METHODOLOGY FOR COMPUTER AIDED INSTRUCTION

There is little controversy that Computer – Aided Instruction (CAI) is ubiquitous. The impact on education has been unparalleled. Libraries of information are now available in a variety of formats. Educators are grasping for methods to harness the data and use it effectively. This is incredible, but at the same time, overwhelming. Additionally, courses in higher education can now be offered online virtually anywhere. Because of these issues, educators are searching for “design methodologies.” Numerous authors have described how to use this new technology (Peters & Sikorski, 1997; Carlton, Ryan, & Sikhtbert, 1998). Two recent studies have provided strong empirical support that compares student outcomes in traditional and web-based courses (Leasure, Davis, & Thievon, 2000; Liao, 1998). All of these articles establish the role that computers are playing in the educational process, but often do not analyze the stratagem employed in course pedagogical development. The purpose of this review will be to appraise design methodologies that have been validated in the literature for use in CAI, especially those that produce higher levels of learning in web-based instruction.

LEARNING STYLE

Course Design Issues

In 1996, the National Survey of Desktop Computing in Higher Education reported that assisting faculty in course design and integrating it into the curriculum as the single most important issue facing institutions of higher learning (Green, 1996). This was five years ago, and it is still an issue today. In fact, the report issued in October of 2001 reiterates this same concern. It is still the single most important issue facing campuses across the nation and will be for the next two or three years (Green, 2001).

To assist faculty in coping with this dilemma, Instructional Technology Centers (ITCs) have emerged as integral departments on most college campuses (Carr-Chellman & Duchastel, 2000, p.233). Employees in these departments are scrambling to help faculty keep current with the rapidly changing technology. Design pedagogy is a major concern (Dick, 1996; Mioduser, Nachmias, Lahav, & Oren, 2000). However, within the literature, there are limited empirical studies geared toward analyzing effective pedagogy for online courses. Faculty members’ reluctance to have their courses scrutinized could be attributed to this. Most likely, it is because teaching methodology has been thoroughly analyzed in traditional classrooms, and the hypothesis is that the same pedagogy should exist in web courses. Nonetheless, a recent study at Brevard College in North Carolina accentuates that lecturing is still the most often utilized method of learning (Newman & Scurry, 2001, p. 7). This passive learning technique is not aligned with current pedagogy. Ross and Schulz (1999), in their article

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A Constructivist Approach to Web Course Design: A Review of the Literature

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Using the World Wide Web to Accommodate Diverse Learning Styles, documents this issue: “For years, we have been hearing about the need for using a variety of teaching approaches to reach students with diverse learning needs” (Corno & Snow 1986; Sarasin 1998; as cited in Ross & Schulz, p. 123). In addition, it has been shown that student outcomes improve with CAI. Mackenzie and Greenes (1997) report, “(S)students who studied with a CAI video disk instead of traditional textbooks scored significantly higher on a skeletal radiology examination than their counterparts who used only textbooks” (p.1786). Repeatedly, literature reviews substantiate the supposition that corresponding methodologies be used in traditional and web courses (Smith, Smith, & Boone, 2000, p. 37), and that educators provide attempts to reach diverse needs. The academic data is clear. It is time for educators to take heed. A supplemental or online component in a course could be the first step at reaching students with these needs. Optimistically, methodologies should support active learning pedagogy.

Testing for Learning Style

The type of active learning to use in a course is dependent upon the learning styles of the students. This is demonstrated in an introductory biology course designed by Sanders and Morrison-Shetlar (2001) at Georgia Southern University. Student learning styles were measured prior to building the course in a web-based instructional program called Web Course Tools (WebCT). This was accomplished by a survey instrument, which was statistically evaluated for reliability and validity. The design of this instrument is beyond the scope of this review. However, from this data, the course instructor developed a learning-style profile. She found the following: “Almost one-third of the students participating in this study were found to use a combination of visual, auditory and kinesthetic learning styles” (p. 253). A conscious effort was made to ensure that all learning styles were accommodated prior to building her course. This was very time consuming, but beneficial nonetheless. It may be impossible to develop a profile on students taking all courses. However, this author noticed the same trends in most of the classes that she taught eliminating the need for further surveys. Educators in other disciplines may find similar findings. To recapitulate active learning pedagogy, Ross & Schulz (1999) said, “A goal of any teacher should be to facilitate student’s success. When used judiciously and with students’ varied learning styles in mind, the Web can play an important role in helping professors reach all students” (p. 138).

CONSTRUCTIVIST DESIGN

Additionally, the literature is abounding with articles describing the attitude of students toward computers (Omar, 1992; Price & Winiecki, 1995; Lin & Davidson-Shivers, 1996), and the differences between traditional and web courses (Sloan, 1997; Nyamathi, Chang, Sherman, & Grech, 1989). Often, however, the necessary ingredients for constructivist design are buried deep within the study. This design process should be of paramount importance and should be analyzed by course designers prior to building a course. The belief that quality should not be compromised when a course is delivered online is sagacious. It should at least be equivalent to the traditional teaching methods (Leasure et al., 2000, p. 149). This can only be accomplished if web courses are developed in a systematic and orderly structure, follow rigorous design guidelines (Carr-Chellman & Duchasterl, 2000, p.229), and conform to ideologies that have been used effectively in the past. Leading educators have emphasized several successful design pedagogies that have been effective for online courses (Carlton et al., 1998; Carr-Chellman & Duchastel, 2000; Mioduser, Nachmi, Lahav, & Oren, 2000). Careful examination of these methodologies would be helpful for first time web course designers.

DESIGN METHODOLOGIES

Components

Carr-Chellmand and Duchastel (2000) have developed a set of key components that should be addressed when developing an ideal online course. They state that the most essential element is a good study guide. In essence, “The study guide is the student’s main reference to the content, structure and activities associated with the online course” (p. 233). The study guide suggested is similar to the traditional course syllabus in many ways, but on a higher level of detail. They state that this guide “must include the traditional elements of good instructional design, in particular, a clear description of the instructional aims and learning objectives of the course. These latter are expressed in student learning terms, as opposed to content objectives of the course. These latter are expressed in student learning terms, as opposed to content coverage” (p. 233). These terms must include a level of detail that would enable the student to proceed in the course with minimal elucidation by the instructor.

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The study guide may include a module design arrangement. Tilson, Strickland, DeMarco and Gibson (2001) explain this design. They describe a method called guided inquiry (emphasis added): “In this design, information is provided in modules and presented in varied ways. The function of the modules is not to deliver the content to the students, but to make available all the information needed and the opportunity to put that information together in a meaningful way” (p. 489). An example presented the students with a “virtual patient” audio-visual presentation. The students analyzed this medical scenario, and at the conclusion, they were encouraged to deliver a medical diagnosis. This active learning strategy provided the opportunity to learn by progressing through a series of guided inquiries.

Correspondingly, when developing the content section, scholars suggest that the “primary learning resource” should not be incorporated into the course (Carr-Chellmand & Duchastel, 2000, p. 233). Many amateur online course developers have made this mistake. It is much easier for the student to read from a textbook than to read from the computer monitor. In addition, assignments should be learning experiences in which the student engages to help master the material. The suggestion is that assignments should be centered on a set of student tasks that promote application in real-world settings. As stated by Carr-Chellmand and Duchastel (2000), “An online university course should provide the students with the broad goals that are to be attained, while leaving them with substantial latitude and initiative to pursue their own goals” (p. 234). This is one of the beauties of an online course. Students take responsibility for their own learning.

**MODEL COURSE Pedagogy Demonstrated**

Agarwal and Day, from the University of Central Florida, use an appealing pedagogy when developing a web course. The model they use is called the Learning-by-Objective (LBO) model. This model has been used to enhance course material in traditional classes and also has been used as a model for web-based courses. The students follow a systematic approach while navigating the course. Each chapter in the textbook is broken down to objective-oriented modules. As stated by Agarwal and Day (2000), “The premise behind the LBO model is that students learn best when the information provided to them is contained in small, self-contained modules that allow them the maximum ability to learn hands-on” (p. 207). This is similar to Tilson et al.’s (2001) design, but also includes a multi-faceted approach. Each module has an objective that is completed in the form of a learning outcome. The student prepares for quizzes and tests by reading assignments from the text. The instructor also provides pertinent links to Internet material. This outside material is used to enhance the learning opportunity. The students are then challenged to practice what has been learned. This is done when they solve a problem or apply the information in some way that requires critical thinking and analysis. This is a crucial component of the web design. Self-tests are then administered that enforce the students’ understanding of the material before actual tests and grades are given. This course is available for review: [http://reach.ucf.edu:8900/SCRIPT/eco2023/scripts/serve_home](http://reach.ucf.edu:8900/SCRIPT/eco2023/scripts/serve_home). To log into the course use the username and password of ecoguest. The software used is WebCT, and the pedagogy demonstrated is impressive. This would be a good format to follow for someone new to web course design.

**COMMUNICATION Major Pedagogy**

Course communication is a major area addressed in the literature as first-rate pedagogy. Therefore, this instrument should be included in an ideal online course (Carr-Chellman & Duchastel, 2000, p.229). Using synchronous, asynchronous or e-mail communication systems can accomplish this objective. Consequently, learning proceeds by using chat rooms, discussion forums or standard e-mail. Oftentimes, students can learn as much from each other as they do from the instructor (Carr-Chellman & Duchastel 2000, p. 233). It is the responsibility of the instructor to present information in a format that is understandable, engaging and accessible (Sanders & Morrison-Shetlar, 2001, p. 252). Indeed, this modus operandi supports active learning pedagogy.

In a “most comprehensive” research study performed in the fall of 2000 by Mioduser and colleagues, an analysis is made that summarizes this methodology. Their survey evaluated 436 educational web sites focusing on mathematics, science and technology learning. They identified several disturbing statistics: (a) only 13% of the sites included interaction with other people – synchronous or asynchronous – and feedback features were included in only a small number of sites, (b) 65% of the sites used e-mail as the
sole means of communication, and (c) none of the sites supported working groups or learning communities (p. 61 & 65). This is alarming and demonstrates a need for pedagogical reform.

Academicians have found that collaborative discussion activities enhance learning. This is substantiated in the study performed by Smith et al. (2000). These authors found that 100% of their participants contributed in an online discussion when, between 77% in one section and 82% in another contributed in the traditional classroom discussion (p. 44). This is emblematic because some students are willing to participate in the virtual world, but seem more timid in face-to-face interactions. In this scenario, the learning opportunity for these types of students increases with the online infrastructure.

At this juncture, it is essential to point out that online discussions necessitate commitments by already busy professors. Limiting class enrollment can alleviate this problem. Burnett (2001), an educator, completed an assessment relating to the growth of distance learning or online education in community colleges in the United States. In this study, she quotes Wallace K. Pond, chief of academic affairs at Education America Online – a 20-campus, for-profit virtual university system. “Most online ‘classes’ offered by community colleges and other higher education institutions are limited to 25 students” (p. 5). Indeed, the small class size seems unbelievable, but categorically, is essential for online discussion.

Faculty Involvement In Discussion Groups
When teaching in any environment, the quality of the learning experience is dependent upon the design and presentation method used by the instructor. Furthermore, students seem to learn better when the faculty member is actively engaged in the discussions. This increases interaction between the students and faculty, and the students’ perception of learning increases. Also, the literature suggests the importance of clarifying what is expected in both quantity and quality of the discussion (Sanders & Morrison-Shetlar, 2001, p.252). If this is not stated in the course syllabus, discussion can become shallow and lacking in direction. Hobbs, an author and educator at Idaho State University, is using this technique in his *Introduction to Radiographic Science* class this semester. The requirement is for each student to post at least three meaningful comments in the group discussion. Meaningful is described as something that relates to the course and contributes to the learning process. Students have reacted favorably. Nevertheless, this process is laborious for the instructor. However, even when arduous, “Web-based resources rests with the instructor(s) and (their) ability to provide useful information in a format that is understandable, easily accessible and engaging for students” (Slattery, 1998; Sloan, 1997) (as cited in Sanders & Morrison-Shetlar, 2001, p. 252). Perhaps an interaction with a student may best summarize this paradigm. During a survey of the online course, the student was asked, “What did you like best about this course and/or instructor?” The response was, “The instructor was the best ever. He always answered questions, enhanced learning and helped out whenever he was asked. The class was great. I wish there were more online classes like this” (Personal Communication, November 2, 2001). This comment supports the study performed by Sanders and Morrison-Shetlar (2001), when they emphasize the importance of accessibility of online course instructors (p. 252). This is time consuming but necessary for success.

STUDENTS’ PERCEPTIONS
Suggestions
The University of Oklahoma offers several online courses in its baccalaureate-nursing program. In April of 2000, a report was written in the *Journal of Nursing Education*. The research project consisted of evaluating the differences between a web-based course and a traditional nursing class. Students were given the opportunity to take the course in the traditional format or online. The evaluation instruments were the same for both groups. Leasure et al., (2000) demonstrated that there was no significant difference in examination scores between the two groups on three multiple-choice tests (t=-.96, P= .343), (p. 152). However, more significant to this literature review was the data obtained from the students. It was gathered during the experimental phase. The premise was that students should be able to define, to a certain extent, what they perceived as essential in a good online course. The suggestions are indisputable, and educators should consider their recommendations. The following description written by Leasure et al. (2000) will help educators to understand the issues documented by the students:

“The use of instructional media should support, not impair, the attainment of predetermined learning goals. Students were critical of links to other sites unless they were very clearly associated with one of the unit objectives. Students preferred learning activities developed by course faculty over links to another site. Students’ perception was that learning activities developed by course faculty were likely to be more meaningful and credible and involved less busywork” (p.152).
Students agreed that learning goals should be present in the course and that reliable resources should support these goals. They were critical of course design – which used haphazard links – and emphasized that merely providing links to other sites does not make a course better. Also, they stressed that it was more beneficial when the instructor presented information, himself. However, Leasure et al. (2000) emphasized that perhaps the reason students felt this way was because it allowed them the opportunity to develop a passive relationship with the faculty member in the virtual world (p. 154). This may not have been true had the instructor been actively engaged in the course. Regardless of the reason, educators should be cautious of providing links that do not contribute to the learning methodology of the course.

**FINDINGS OF EMPIRICAL RESEARCH**
The previously mentioned study performed by Mioduser et al. (2000) examined the current pedagogical and technological state of web-based learning. Each of the 436 educational web sites analyzed used a taxonomy that characterized educational web sites by approximately 100 variables in four main dimensions. One of these dimensions, pedagogical and educational considerations, is relevant to this discussion. The authors found that the most frequent cognitive processes in these sites were related to information retrieval and memorizing. They said, “Only a few sites support higher-level processes such as problem solving or creation and invention” (p. 57). Disheartening was the fact that few of these sites included an online adaptive mechanism. This was interpreted as an activity that promotes interactions between members. In addition, this statement was surprising: “Sophisticated navigation tools more suitable to the Web environment (image maps or search engines) appeared in only a relatively small number of sites” (p. 58).

The hypothesis used in this study assumed that these web sites would replicate current learning processes used in the traditional classroom. They expected to find students actively involved in the construction of knowledge and using collaborative learning techniques. Alarming was the statistic that only 28.2% of the sites included inquiry-based activities – teaching strategies utilizing planning, questioning and problem solving techniques – and more than three-quarters of the sites were highly structured, giving the control for learning back to the computer. Mioduser et al. (2000) summarized this disturbing data decisively: “These results conclusively show that the pedagogical approaches favored by educators and researchers for the development of valuable learning environments are still far from being implemented in most educational web sites” (p. 60). In fact, this study has shown that passive instruction in traditional classrooms is now being emulated online. This is daunting.

Furthermore, the majority of the sites evaluated were heavily text based, and 58% of the sites included at least one image per page. Most did not include interactive images, animations or sound. This supports the reality that educational websites lag behind state-of-the-art sites. Perhaps it can be best summarized with this statement: “One step ahead for the technology, two steps back for the pedagogy” (Mioduser et al., 2000, p. 66). Future course development by instructors in all disciplines should take heed of the results found in this study.

**REVIEW PROCESS**
As a final point, a good online course should include in its design process a mechanism for review. In an article titled, Developing Interactive Continuing Education on the Web, Hayes, Huckstataadt and Gibson (2000) discuss a review process that has been successful prior to implementing instructional material on the Web. To assure that their educational material is educationally sound, it is subject to an internal review by a panel of expert reviewers. They rate the content of each module on a Likert scale from poor to very good. Modifications are then made to the content before it is posted on the Web (p. 202). This is sound practice. Pennsylvania State University follows a similar approach. They suggest that the distance education department or a similar department have the responsibility of assuring that all online courses are of high quality (Carr-Chellmand & Duchasel, 2000, p.233). Some educators may be resistant and reluctant to this invasion. Regardless, the ideal pedagogy for online instruction should include some type of ‘review process.’

**CONCLUSION**
Given that web course instructional design should follow good methodological processes that have been used in the traditional classroom, the findings of this review may prove useful for online course developers. When Penn State’s Commonwealth College sought to improve instruction by using active learning techniques, which were supported by CAI, the words of Ann
Deden (1998) materialize. She said in reference to Penn State’s pedagogy:

“The goal has not been to develop online courses. Rather, we seek to improve instruction by offering well-structured, active learning for individual students and teams, to extend group as well as individual learning beyond the classroom hours with asynchronous conferencing, project collaboration, and coaching, and to increase students’ ability to access and critically analyze the human and information resources available on the Internet. Thus, the goal implies not only technology use, but more importantly expanding the faculty’s instructional methods repertoire. (p. 58)”

This approach is commendable. The use of the Internet for educational use is still embryonic, and will develop to its full potential by educational entrepreneurs who are ready to accept the challenge. Course designers should emulate methodologies that have been successfully implemented in the past. Literature reviews substantiate a constructivist design, which includes an exceptional study guide and a syllabus. The applied learning technique must require critical thinking and analysis. Empirical research categorizes an online communication forum as one of the most important (emphasizes added) characteristics of a good course. In addition, several authors emphasize the importance of a good review process. Professors that include these fundamental items will be on the way to developing exceptional online courses. They will begin to construct a teaching format that collaborates the Web, diverse learning styles and active learning pedagogy. When this happens, CAI will flourish.

REFERENCES


