The Design, Assessment, and Implementation of a Web-Based Course

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The design of a web-based course is discussed based upon considerations of content, pedagogy, learning styles, and assessment. The learning styles are examined as primary considerations and indeed dictate needed elements in a web-based course. Assessment is also considered in the initial planning of such a course. These design elements are discussed with particular web elements given for each design element. Further illustration of the design procedure can be seen by going to a freshman chemistry course referenced at the end of this article. All considerations discussed in this article may be used both for a web-enhanced course and a course taught totally online. This discussion was presented at EdMedia00 in Montreal, Canada.

To design a course for optimum impact, the following should be simultaneously considered: the course material; the students’ learning styles; pedagogy, which includes methodologies of presentation; and assessment. These items then need to be considered as itemized.

- Regarding course material, experienced educators know the needs of the customer regarding the content of the courses. The students (learners) need courses that are current and that are relevant to their career choices. Because most faculty members keep up with their disciplines and their relevance to other disciplines, they generally know what is
needed in the lower-division courses and in the upper-division courses. Course content is not constant over the years, and all educators must work to keep up with subject advances. However, the area of course content is usually the most dependable part of course design.

- Learning styles often vary significantly among a typical group of freshman students. However, most faculty members often omit consideration of the students’ approach to the course. The teacher often will teach the course based upon his/her learning style and the way that he/she was taught. Certainly most faculty members usually don’t plan their course presentations based upon the myriad learning styles of their students. Many students leave science partly because of our poor planning regarding these learning styles (Tobias, 1990; Felder, Forrest, Baker-Ward, Dietz, Mohr, 1993). This area is usually the weakest component of course design.

- Pedagogy appropriate for each particular course must drive the development of the course (Roberts & Robson, 1999). Although course content and the relevance of the subject matter to many disciplines may be well known, often not enough thought is given to the pedagogy required for the best development of student learning. Methods of effective presentation can vary widely among disciplines. The white board is still an excellent tool for presentation, however, now we also have the smart board. The importance of small group work is well known. Student presentations are also an important component of educational methodology. Faculty members now have a wide choice of technology suitable for enhancing their teaching of the courses. Modern technology can considerably enhance their applications of good pedagogy. So we must consider how to incorporate these techniques into a web-based course.

- Course assessment must also be considered at the development stage of a course—note in the title that assessment is listed before implementation. Many books have been written about course assessment (Astin, 1993). At the beginning of the course, it is very important to know the beginning level of student understanding of the subject. It is also important that all of the students know their own learning styles, and the best way to approach learning based upon them. The student and professor must also understand their personality profiles to aid in a more proficient learning experience. Assessment will involve studies of content knowledge, before and after taking the course; learning styles; personality profiles; and environment.
WEB SITE CONSIDERATIONS

When beginning the course development/design, considering the course material that needs to be mastered, pedagogy, the possible learning styles of our students, and assessment; a new paradigm of course design develops. What follows can be used for either on-campus or online courses. It can also be applied to any other area of learning (government, industry, etc).

Assume that the gross course content is not an issue. For the first-year teaching faculty member, putting together the first set of course material can be quite a daunting task. Also, every year the faculty member must fight against the tendency to use the “yellow notes” from previous years. It is very important for all faculty to keep their course content current, however, the assumption is that such a consideration is a given. Putting the material on the World Wide Web (WWW or Web) presents some additional considerations. It is desirable to make the best use of the web medium to maximize the constructivist possibilities (Koyanagi, n.d.). There will be some elements of objectivism in the presentation because some material has to be memorized so that deeper understanding can be based upon that memorized base. This discussion is now overlapping between course content and pedagogy, but such an overlap is an essential part of the design process.

The pedagogy and the method of presentation have to be reconsidered every year by the faculty member. New technology for use by the educator is being developed every month. A good example of the use of modern technology is in the development of a web component to a course. The amount of web involvement for a course can vary considerably from a very minimal involvement of putting a course syllabus on the Web to the considerable effort of developing a web-based course. Web-based courses are courses that have a major component of all aspects of the course on the Web. These web-based courses can be used as course supplements for lectures or for totally online courses. Since they can be used in both venues, the development time is optimized for its effectiveness. As stated in the preceding paragraph, the intent is to maximize the constructivism that can occur based upon the design of the web site. In chemistry, some objectivism in the design is desired so there will be some drill exercises. However, that memorized base will clearly be used to lead the students into a constructivist approach to their knowledge development. Abstract topics such as in chemistry and physics can be considerably enhanced by the use of simulations and animations. The simulations can also have a student interface.
allowing for students to change the operational parameters of the simu-
lations and thus lead to a deeper understanding of the concepts.

The *consideration of the learning styles* of students is usually the most
neglected item. Following are some learning styles and the course elements
needed for those learners.

<table>
<thead>
<tr>
<th>Learner Type</th>
<th>Needed Course Elements</th>
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<tbody>
<tr>
<td>Visual Learners</td>
<td>Graphics (illustrations, films, slides, and diagrams), flow charts, discussion bulletin boards, animations.</td>
</tr>
<tr>
<td>Auditory Learners</td>
<td>Films, sound-enhanced slides, Microsoft Net Meeting</td>
</tr>
<tr>
<td>Read/Write Learners</td>
<td>Written web material, referrals to other web sites, written assignments such as chapter summaries, suggested exam questions, and so forth.</td>
</tr>
<tr>
<td>Kinesthetic Learners</td>
<td>Different web pages for different materials (makes them take a needed break), short web pages, memorization drills, animations requiring input, non-web assignments (surveys, lab experiments).</td>
</tr>
<tr>
<td>Sequential or Global Learning</td>
<td>Give a good overview of each section and provide a logical progression through the material that can be chosen by the learner.</td>
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<tr>
<td>Inductive Approach</td>
<td>Facts and observations given, principles developed</td>
</tr>
<tr>
<td>Deductive Approach</td>
<td>Principles given, consequences and applications deduced</td>
</tr>
<tr>
<td>Active Learners</td>
<td>These learners need group work. We can make assignments to groups of students and require presentation of results over the web using a course management system such as WebCT. Case studies appropriate to the discipline can be used very effectively in this component. Reports of these assignments should be due often (every two weeks).</td>
</tr>
<tr>
<td>Reflective Learners</td>
<td>These learners need time to think over the material before trying it out. Online quizzes that are taken at the time of their choosing appeals to these learners. A thorough assignment due at the end of the semester also appeals to these students.</td>
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Other authors have also examined using some of the implications of learning theory and web-based instruction (Henke, 1997a).

It is recommended that faculty begin work on designing the web site and how to include course material while considering assessment. The methods of assessment need to be in place well before the first semester of use begins, and a specialist in assessment should be part of the team. The assessment needs to include comparisons with an on-campus class covering the same subject, and the best arrangement is for the same professor to teach the on-campus and online class. Before the classes begin, both classes need to take a subject matter test, a personality profile test, the Learning and Study Strategies Inventory (LASSI) test, and at least two different kinds of learning styles tests. It is best if a standardized subject matter test can be found such as is offered by the American Chemical Society for chemistry tests. At the end of the class the students need to then take the subject matter test again. Studies of the student environment involve the actual class-related experiences of the student during the course. Obtaining student input on the environmental issues is very important. For a web-based course the environmental issues are ease of site navigation, usefulness of various sections, ease of use of audio/video components, ease of electronic correspondence with other students and faculty, and so forth. The assessment expert should help the faculty member choose the proper tests and opinion surveys, and aid in the analysis of the correlations.

**WEB SITE CONSTRUCTION**

For effective use of everyone’s time, it is very important to use a team approach to the construction of the web site. It is unreasonable to expect one person to become an expert in all needed areas. The team should consist of a content expert, an instructional designer, a programmer, a web interface designer, a graphic designer, and an assessment expert. There are a number of good references for considerations in the web design process (Henke, 1997b).

At this point, the discipline material needed on the web site, how to design the web site for optimal use by the students, the methodologies of presentation, and the methods of assessment are known. Now begins the development of the web-based course by including all of the previous elements in
the design. By reviewing the preceding, the needs become clear: synchronous and asynchronous means of communication among the class members, video clips, sound bites, simulations and animations, photos with sound and text, access to a conference software package like Microsoft Net Meeting, short web pages, different web pages for different topics, drill routines for help in understanding and memorizing, animations with input, a good overview of each section and of the entire site, prepared method of progression through the site for those who need such, methods for inductive and deductive approaches, short-term and long-term group assignments, and online quizzes at appropriate locations to help students gauge their educational progress.

Now it’s time to design the web site for the course. From all the previous considerations, there are many needed components of the web site. Now the team must examine the course material and begin to storyboard it into needed segments, and requisite interactions among the segments. The overall site should be designed so a student can be guided through it, or so a student can choose his/her own path. At this point it is a good idea to use a hierarchy program and place the titles of all segments in the spaces and begin to determine the best arrangement and interactions. Because we are trying to maximize the constructivist element of the web site design, the placement of the course material must be done with that priority. It is very important to remember that the individual web pages need to be short, so a given chapter of material will need to be divided into appropriate small sections.

It is also time to begin to determine what animations and simulations will be placed with what sections and where to place drill exercises. Drills are to be placed at necessary points in the objectivist portion of the site (such as in the learning of significant figures). If a programmer is part of the team then he/she needs to begin developing the needed animations, simulations, and drills. Generous faculty members at many universities are also willing to share their work, which could save a lot of time. There are also a number of software packages that can help in constructing these portions of the site.

Once the design of the web site has been determined, the conversion to html coding begins. Much of this work can be done with word processors, although usually such conversions have to be considerably modified to appear as desired. Because most of us are never satisfied with the html conversion of word processors, it is advisable to just create all the code
with an appropriate web page software suite. There are many software packages available for constructing web pages. *Dreamweaver MX 6.0* (Macromedia) is a very good package for this work.

The style of the writing needs to be different from that in a textbook. The writing should be friendlier and written like one would talk when tutoring a student in the office. That is what a good site is—an electronic tutor. A good method is to start with lecture notes and then fill in details and modify the tone of the writing. A good reference point for the writing is to think about explaining the material to your 15-year old child or grandchild. The entire course should begin with a broad overview; each “chapter,” and each “section” of each chapter should have an overview and learning goals clearly stated. Each “section” should then be followed with a conceptual quiz to help the students assess their progress.

The learning style considerations revealed that one needed component was video, which presents some problems if students are accessing the material from off campus, as most will be doing. The videos should be short, approximately ten minutes, and narrowly focused in content. Short topical lectures on many topics were produced in freshman chemistry and compressed for Real Streaming video presentation over the web. However the pipeline to homes is still too narrow for the effective use of such video. Therefore, it was decided that for the next few years, the best method for delivering such videos to students is through CD-ROM disks. The video on the disks can be assessed from the web course material, and it is easy for the students to then watch at their convenience. The videos should be produced in their original form with streaming video in mind (few motions, simple background, simple scenes, etc), so that they will compress into as small a file as possible. Later, when the technology improves for video delivery over the Web, the same videos can probably still be used over the Web.

The synchronous and asynchronous communications among the students can be accomplished by a course management software package such as *WebCT* and *Blackboard*, or needed individual components may be used. *WebCT* was chosen for the discussion forum, chat room, and mail aspects of the web course. *WebCT* is also used for online tests to be made available to the students a couple of days before each proctored test. These online tests are of similar coverage and difficulty as the proctored tests. For some students who have the computer capability, a server for use with Microsoft *Net Meeting* is also made available. Using *Net Meeting* online office hours can be scheduled and students can schedule group meetings.
A web site that has general information about the campus and specifics about online learning should also be available for the students. A site called “ChemNet” that contains links to the university homepage, campus resources, admissions, financial aid, the catalog, the bookstore, library resources, the university online registration site, and a site where the students can obtain free e-mail and web pages was constructed. The site also contains a link to a site that discusses online learning, has links to needed software, and has online learning style tests. This site also has links to information about all degrees offered on campus, and to the online courses available from this campus. Such a site is essential to including the students of the online class into the oncampus scene and is located at http://chemnet.kennesaw.edu

IMPLEMENTATION

Now that the site is constructed; it is time for implementation. It is very important to have an oncampus meeting before the course begins. At this one mandated meeting, the students get to see the professor and each other, work through some of the details of the class in a computer lab, and take some of the assessment tests. I also prepared a web site that walks the students through the various aspects of the web-based course that is useful for those students who can’t attend the oncampus meeting and as a review for those who did attend the orientation.

Each chapter should have group assignments that are due every two weeks. Testing should be frequent. Optimally the students should be given a test every two weeks and group assignments due every two weeks with the timing such that something official happens every week. For a semester course, there would then be eight proctored tests, eight online quizzes, the final exam, eight group assignments, short quizzes, and homework (due the day of the test) all to be used in some combination to give a grade. It is preferable to require that the tests be proctored either on or off campus. The validity of off campus proctors must also be carefully checked. If this sounds like a lot of work for the students and the professor, it is! An online course conducted in this manner forces the students to study as ideally all students should study, but it is known that probably only about 10% study this intensely. Professors and students must be warned about the extra work before the course starts. Data show that students finishing such a course in freshman chemistry scored 57% better on a standardized test, so for the serious student such an approach is worth the effort.
The professor must check all possible student input at least daily. It is critical to keep the students involved in the course and motivated to learn. Nothing turns off a student as much as having a request for information sit in a mail hopper for days, or a message posted to the discussion forum to go totally unanswered for days. It is a good procedure for the professor to enter himself/herself as a counterfeit student in the class so the professor can pose as a student, see the material from the student’s view, and discuss issues with the students from a different perspective. Students will discuss concepts more openly with other students than with a faculty member. Of course, usually someone begins to wonder who the kid is who seems to know all the answers! It is also a good stratagem to let the discussions continue on the bulletin board without intervention unless the students are getting way off course on trying to understand some concept. Students learn more when they teach each other rather than having the professor answer all questions immediately. It is also a wise procedure to sometimes enter as the counterfeit student and pose a question to try to get the discussions focused properly.

Assessment tests and surveys are also available online for ease of taking and analyzing.

Upon implementation the professor becomes the guide through the material. The web site must also be kept updated, which includes checking all referenced links often, changing course content as needed, modifying and adding new animations and simulations as needed, monitoring the use of synchronous and asynchronous communication tools so the most effective methods are used from the students’ perspective, modifying areas of the site as needed to meet the needs of all learning styles, and continual use of assessment data to make the site optimally effective.

**CONCLUSIONS**

Assembling a web-based course is not an easy task and requires a lot of time and commitment of the professor and the team. After the initial implementation, the professor is forever in a continuous iterative process of assessment, modification, learning modern techniques, and implementation. However, this iterative process has always been the job of the professor. The web era has not introduced any new job description, just different details and a new medium that can be used to develop constructivist learning in a more
effective manner than ever before. This last statement is a rather bold statement, but the author believes it is true, especially for rather abstract subjects. The use of computer simulations with feedback loops, animations, drills for memorization, and computer models of molecules and their interactions (again with feedback loops) afford a method for active learning that was not available until recently. The web-based uses of these techniques allow the students to repeat them as often as the student desires rather than just once in class. The use of the electronic bulletin boards for discussions generally afford a deeper level of discussion as students can think more about their comments than most do in person-to-person interactions.

A major benefit of a web-based site from the students’ perspective is that the students leave such a course with better-developed abilities to be life-long learners. They will always have to be learning on their own, and the Web is a fantastic tool for education. They will also have learned how to approach the Web cautiously regarding the validity of information on the Web. They will have developed skills in working with other individuals using various technologies. Most corporations now use the Web for training employees and keeping employees modernized in their knowledge relating to their jobs. The successful completion of a web-based course is an excellent part of a student’s education and the author believes that at least one such course should be required of all students.

One of the sites that contains most of the previously discussed elements is located at http://SurveyChem1.kennesaw.edu/ and anyone is welcome to visit it and reference it in any of their courses. The links in this site to WebCT are protected, but all other aspects of the course are open to the public.

References


