material. I think well designed web courses are an excellent choice for distance courses because they hold student attention effectively while efficiently conveying large amounts of relevant information. The feedback from the Renewable Energy students indicated that my course was very easy to use, well designed, and interesting.

Course accessibility

Access flexibility is one of the biggest advantages of online courses. Having the course web site to refer to at their own pace and frequency gives students a chance to absorb the material more thoroughly than does attending lectures and taking notes. Students can only take notes as fast as they can write, and if they miss a point, get behind, or miss a class, the information is usually lost to them. Students can review the courseware as many times as they want. Notes taken during lectures can also be reviewed at will, but because the notes are the student's interpretation of what the instructor says, they can be incomplete or inaccurate. The accessibility of the course material is one of the greatest

advantages of having developed the Renewable Energy course in an asynchronous online format.

Interaction

One of the issues many educators have with distance education is the perceived lack of student-instructor and student-student interaction. However, I discovered that I actually had increased interaction with students in the online format than in the traditional lecture setting. Havice, et al, 2000, report that they "generally found that using technology-based instruction not only allowed students to become more interactive with each other and the faculty during the course, but also increased student participation"[10]. The one-on-one relationships I developed with the online students is something I have only approximated in laboratory classes up to now. Perhaps this is because all communication happens on the student's territory instead of only in a group situation in a classroom.

I feel that I designed adequate opportunities for interaction into the Renewable Energy course structure. The interactive elements include email, the discussion board, my "office hours", and the field trips. I think that the online environment actually encouraged my students to interact with me much more than they usually do for traditional classes. I developed personal relationships with all of the online students during field trips and because I spoke to them regularly by email or by phone. Online features such as email and the discussion board encouraged students to readily express their ideas and opinions. I think this is due partly to electronic communication being readily available and instantaneous, and partly because many students are shy about speaking out in public. Before sending an email or posting a reply to a discussion board, students can think about what they want to say and how they want to say it, and even edit their comments.

However, I think that a traditional classroom may offer more opportunities for interaction between students than the web course did. Students seem to form interpersonal relationships with each other more readily in face-to-face situations. Perhaps they feel more comfortable when they can see each other, whereas they felt comfortable with me to begin with because students are used to trusting instructors. Students have to

personally interact with instructors sometimes, and electronic communication feels safer than face-to-face interaction. Interaction with other students is voluntary unless they are assigned group projects.

Perhaps employing a chat room would catalyze student-student interaction. Several students in the online Renewable Energy class mentioned on their feedback forms that they would have liked to be able to chat directly with the other students in the class. Students could use the chat room to talk to each other whenever they want to and form personal relationships in that way. Next time I teach the Renewable Energy course I will try using the chat feature. I may also try using the chat room for my office hours to see how students react to that form of student-instructor personal communication.

Field trip observations

The Renewable Energy class field trips were a highlight of the course for both the students and myself. We had time to interact face-to-face on the field trips. Without the field trips, there would have been no face-to-face interaction during the class. Another reason the field trips added to the course experience was that they made renewable energy real for the students. The trips also showed that renewable energy projects are happening here in New Mexico. The students that answered the feedback questions agreed.

Most of the field trips were held on weekends so the teachers did not have to miss school. Next time I teach the web course I may not offer so many field trip options however, as trips required large time commitments for me to set them up and I also had to go on all of the them. Even with 5 trips offered and only 2 required, several students did not attend any of the field trips. Those students did not earn good grades in the course because they did not even do the alternate assignment option I offered for people who could not go on field trips.

Email

Email has distinct advantages that encourage student-instructor communication. Students can send private email messages at any time and receive personal attention. Even though

students in my traditional classes can communicate with me by email, I usually only receive a couple of emails a week from the entire class. The students in my web course emailed me regularly, most of them several times a week. I also found that students were more forthright with their expression because email is private and they knew they would get personal attention.

Discussion board observations

The discussion board turned out to be an excellent tool for both student-instructor and student-student interaction. "Students can not only reflect on their positions on an issue but can also compare their positions of their peers."[11] I wrote the discussion topics and initial replies for the first three modules, and the rest of the semester the students submitted the topics, which I approved or sent back to them with suggestions for modification. Students were required to reply to at least two posted topics per week. I also posted the topics and made sure the students were participating in the discussions sufficiently. The discussion board instigated much more participation than I had required. The students in the Renewable Energy class often responded three or four times, sometimes more than was expected. The students really got into the discussions about energy topics in NM and the Southwest that I encouraged the students to post. The extra replies were great, but they required more time from me to monitor the extra replies. Even so, the discussion board was a huge success and helped accomplish my goal of getting my students to think about current local energy issues and talk about them.

The students were much livelier in the online discussions than they have been in live class discussions I have facilitated. I found this interesting because if I had been asked if this would be the case before teaching this class, I would have said certainly not – live discussions are surely better. But after experiencing teaching the web course, I believe the interaction was richer in the online discussion board.

Student feedback

While we were on field trips, I made a point of asking students for verbal feedback about the course, its content, and format. Several students in my class who had previously

taken the MST courses delivered by video streaming or VHS/CD/DVD recordings told me that they preferred the web delivery format used for the Renewable Energy course. The majority of the responses of the students who returned the NMT Distance Education Department's electronic feedback form for the Renewable Energy course were strongly positive to this statement, "the online elements of the course enhanced the learning environment". One of the students in my class, Greg Frostad, gave this response on the feedback question form I sent out to my students, "The web site was relatively easy to navigate. I liked the general structure of the learning modules. I thought the length of the modules was very appropriate. There was in-depth coverage. Email and discussion worked well. I liked how the discussions were arranged by module."[12] A summary of the feedback I got from the students is included here. The students in the Renewable Energy web class indicated that:

- They found the course structure well designed and easy to navigate, but maybe a little complicated to use initially
- The modules were not too long or too short, and the content was at the appropriate level
- The incorporation of graphics and embedded links was especially appreciated
- The material was directly applicable to their curriculums and that they would be using much of it in their own classrooms
- The many field trip options and flexibility were appreciated
- They really liked getting to choose which assignments to do
- They didn't like that I changed the assignment requirements after the semester started, but they did like that they would have to do fewer after all
- They considered my response to emails very good and timely
- They liked having the chance to call me on the phone even though most of them did not
- A couple of students mentioned that they would have liked to use the chat and calendar features available with WebCT, so I will include those options next time I teach the course

- They all expressed appreciation for learning material that they could use in their own classrooms and for the chance to involve their students in meaningful projects as part of their assignments
- Several students mentioned that they would recommend the class to other teachers
- Overall they enjoyed the course, learned a lot about the energy crisis and renewable energy, and afterwards gave positive feedback

Several of the teachers from my class were already passing on information they learned to their students while the class was going on. Others indicated that they would be adding the renewable energy information to their curriculum in the future. Several teachers are continuing the classroom and school-wide recycling and energy conservation projects they started during my class, or plan to do similar projects again next year.

VII. Conclusions

Things I would do differently

I would not change most of the structure of the web site or the pedagogy I used. But I do plan to try a couple of things differently that I think will make the site more usable and the class go more smoothly for myself and the students. Next time I construct or teach an online course, I would:

- Complete construction of all of the modules before the course starts.
- Delineate the assignments completely and set their exact due dates before the course starts, maybe even create a rubric for assignment expectations.
- Have the horizontal navigation buttons link to the first page in each module directly, instead of linking them to the assignments pages first.
- Use the calendar feature available through WebCT.
- Use the synchronous chat feature available through WebCT for my office hours and for students to communicate with each other directly.
- Make the courseware meet the American Disabilities Act (I didn't have any handicapped students this time but may in the future.)

- Announce the exact field trip dates and destinations before the course starts, or not have any field trips.
- Include a navigational aid known as "breadcrumbs" so students will know how to go back where they came from within the site
- Perhaps include a site map, so students have more reference for where they are within the course structure
- Develop a smoother integration of the larger detailed graphics. Instead of a new full-size browser window opening, use pop-ups so the original page won't be obscured

I came to several major conclusions during this project, which are listed below.

1. Simply converting a PPT presentation to web pages does not a web course make!
2. Instructors who want to convert their courses for web delivery must be prepared to spend the extra time to learn the necessary skills, to assemble the digital course material and construct the web pages, or to hire somebody else that knows how to do it for them. Once the online course is constructed, the class can be taught using the same courseware with regular updates.
3. The process of preparing course material for and teaching an online distance course is very different than for traditional face-to-face courses.
4. Preparation and organization are the keys to being successful at online course development.
5. Completing an effective online course website requires adequate training in web development and web design, technical communication skills, teaching experience, and a particularly deep understanding of the course subject matter.
6. Teaching online courses requires more time and a modified pedagogy, but the students come away with greater comprehension of the course content.
7. Material produced for this web course is more understandable, concise, and complete than the course material produced for traditional classes that I have taught and many that I have taken.

8. I think that students in the web class came away with a greater understanding of renewable energy and that they will retain more information than they did from the traditional version of the course.
9. Writing course material delivered by web pages requires more precise and in-depth content than writing for lectures, presentations, or even textbooks.
10. The ability to pace learning and access course material when student's schedules allowed made this course particularly suitable for MST students.
11. Well-designed web courses like mine can hold student attention better than video taped lecture courses. The interactive element of web courses makes them more dynamic and interesting than video courses.
12. The design and format of the on-line Renewable Energy course actually allowed for more and richer student-instructor and student-student interaction than most traditional courses do.
13. Choosing a page design that limits the amount of information on each page can make for very organized and compartmentalized content and a website that is easy to read.
14. Including hyperlinks to more detailed information within the content can increase the depth of the course without adding bulk.
15. Because creating web courses is a form of publishing, accurate formal documentation is necessary for web course content.
16. Unlike traditional courses, preparation of material for an online course must be done well before the semester starts so that the web site can be constructed.
17. Online delivery is a very effective format for distance courses and web courses will become more popular as educators and students realize that.

The MST department already has a waiting list for next time they offer the online Renewable Energy course and they have asked me to teach it again this fall. Before that time I will edit the content, add any new developments in renewable energy, include some of the differences mentioned in this section, and validate the web site again. The Renewable Energy web course remains the only completely online course offered at NMT. Both the content and the format of my class was very popular with the students.

My sincere hope is that the information and experiences reported here will inspire other educators to choose to create web courses and that they will benefit from this report and have an easier time than I did.

VIII. Acknowledgements

I gratefully acknowledge the support of my committee members Drs. Andy Campbell, Daniel Jernigan, Peter Mozley, Rick Mott, and Dave Norman (who is also my academic advisor). Thank you all for your help and inspiration. Extra thanks go to Daniel for doing the extensive preliminary reviewing on this document.

Daniel Jernigan, Maggie Griffin, and Mike Smith reviewed (and reviewed, and reviewed) the document for me. Thank you, Daniel, Maggie, and Mike! I think the final product is very much better thanks to all of your help!

I very gratefully acknowledge the very patient assistance, editing, and technical help from my boyfriend, Mike Smith. Thanks for everything, Mike!

Appendix 1. About the author

I have been doing graduate work in Geology at New Mexico Tech since 2001, and will graduate in May 2005. In recognizing my talents lean more towards technical communications, writing, and editing than towards research, in 2003 Dr. Norman suggested that I switch my academic focus from Geology to Technical Communication (TC) for my last year and go for a second Master's degree in Geology. Dr. Norman felt that the combination of TC and geology would be more suitable for me and, in the end, more marketable than a PhD in geothermal geochemistry, which was the focus of my original curriculum. Consequently, I was assigned a new committee - two faculty members from the TC department and three from the geology department. Dr. Norman, who remained my academic advisor, also suggested that I create a distance education course for the MST program for my new thesis project.

As a part of my new curriculum, I completed 24 credit hours of TC classes chosen by my new MS committee, including Advanced Technical Editing, Proposal Writing,

Instructional Writing, Article Writing for the Mass Media, Senior Seminar, and two Web Development courses. During this curriculum I learned web design and the HTML-based web development programs *Dreamweaver, Fireworks* and *Flash*. After a whole year of taking TC classes and successfully authoring over 450 web pages for the Renewable Energy online course, I now agree that this was the right choice for me.

Because NMT does not offer a master's degree in TC, my committee decided I should work towards a second master's degree in geology so as not to waste the two years of graduate level geology courses I had already completed. Geologists who are also trained in technical communication are rare and therefore especially in demand by employers. Consequently, I should have excellent job opportunities after I graduate, and so I appreciate my committee steering me in this new direction.

References

[1] http://www.program-online-degree.com/, Online Degrees & Programs Information - Resources and links for Bachelors, Masters and MBA Degrees Online, accessed 13 Jan 2005.

[2] Feulner, Erika G., Adapting Content to Distance Learning Delivery Systems, http://www.cristalla.com/adapting_content.htm#Content%20Development, The Technology Education and Communication Institute (TECI) Inc., accessed 13 Jan 2005.

[3] Fisher, Mercedes, 2003, Designing Courses and Teaching on the Web: A "How To" Guide to Proven, Innovative Strategies, Scarecrow Education, Lanham Maryland.

[4] Feulner, Erika G., Adapting Content to Distance Learning Delivery Systems, http://www.cristalla.com/adapting_content.htm#Content%20Development, The Technology Education and Communication Institute (TECI) Inc., accessed 13 Jan 2005.

[5] Tollett, John, Williams, Robin, and Rohr, David, Robin Williams Web Design Workshop, Peachpitt Press, Berkley, CA, 2002, www.peachpit.com

[6] Tollett, John, Williams, Robin, and Rohr, David, Robin Williams Web Design Workshop, Peachpitt Press, Berkley, CA, 2002, www.peachpit.com

[7] Fisher, Mercedes, 2003, Designing Courses and Teaching on the Web: A "How To" Guide to Proven, Innovative Strategies, Scarecrow Education, Lanham Maryland.

[8] Wolfe, Marisa, NMT MST Program Coordinator, 2004, personal communication.

[9] Feulner, Erika G., Adapting Content to Distance Learning Delivery Systems, http://www.cristalla.com/adapting_content.htm#Content%20Development, The Technology Education and Communication Institute (TECI) Inc., accessed 13 Jan 2005.

[10] Havice, P., Havice, W., and Isabell, (2000), Rubrics and a Strategy for Integrating Traditional Instruction and Distributed Learning, in C. Mann (Editor), Perspectives in Web Course Management, pp. 199-210, Toronto, Canadian Scholars' Press.

[11] Fisher, Mercedes, 2003, Designing Courses and Teaching on the Web: A "How To" Guide to Proven, Innovative Strategies, Scarecrow Education, Lanham Maryland.

[12] Frostad, Greg, 2004, Renewable Energy web course student feedback form.