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Internet-based instruction in college teaching

by

Kathleen Flickinger

A dissertation submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

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Major: Education (Curriculum and Instructional Technology)

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ABSTRACT

Distance education and Internet instruction are increasingly being used in college science teaching. In an effort to reach more students, Iowa State University's Human Anatomy and Physiology course was offered via Internet as well as via traditional lecture format. To assess the educational ramifications of this offering, three studies were conducted. In the first study, a collective case study approach was utilized to describe the learning environment created by an Internet-based college science course. In this study, three students were followed as they worked their way through the course. Collective case study methodologies were used to provide a rich description of the learning environment experienced by these students. Motivation, computer savvy, and academic and personal self-confidence appeared to impact the satisfaction level of the students enrolled in the class.

To evaluate the effectiveness of the learning environment offered through the Internet-based science course, a quantitative comparison study was undertaken. In this study a comparison of achievement scores and study habits between students enrolled in the Internet-based class and those enrolled in the traditional section was made. Results from this study indicated that content understanding and retention did not appear to be effected by the type of instruction. Desirable study habits were reportedly used more frequently in the Internet section of the class than in the traditional class.

To complete the description of the Internet course experience, a qualitative examination of Internet instructors' time commitment and level of teaching satisfaction was conducted. Data for this study consisted of interviews and researcher observations. Instructor time-on-task was initially quite high, and remained above the average spent on average face-to-face instruction in subsequent semesters. Additionally the role of the faculty member changed dramatically, causing some lessening of job satisfaction.

Taken as a whole, these three approaches to understanding the phenomenon of Internet science instruction reveal that the experience of learning science on the Internet can be a viable alternative for diverse learners. Students can learn science on-line at an achievement level that is equal to or better than students in a traditional course. Moreover, such courses may stimulate increased student interest in science and on-line learning. The results of this research indicate that Internet- based courses change the nature of instructional tasks.

Instructors spend more time preparing for Internet-based courses than traditional courses; however, the majority of course preparation is associated with technical issues. These technical issues and changes in the nature of instructional tasks will have to be addressed by higher educational institutions.

CHAPTER 1. GENERAL INTRODUCTION

Higher education is moving from telecommunications and audio/video technologies to the more sophisticated and rich arena of the Internet. This move is a complete cultural change from an education based on the campus, the classroom and on teaching in a time-specific way to an education based on the power and dynamic nature of information technology and telecommunications (Connick, 1997). Inherent in this move is the responsibility of the instructor to maintain quality and accountability over the content and the learning experience (Wagner, 1997). In order to do that, some understanding of the effectiveness, efficiency and overall experience of the student in taking an Internet class must be provided.

The overall topics investigated in this dissertation relate to Internet teaching and science instruction via the Internet. Distance teaching is not a new subject, but the use of the Internet as the medium of choice is relatively new. The current body of research includes studies looking at the way that Internet capabilities have been added to instruction without delving into the effects of that use (Brooks, 1997; Chute, Thompson & Hancock, 1999). As a partial answer to this dearth of knowledge, research was undertaken to begin investigations of Internet teaching effectiveness.

The purpose of the research presented in this dissertation was to better understand the phenomenon of Internet instruction at the college level. Toward this end, three studies were conducted and comprise the dissertation research. In the first study, on-line learning experiences were investigated using a case study approach. The second study was a comparison study in which student study habits and achievement in Internet-based instruction were compared with those in traditional instruction. In the third study, an investigation of teaching via the Internet was conducted. The intent of this case study was to better understand instructional factors of Internet-based instruction by gathering data from professors who teach via the Internet.

Dissertation Organization

This dissertation is arranged in five sections associated with each of the research questions. First, a general abstract is presented in which an overview is provided. Next, each research study is presented as a separate paper. Each paper contains a literature review, a statement of the problem, a description of the research methods, the results, and conclusion. The last section, a discussion of the results and implications, is presented. Supporting materials for each study (i.e. surveys, interview questions, etc.) are presented in the appendices.

References

Brooks, B.W. (1997). Web-teaching: A guide to designing interactive teaching for the World Wide Web. New York: Plenum Press.

Chute, A., Thompson, M., & Hancock, B. (1999), The McGraw-Hill handbook of distance learning. New York: McGraw Hill Publisher.

Connick G. P. (1997). Issues and trends to take us into the twenty-first century. In T. E. Cyrs, Fall (Ed.), Teaching and Learning at a Distance: What it Takes to Effectively Design, Deliver, and Evaluate Programs (pp. 7-12). San Francisco: Jossey-Bass Publishers.

Wagner, E. D. (1997). Interactivity: From agents to outcomes. In T. E. Cyrs., Fall (Ed.), Teaching and Learning at a Distance: What it Takes to Effectively Design, Deliver, and Evaluate Programs (pp. 19-26). San Francisco: Jossey-Bass Publishers.

CHAPTER 2. ASSESSMENT OF THE LEARNING ENVIRONMENT EXPERIENCED WHILE TAKING AN INTERNET-BASED COLLEGE SCIENCE COURSE

A paper presented and published in the Proceedings of the 14th Annual Distance Education Conference in Madison, Wisconsin.

Kathleen Flickinger and Dr. Tom Ingebritsen

Abstract

College courses are being offered on-line in a variety of subjects. Iowa State University has offered a series of courses in the general sciences, recently adding Human Anatomy and Physiology to the course offerings. The increase in college on-line courses makes it imperative that educators understand the learning students experience in on-line courses. The purpose of this study was to describe the student experience while taking an on-line science course. Collective case study methods were used to develop a rich thick description of the student experience in the course. Three students were chosen as subjects based on their demographic information. They were closely followed as they completed the on-line Zoology 155: Human Anatomy and Physiology. Data collection instruments included formal interviews, e-mail, phone conversations, journals, and standard course assessment tools (such as quizzes, homework, and exams). These data were analyzed to determine the nature of the experience of the student. All three students were positive at the beginning of the course, and despite difficulties associated with the technology, all three completed the class with a degree of satisfaction. The content retention did not appear to be a problem, but motivation played a large part in student success in the course. Overall, these three students each learned the content and demonstrated interest in the course as well as computer-integrated learning.

Introduction and Literature Review

Since the inception of formal education, technological advances have sparked debate over their influence on educational design. Interesting parallels can be made between the current debates surrounding computer-enhanced education and debates voiced over the use of such new technologies as paper instead of slate in the classrooms (Fuhrmann & Grasha, 1994). Similar debates arose with the advent of disposable pens; it was thought that "ballpoint pens will be the ruin of education in our country. Students use these devices and then throw them away. The American values of thrift and frugality are being discarded" (Urban & Wagoner, 1996, p. 47).

The literature is replete with debates and discussions centering on the use of technology in instruction (Clark, 1995). Unfortunately, most of this research has centered on the theoretical value of technology or the instructional design enhancements and deprivations of that technology (Jonassen, 1996). Little attention has been paid to the student and the specific learning environment created by and through the use of technology (Jonassen, 1996; Brooks, 1997).

Learning Environment

In the present study, the learning environment is defined as the situation surrounding the student's individual process of acquiring knowledge. The learning environment is created by the instructional design and by the surroundings of the student and the place of instruction (Fraser, 1994). The learning environment is important to the process of learning, as it sets the tone for the assimilation and accommodation of new information (Atwater, 1994; Fraser, 1994; Kahle & Meece, 1994).

Sheila Tobias (1990) found the learning environment to be a major deterrent in attracting and retaining students in the sciences. Her work entitled <u>They're not dumb, they're different</u> specifically addresses this issue. In the conclusion, Tobias (1990) notes that students who felt intimidated by the learning environment did not perceive the content as interesting or worthy of further pursuit as those who were not intimidated by the environment. In those instances where the instructor made changes in the class structure to accommodate those students who initially demonstrated an interest in science but were fearful of the learning

environment, the response was far greater. Retention in the sciences was increased for females and other second tier pupils when the environment was taken into account (Tobias, 1990).

Tobias is not alone in noting the importance of the learning environment to interest and retention in sciences (Brooks, 1997; Papert, 1993; Phye, 1997). In discussing learning and remembering, Phye (1997) argues the importance of the relationship between the learner and the classroom. He defines classroom learning (as opposed to unstructured learning outside the bounds of formal education) as a relatively permanent change in behavior occurring as the result of an affordance. The term affordance refers to the reciprocal relationship between a student and his or her environment (Gibson, 1994). The environment provides opportunities for the learner. It is up to the learner to either take advantage of these opportunities or let them pass. In classroom learning, the environment can include the student working alone, in a group, with a teacher or with technology. In any case, the learner is responsible for providing an action system that takes advantage of what the environment offers (Phye, 1997).

In the book, The Children's Machine, Semour Papert discussed the learning environment. Papert (1993) suggests that learning is facilitated when connectivity in the learning environment is improved. Papert laments the loss of a visual, experiential connection between the lessons learned and the learning environment. The relative inaccessibility of modern machinery, as opposed to older technologies that could be fixed on a regular basis with household gadgets and ingenuity, causes a rift in students' learning environments. This rift allows students to understand a concept well enough to pass the course, but not well enough to explain it to others. Papert (1993) argues that the computer, in and of itself, generates a feeling of positive learning regardless of the actual instructional design followed during its use. Thus the use of the computer in the classroom may encourage students and increase their motivation for learning.

Motivation and Technology in the Classroom

Motivational factors are another area of interest to those studying technology in the classroom. Cognitive motivational theory implies that the intrinsically motivated learner will

perform at a higher level than others not so motivated (Forsyth & McMillan, 1981). Listing six ways to stimulate intrinsic motivation with instructional design, Forsyth and McMillan (1981) provide strategies for creating potentially effective courses with or without technology. These strategies include: introducing topics in an interesting way, challenging students with the level of material presented and expected from them, focusing on higher order outcomes, modeling enthusiasm for the content, and returning responsibility for the learning to the student rather than retaining responsibility as the instructor. Using these strategies when creating technology-based courses may improve student performance by increasing intrinsic motivation. These strategies also create a friendlier environment for learning, as defined by Tobias (1990).

It is well known that students' judge their ability to succeed in a particular situation based on past performances in similar settings (Tollman, 1955). Moving from traditional teaching methods to Internet-based instruction creates a new learning environment, that may allow students to move beyond past science. In the book Web Teaching, David Brooks (1997) discusses extensively student motivation. Brooks argues that self-motivated students perform best in technology-based learning environments. "My sense is that those students who are poor at self-regulation easily can be 'slaughtered' in WWW-based courses." (Brooks, 1997, p. 32). Brooks bases much of his beliefs about motivation on the research of Pintrich (1995). Equating effective learning with the ability to self-regulate, Pintrich (1995) notes "self-regulation involves the active, goal-directed, self-control of behavior, motivation and cognition for academic tasks by the individual student."(page 64). Pintrich (1995) defines self-regulation as a way of approaching academic tasks that is learned through experience and self-reflection. The learning environment plays a subtle role in motivation – without adequate structure, the self-regulated learner is left with poor educational experiences and therefore little on which to reflect (Pintrich, 1995).

Computer-mediated Learning and Distance Education

Much press has been devoted to technology in the classrooms and its relationship to distance or distributed education. Terms such as computer- based education (CBE), computer aided instruction (CAI) , and microlabs are prevalent in science education literature

(Kulik and Kulik, 1986; Wise, 1988; Freidler, Nachmias, & Linn, 1990; Berger, Lu, Belzer and Voss, 1994). Studies have shown that computer-based instruction and computer-aided instruction have merit and can in fact the learning of some students (Berger et. al., 1994; Lui, 1996; Barker, 1998). In recent years, the use of computer-mediated communication has increased in education, especially in colleges and universities (Barker, 1999). This move toward computer-based distance education is aimed at enhancing student autonomy and responsibility, extending learning beyond the classroom, and creating active learning circumstances (McComb, 1994).

The communication developments that impact education include low-cost personal computers, global information access virtually anywhere, software programs that allow easy creation of Internet-based courses, and 24-hour help lines. The educational experience created by these technologies, both at a distance and locally, has increasingly become more supportive with each new technological development. The technology provides a learning environment where the science student is carefully guided through work on complex, meaningful and authentic tasks (Lui, 1996). Within computer-mediated learning environments, students are able to participate in a community of learners composed of instructors, experts, and other students. This provides a lively, realistic culture where the content is seen as intrinsically motivating, and the distance education experience seems far less isolating than traditional classrooms (Hawkins, 1991). Studies of the impact of computer-mediated technologies are beginning to appear in the literature. Bates (1997) notes that the new technologies now allow for a powerful combination of highly interactive stand-alone material with two-way asynchronous communication between teachers and students. There is appears to be a relationship between the type of technology used and the type of learning outcomes achieved, but still little hard evidence that these outcomes are actually achieved. Finally, Johnstone (1991) suggested that earning at a distance may have positive implications for students and teachers. Distance learning may result in positive attitudes among students, higher levels of communication between schools and districts, greater levels of parental involvement in courses, and the ability of teachers and students to use new technologies in an educational setting (Johnstone, 1991).

In spite of its achievements and promises, the efficacy of distance learning is not yet as well-established nor as well-evaluated as traditional education (Hochner, 1996). Thus far, there is still no clear, irrefutable quantitative evidence of the superiority of educational uses of information technology (Gilbert, 1995). However, on a small scale, interactive learning environments have resulted in effective distance learning (Martens, Valcke, Portier, Weges and Poelmans, 1997). Researchers at the Open have conducted initial studies on the effects of computerized instruction in descriptive statistics, continuous mathematics and substantive criminal law. In a comparison between those students enrolled in these classes at a distance (via computers) and those enrolled through traditional (printed) modes, Martens et al., (1997) reported that students' found the interactive learning environment suitable for their studies.

Early in the development of distance education, Christopher Dede (1991) examined the characteristics of successful communications channels between learners and content. He concluded the wider the bandwidth of a communications medium, the more immediate and rich the learning experience can be. Additionally, Dede (1991) noted that the greater the interactivity of the medium, the more learning can be motivated, individualized and optimized. Dede (1991) listed three fundamental characteristics of technology-mediated interactive learning essential for creating a successful learning environment. Dede stated that a technological medium must either interpose between direct person-to-person interaction or create a shared environment that shapes the process of interpersonal communication; the technology should provide tools and experiences that enhance the collective learning of the people involved as well as their individual accomplishment; and the participants' interaction should be spontaneous and actively engaging their cognitive systems.

Research Problem

Although the research in distance education clearly describes the technological factors an the instructional strategies necessary for creating effective learning environments, few studies describe the experience of the student who learns in distance education environments. Specifically, few researchers have investigated how the technology effects the students' perception of the content, the students' willingness, within the environment, to learn the content or how the technology impacts student interest in the subject.

The on-going debate between Richard Clark, Robert Kosma and others may shed light on the student's experience in distance education. Reiser (1995) argued that because certain media allow for a broader range of instructional methods, it is the media and the methods together that are responsible for the learning. In the present study, I examine the joint impact of the medium and the methods by studying the student experience in learning science concepts via the Internet.

The media/methods debate, with its underlying implications for the learning environment and learner motivation, has immediate relevance for the present study. In this study, an introductory-level science course was taught via the world wide web (WWW). The WWW-version of the course was based upon the traditionally taught course and was designed in a similar manner. That is, the traditional lectures and course materials were recorded and made available via the WWW. All lecture material, assessment and communication was conducted electronically, providing the students freedom to learn at their own pace with constant access to both the wealth of information available on-line and instructor assistance through e-mail correspondence.

Guiding Research Question

The goal of this study is to better understand the learning environment perceived by the students enrolled in an Internet-based science course. Toward that end, the research was guided by the question: What does the student experience as he or she works through a semester-long college-level science course taught entirely on-line?

Zoology 155:Human Anatomy and Physiology

To investigate the phenomenon of Internet instruction, a first-level science course at Iowa State University was examined. Human Anatomy and Physiology is a three credit, single–section course taught via lecture to more than 500 students who enroll each semester. Traditionally it is taught on campus in one large section that meets three times a week for 50 minutes. Because of the large number of students enrolled, the instructor attempts to heighten student motivation through question and answer periods, student-participation in

demonstrations, and attendance points. There are no laboratory exercises associated with this course, although a companion laboratory class may be taken during the same semester.

Assessment is based on student performance on three or four exams, one comprehensive final exam, and three to seven homework assignments and/or quizzes throughout the term. The class is taken by students from all colleges and majors in the university. It is required for a degree in Psychology or Food and Nutrition, is used to fulfill requirements for coaching certifications and has been added as a requirement for entry into the Veterinary program. Additionally, the course has a popular following and is taken by many students simply to complete their general science requirements prior to graduation.

An Internet offering of Zoology 155 was prepared in summer 1997. The Internet version follows the protocol created through ProjectBIO, an externally funded project for the development of on-line science courses. The ProjectBIO protocol allows instructors to teach college courses entirely on-line, with no need for face-to-face interaction. Each course in ProjectBIO, including Human Anatomy and Physiology, includes a series of lectures with pages of text and visuals that appear in the same manner as they do in the traditional lecture. An audio stream accompanies the lectures, following as closely as possible to the audio given during traditional instruction. All lectures, exams, quizzes and homework assignments can be created and made available to the student the first week of classes.

For Zoology 155, 32 lectures and corresponding materials were prepared. The homework assignments, quizzes and examinations were available to the students at the beginning of the 1997 Fall semester. The links that were given to the students in the Internet-based course were in the form of additional Internet-based resources. The web addresses for these links were presented at the end of the lectures on the last slide of each talk. Clicking on the link itself would move the student from the course material to a new site on the Internet, related to the material just covered in the class. The students who enrolled in the WWW section of Zoology 155 received the class in a manner to which they were accustomed. That is, the students were accustomed to lectures with visuals and supporting materials, periodic examinations over lectures and textbook materials and few homework assignments. The on-line section of Zoology 155 was designed in this manner. The only difference between the

on-line and traditional sections of Zoology 155 was that in the on-line version, the instructor was not physically present as the lecture was delivered.

Methods

The outcome of this study is to provide a rich, thick description of the student experience taking a science course via the Internet. A qualitative approach is warranted, as the resultant information is descriptive and non-generalizable (Bogdan & Biklen, 1982). This research paradigm is largely an investigative process where the researcher gradually makes sense of a social phenomenon by contrasting, comparing, replicating, cataloguing and classifying the object of study (Miles & Huberman, 1984). Qualitative research is the preferred method used to provide insight into the participants' views, beliefs, feelings and actions as they engage in the Internet-based course. Through this qualitative study, I am looking to gain an "in-depth understanding of the situation and its meaning for those involved" (Merriam, 1988, p. 23). Narrative text has been the most frequent form of data display for qualitative research and will also be used in this study (Miles & Huberman, 1984). I have chosen thick description as the vehicle for depicting a holistic, detailed picture of the learning environment. Additionally, quotes from the informants' are presented to illustrate the research findings. Due to the multiple realities that exist in a given situation, qualitative research must faithfully and accurately report phenomenon (Creswell, 1994). A different view of each situation will exist for those involved. The phenomenon will not be identical for the researcher, those individuals being investigated, or the reader interpreting the study. The qualitative researcher, therefore, needs to report faithfully these realities and rely on the voices and interpretations of the informants (Creswell, 1994). Qualitative methodologies were undertaken in this study to identify themes as they emerged from an in-depth understanding and interpretation of a single event. In this case, the event studied was the experience of taking an Internet-based science course. According to Glesne and Peshkin (1992), the qualitative paradigm most closely answers the needs of this particular study.

The particular investigative procedure within the qualitative research paradigm was that of case study. The case study is not a methodological choice, but a choice of object to be studied (Stake, 1994). Each case is specific, a bounded system which is interesting to the

researcher for its uniqueness as well as its relation to the whole. The choice of case is made because it is expected to advance our understanding of the larger interest (Stake, 1994). "For the most part, the cases of interest in education and social service are people and programs. Each one is similar to other persons and programs in many ways and unique in many ways. We are interested in them for both their uniqueness and commonality" (Stake, 1995). Stake (1995) sorts case studies into two categories: intrinsic study and instrumental study. In an intrinsic study, the researcher is interested in the case just to learn about that particular case. Instrumental case study is a case study where the researcher intends to use the information to understand something larger than the case itself, an issue or theory. The researcher may study a number of cases jointly to inquire into the phenomenon, population or general condition. Stake refers to this as a collective case study (1994). To gain a full understanding of the learning environment created by Internet instruction, more than one case was examined. The present research can be defined as an instrumental, collective case study. It is believed that understanding the individual cases will lead to a better understanding of a larger collection of cases. (i.e. the larger group of students involved in Internet education.) Also, it is hoped that by understanding the three cases investigated, a common learning experience will be elucidated.

Participants

Three students were chosen as subjects to be followed as they worked their way through the Internet offering of Zoology 155. As a basis for choosing these students, demographics on past enrollment in Zoology 155 were analyzed. From this analysis of three semesters of student demographics, it was determined that the typical student in the traditional Zoology 155 is a female of sophomore standing with a GPA of 2.7. She is an Iowa native graduating from high school in the 68th percentile and currently enrolled in the College of Liberal Arts and Sciences.

In choosing the three subjects from the Internet section of the course for this study, one was chosen to match the demographics of a typical Zoology 155 student. Demographic information on the students enrolled in the Internet-based section of Zoology 155 was obtained from the Registrar's office. One of the students enrolled in the Internet section

matched the description of the typical Zoology 155 student, and she was asked to participate in the study.

A second student was chosen as a representative of the non-traditional student population as defined by the Iowa State University student handbook. According to the handbook, a non-traditional student is defined as a student who has enrolled in college years after high school graduation. Usually this student has joined the work force and is returning to college to improve socio-economic status, or to increase personal education. In the Internet-based section, there was a total of eight students classified as non-traditional. From this population, a second participant was chosen based on the researcher's impressions of each after initial electronic contact. The student chosen responded to the first assignment in a timely and humorous fashion, indicating a willingness to become involved in the research.

The third student selected for participation in the study was chosen from the University – defined at-risk population. According to the Iowa State University Handbook, an at-risk student is one whose academic standing may be jeopardized by lack of prior knowledge, poor basic educational training, or lack of experience with the American educational system. The Internet-based section of Zoology 155 had 2 such students as identified at the start of the semester. Because one at-risk student dropped Zoology 155 in the first week of the semester, the remaining student was asked to participate in the study.

All of the students enrolled in the Internet-based section (N = 47) were notified of this study, its goals and their role in the research. Consent to study the three participants, as well as the remaining students, was obtained during the first two weeks of the semester via student-signed informed consent form. A copy of this form appears in the appendix.

Data Collection

Data collection techniques used in this study included interviews, informal on-line conversations, open-ended phone conversations, journals and e-mail correspondence. Additional information was gathered using the standard assessment tools of Zoology 155, including homework and exam scores and participation points for joining in discussions and chat sessions. These many avenues of data collection were employed to reduce the likelihood of misinterpretation and to include redundancy in the findings (Denzin,1989;

Goetz & LeCompte, 1984). These multiple methods of data collection allowed for triangulation of findings to ensure validity of the conclusions (Stake, 1994).

Due to the fluid nature of instrumental collective case study research, a flexible design was used. As data were obtained and analyzed, the direction of the research shifted (Marshall & Rossman, 1989). This is not uncommon in qualitative research. The entire process was inductive, rather than deductive (Lincoln & Guba, 1985).

Throughout the study, member checks, as defined by Merriam (1988) were used to ensure that valid conclusions were drawn. Furthermore the data and interpretations included were given to the participants and their feedback was solicited. Specifically, each of the subjects reviewed their case, made changes as they saw fit and discussed the findings with the researcher. In this way, misrepresentation or misinterpretation of the data was avoided.

Data Analysis

Data analysis in a case study is the search for meaning (Stake, 1995). Creswell (1994) pointed out that "data analysis requires that the researcher be comfortable with developing categories and making comparisons and contrasts. It also requires that the researcher be open to possibilities and see contrary or alternative explanations for the findings". Analysis of data in this study utilized both direct interpretation and categorical aggregation methods as defined by Stake (1995). In direct interpretation, the researcher concentrates on the instance, trying to take it apart and put it back together again more meaningfully. Categorical aggregation refers to collecting and grouping instances until something can be said about them as a class. This study attempts to understand individual instances of behavior, issues, and contexts in the case, while at the same time looking for patterns and themes. These themes were expected to emerge from aggregating consistencies from the data, generating categories, and comparing and contrasting these categories.

The data analysis was carried out in three steps. First ,the data were read in general to gain an understanding of what was occurring. As information accumulated, it was initially read and placed in a folder indicating from which subject the data was gathered. As more data were obtained, the folders were individually opened and the data read again, this time looking for patterns or themes. When themes did emerge, the topic was recorded on the data

sheet, and the participant's file was restructured in light of the new categories. This reading and re-shuffling of pieces of information continued throughout the research period. At the end of the semester, the data were again read and a thick description of each case was outlined using the categories and themes identified throughout the semester. As a final step, the researcher-prepared descriptions were read once more so as to develop final themes which were organized into broader concepts. Throughout the study, member checks, as defined by Merriam (1988) were used to ensure that valid conclusions were drawn. Furthermore the data and interpretations included were given to the participants and their feedback was solicited. Specifically, each of the subjects reviewed their case, made changes as they saw fit and discussed the findings with the researcher. In this way, misrepresentation or misinterpretation of the data was avoided.

In this particular study, reliability was not considered a problem. The purpose of this study was not to produce a generalized answer to a hypothesis. The study was not designed to be replicated, as each case analyzed will unfold in slightly different ways. This again is an inherent characteristic of qualitative research (Merriam, 1988).

To ensure external validity in this study, three primary strategies were employed. First, the report provides a rich, thick description of the context of each case, the rational behind choosing the individual subjects, and the researcher's personal biases (LeCompte & Goetz, 1984). In reporting each situation, the students' quotes were used and a detailed narrative description of the case was provided. Second, triangulation of data was conducted through multiple methods of data collection. Triangulation is considered the process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation (Merriam, 1988). It allows the researcher to identify different ways in which the phenomenon is seen (Flick, 1992). Effective use of triangulated data increases external validity as well as reliability. Third, to ensure external validity, outside experts in the fields of qualitative research and science education were asked to scrutinize the data and the findings of this study.

Study Limitations: Researcher Bias

A major limitation of qualitative research is the use of the researcher as the data-gathering tool (Guba & Lincoln, 1989). "It is the researcher who will decide what is included and what is irrelevant to the telling of the story. ... More will be pursued than was volunteered. Less will be reported than was learned" (Stake, 1994). Criteria for selecting content are many, including any guidelines set by the funding agency, prospective readers, the researcher's career pattern, and the prospect of publication (Van Maanen, 1988). In pursuing the case study approach, my personal biases and career path have been introduced into the data gathering and analysis of this material. As noted physicist Stephen Hawking cautions, all research can suffer from lack of objectivity (1988). "Analytical measurements can be a case of knowing the results they want to get, not an uncommon occurrence in science" (Hawkins, 1988, p. 32). For this reason, I will provide a brief description of my attitudes and beliefs coming into this study. The reader can then view the work and conclusions in light of my biases.

In thinking about this study, I had some expectations as to what I would find. It was my belief that the students in the Internet course would not enjoy nor understand the material as well as those in the traditional section. Having taught the traditional section of Zoology 155 for seven years, I believed that I had a large experiential base from which to gauge the attitudinal changes in the Internet students. Consistent with what I observed in the traditional section, I expected to see a noticeable shift from the usual "this is fun, but really hard" attitude to an attitude that reflected the difficulty of the subject without the fun.

When teaching in lecture settings, I try to present a positive enthusiastic demeanor. I feel this carries over into the material I am presenting, making the lecture/presentation more bearable. When I created the Internet class, I was unsure how well this enthusiasm would carry over the computer. I did not edit my audio stream when the "lectures" were created, as I do not edit my lectures in the traditional setting. The students who listened to the WWW lectures received a typical lecture presentation, complete with mis-spoken words, hesitations, side tracks and laughter. Although I tried to incorporate active learning requirements into these Internet lectures, I again was unsure of the effect of these attempts. In total, I offered the Human Anatomy and Physiology course over the Internet with trepidation. I felt this was

an excellent attempt to reach students unable to attend lectures, but was wary of its effects on the students' learning environment and educational experience. Similar to David Brooks (1997), I rely heavily on face-to-face contact with my students in lectures. I place great emphasis on learning names and using student examples in my discussions. How could I possibly teach without this interaction? What would the students experience as they waded through the course? In short, what had I created?

Both personally and professionally, I needed to know the answers to these questions. Having been trained as a scientist and having worked at bench research for almost 8 years before entering the teaching profession, I was hesitant to begin a qualitative research program. After much deliberation, I chose the collective case study approach as the method most suitable for the research problem. I had no prior experience at this type of research, as all my previous experiments and papers were quantitative. As is obvious, this research was undertaken to assuage my own curiosity as well as to advance the field of Curriculum and Instructional Technology.

Study Limitations Due to Qualitative Approach and Technology Comfort and Access

There are other limitations to this study that are not inherent in qualitative studies in general. In this particular instance, the researcher was also the instructor for the course. This may have affected the responses of the students as they answered interview questions and dealt with me as both their instructor and a researcher interested in their approach to the course. Although all three participants indicated this was not a concern, it is a limitation of the study.

An additional concern in this study was student experience with technology. Zoology 155 was the first Internet-based course two of the three participants had taken. Their expectations for the course, and any trepidation, excitement or latent fear of technology they may have experienced would be difficult to separate from the learning environment created by the class. To better understand how experience with technology impacted their Zoology 155 experience, the student's comfort level in using the Internet was discussed at the beginning and at the end of the semester. The student's access to the technology may also have been a limiting factor. If the technology was not convenient to the student, attitude

toward the course may have been negatively affected. Two of the three students followed in this case study used computers outside their private homes. This variable may have created for these students some tension not related to the learning environment created by the class itself. Again interview questions and informal conversations were used in an attempt to clarify this limitation.

Theoretical Base

The theoretical base on which this research is founded is phenomenology. I am interested in providing a rich, thick description of the individual experience or the lived experience of the phenomenon of taking an Internet course. Phenomenology attempts to answer the question "how does the thing in question present itself?". Using this base, the research becomes less interested in the social and structural focus and more concerned with the situation of the individual (Martusewics & Reynolds, 1994). As previously mentioned, qualitative research is an unfolding, inductive process. While conducting this research, other theoretical approaches began to play a role. Feminist, critical, adoption / diffusion and constructivist theories all played a part in understanding the experience of the student in learning science via the Internet.

Feminist theory is a blanket term for many different types of research. The unifying concept in this theory is its interest in understanding and improving the lives of women (Martusewicz & Reynolds, 1994). In this study, two of the participants were women, and their individual experiences exhibited common threads. Critical theory addresses the processes and practices, policies and structures in society that cause oppression or inequalities in the educational arena (Martusewicz & Reynolds, 1994). Identifying where the power lies in each social situation, and how that power and control shifts as roles and information changes within situations are central to critical theory. One of the goals of the critical theorist is to empower the student to indentify oppression, and work for change in the causative social, political and economic structure (Freire, 1970). In this study, critical theory elements were indicated as the participants worked through the Zoology 155 course monitoring their own progress and maintaining control of their learning.

Adoption/diffusion theory deals specifically with the movement of technology into a community (Rogers, 1986). Both the integration of the technology into local educational practices and the adoption of this technology by the community are addressed by adoption / diffusion theory. The current study deals with technology adoption and diffusion at the college level.

The final theoretical base that was found to be important to understanding the phenomenon of student learning via the Internet was constructivist theory. According to Pressley and McCormick (1995), constructivism deals with the way in which people construct their own cognition through interactions between biological endowment and the environment. In efforts to better understand how the technology effects student construction of knowledge and how students take advantage of the relative freedom in the Internet environment to create meaning, constructivist theories were relied upon.

Results

Note:

In reporting the results, the actual data collection tool will be noted when appropriate. Formal interviews were conducted with each student three times during the semester they completed the Internet course. These will be referenced I1, I2, or I3. E-mail will be referenced along with the date of the transmission, for example E-6/3 refers to e-mail received June 3. Phone calls and journal entries will be referenced in a similar manner, using the prefixes P and J respectively. Exam scores, homework assignments and other pieces of information will be explained on an individual basis.

Case 1 "Judy"

The first case presented is "Judy". She was chosen because she matched the demographics of a typical student enrolled in the traditional section of Zoology 155. Judy is a native Iowan and a sophomore in the College of Liberal Arts and Sciences. At the start of the semester, she had a grade point average of 2.8. She is a psychology major, and Zoology 155 is required for completion of her degree. Her career goals include becoming a mental health therapist or a counselor. She was looking into Hotel/Restaurant Management as a

second major. When I approached her and asked if she would be willing to participate in the study, she was enthusiastic. "I'd be very happy to help you.... I'll start keeping my journal as of today.... Hope to hear from you soon" (E-8/26). "I am excited to help you in anyway [sic]. Hope to hear from you again soon ... Feel free to call me at either place if I am not home. As for the computer, that's great too. I get on-line almost everyday. So, you can leave me an e-mail and I should return the message promptly ... Talk to you soon" (E-8/27).

Judy is a personable, chatty 19-year old with short, reddish hair and a slight build. She wears comfortable clothing, usually coming to our meetings in baggy jeans, loose T-shirts or flannel shirts and silver jewelry. She waves her hands when speaking, looks off to the side and giggles or rolls her eyes often when talking. She relaxes into her chair immediately upon sitting, and straightens up only when emphasizing points. For the most part, Judy appears unsure of her interests and abilities, and appears to lack confidence. Admittedly, she is "beginning to appreciate herself and her worth" (I1) She is a middle child, with a "perfect" older sister and a brother four years younger than her (I1). She describes her brother as "in trouble a lot", but speaks of him with obvious affection (I1, I2). She has low self esteem, as evidenced by both her constant reference to her smarter, prettier, thinner sister and by her admission of dealing with an eating disorder. "I'm the short, fat, normal one in the family" (I1). "I guess I'm smart – at graduation I got to wear the yellow sash". Then Judy quickly pointed out that her sister had two more, denoting she was really smart (I1). She constantly refers to her weight, and mentions feeling "fat if [she] doesn't walk every day" (I1). She stated that she gained 70 pounds in her freshman year and is still working to loose that weight. She proudly mentioned her weight loss on several occasions during the semester (I2, E – 11/14).

Her social life is fairly stable; Judy had been dating the same young man for many years, and just recently got engaged. She had been living with her fiancé, but moved back to her parent's house for the Fall semester. She is employed at a local restaurant, putting in 30 hours per week. The reason she is enrolled in the Internet section of Zoology 155 was because of her schedule. She had no other classes Monday, Wednesday and Friday until 1 pm. "It's not convenient or fun to come to campus at 9am and sit around all morning" (I1).

Judy's science background is not strong. She completed Biology 109, an introductory Biology class prior to enrolling in Zoology 155. Her computing skills also are weak, as she has had no formal training in computer use. Judy has a Gateway 2000 at home and taught herself what she knows of Internet surfing (I1). When asked about her overall feelings toward science, Judy first laughed then said "I don't like Chemistry. I'm pretty good at Biology and Earth Sciences. (pause) Science is an ordeal for me – I have an English bend" (I1).

The beginning of the class was not easy for Judy. In an e-mail response to my asking if she would be willing to serve as one of my case studies, she replied "Yes, I would be happy to help. I was the red head who had problems accessing the Web class from home" (E – 8/26). In her first journal entry, she wrote "Today was a disaster! It took me an hour to figure out how to register on ClassNet. Talk about vague directions. Anyway – I finally did it and managed to figure out how to respond to the discussion topic. I think that's way cool. It was fun to talk about myself and read about others" (J 8/26). She began her study of Zoology 155 immediately and submitted the first homework August 27.

Again, Judy had some difficulties. "I recently submitted my homework assignments 1 & 2, but the ClassNet says that I earned no points for those assignments. I'm thinking I did something wrong when I submitted them because [sic] I know I couldn't have gotten no points for either. Can you explain [sic] this to me? I thought they may not have been graded yet, but when I click on the answer icon under homework it brings up my answer and says 0/79. Did I really miss all the points or did I do something wrong? Please try to respond. Also, if I messed up when I entered them, is there any way I can go in and fix them?" (E – 8/27). Her insecurity with the technology persisted throughout the course. "I am totally freaking out and hope it can be fixed. I hope I didn't screw it all up. I hate this ClassNet thing right now! I really do!" (J – 8/28).

After this rocky beginning, Judy appeared to calm down a bit. By September 3, she "got in and out [of the class] without any major problems (J – 9/3). September 10 brought a new problem with viewing lectures for Judy. "I tried to see lecture 6 – damn computer wouldn't let me – it's lucky I didn't break it! So I moved on to lectures 7, 8, and 9, which it allowed – You figure it out – I even tried 6 again later – but it still hated me – damn modern

technology!!!" (J – 9/10). Judy's lack of confidence in her ability to use the technology was evident with the problem with lecture 6, even as it resolved itself. "Finally – lecture 6 is mine! I have no idea what I was doing wrong" (J – 9/12). Judy did nothing wrong. The error was due to a server problem. For Judy, the technology continued to be an underlying source of frustration, although it did not appear to impact her performance in the course. She sent numerous e-mails and left phone messages about her grade and my receipt of her homework assignments. Even at the end of the semester, Judy had trouble relying on the computer to get her submissions to me. "I'm curious why my grades didn't appear on the grade list. If you could, would you e-mail me my scores so that I can check then with my total. Thanks!" (E – 12/17). "Just wondering if you could explain why the grading for exam three is all goofy. Could you let me know exactly how many I missed. I keep track of this stuff. Thanks" (E – 12/9). Again, there was nothing wrong with the grading. Judy was not getting to the proper screen in the grading program. At the last formal interview, I asked Judy what the most difficult portion of the class was for her. She responded "The computer itself. Once I got used to it, it was OK" (I3).

Judy began to have trouble with the course content at the time of the first exam. "Trying to review a little since I haven't touched my Zool for almost 2 weeks ..." (J – 9/24). She had some confusion about how exams were to be taken, and dropped out of contact for a while. "You probably thought I was dead? Well, I'm not! Life's just been really busy lately so I haven't had a chance to drop you a line. I feel really out of control right now ... Anyway, we have to come to your office to take the exam? Is that right? Boy, I better get to studying that stuff" (E – 9/25).

Judy began to postpone her exams beyond the time frame I recommended for the class. "Also, is it possible for me to take the exam on October 6th. I know that is the last day it is up on the web but can I take it that night between 3 pm – 6 pm. I've got so much happening this week – I don't think I will find enough time to study until this weekend. If this is possible, please get back to me soon, Have a smiley day!" (E – 9/30). I called Judy October 1, and we talked about her taking the exam from her home, using her boyfriend as a proctor. He is a trustworthy student, and promised to maintain the integrity of the exam for

me. Judy was very appreciative of the extra time, "Thank you again for letting me take the exam this way. It takes a lot of stress off me. You're the greatest!" (E – 10/1).

At the second interview (10/21), part of Judy's reluctance to take the exam was revealed. "I am slightly dyslexic. I get nervous with numbers. Questions need to be clear. Short little questions are best. I was nervous before I started [exam 1]. Thought the content would be hard. The computer medium was OK" (I2). Her grade on that exam was 53 out of 60, far better than the average of 45. She admitted surprise at her score, and seemed to relax more as she continued the class. Her reaction to the score was typical of Judy. "I didn't do nearly as well on the exam as I thought I would. I studied for days and still didn't ace it" (E – 10/20).

With the sliding of the time on the first exam, Judy began a pattern of sliding. By the second formal interview, she had not viewed any lectures since taking the first exam, noting "Other classes come first" (I2). When asked if she took advantage of the links to other web sites, she said "If I have time. I like to go around the links, play around and see cool stuff" (I2). In contrast to her behavior, Judy indicated that the freedom of time as her favorite aspect of this class. The freedom was actually hurting her study habits. When asked what she liked most about the lectures, she said "freedom of time ... 3:00 am lectures. The class doesn't screw up my schedule" (I2).

Even though Judy was not keeping up with the suggested syllabus, homework assignments #2 and #3 were turned in on time. These were case studies, in which the students were asked to diagnose patients and answer specific questions posed at the end of each medical history. The case study assignments seemed to motivate Judy. "I love this case study stuff! It is like detective work. I just wanted to make sure I was doing it correctly. You should receive my next one tonight" (E – 10/30). Each time she submitted a case, she raved about the fun she had working on it. These were the only e-mails from Judy that included content questions. She asked me to define "precordial" once, and asked for an explanation of a clinical test on another occasion.

Judy was able to take the second exam on November 6, just one week after I suggested it be done. Her grade was 54 out of 60, but she did not send me any complaints about her performance. She did recommend that I include more pictures in the lectures

covered in the second exam. "Also, the lectures on the web need more pictures, I think. I find it hard to look at the notes, book and computer all at the same time. Another thing, the lecture notes were hard for me to follow this time" (E – 11/11). When asked how I should improve the lectures, she said, "Don't know. I just sort of think the lectures are out there. A moving cartoon might help. I spend most time listening and writing, not looking at the screen. I look up at the end of the audio stream to see if the overheads make sense" (I2). This behavior was confirmed in observations of Judy as she "attended class" on two separate occasions. The concept Judy felt was most difficult through the entire course came from the lectures covered in the second exam. "Muscles – part I couldn't understand at all. Way too detailed. The only thing was, I didn't learn it at all. I blew it off – that calcium and potassium thing" (I2). I was surprised that she did not send me an e-mail question on the topic. She appeared to ignore this topic. After she took the exam covering muscle contraction, she did e-mail and ask for clarification of the exam questions that covered the topic.

In December, Judy's family suffered a loss, and she took some time from school to deal with it. She sent me a chatty e-mail 12/1 letting me know what was going on "Just to let you know what was going on in case I don't write to you for a while. ... To better days!" (E – 12/1). This trouble led to Judy's taking both exam 3 and the final back to back on December 8. She received 59 out of 60 on the third exam and an 88% on the final.

Although Judy finished the class on schedule, she felt rushed to get it done by semester's end. Judy felt the class was "good". The content was OK and the format was easy for me 'cause I'm on campus a lot. I did better than I thought. The web affected my grade positively. It allowed 2:00 am access to the lectures. It helped a lot to be flexible. I used the lectures more than once – that helped a lot" (I3). Judy's final grade in Zoology 155 was an "A". She performed well on homework assignments and participated in class discussions. "I am surprised by my grade. I'm more average – B's. I have gotten A's but it's not usual. I got one A, three Bs and an uncharacteristic D in psych" (I3).

In the last meeting with Judy, we discussed her impressions of the class and what she learned. Judy said she would take another class over the Internet, as long as it was organized in the same way as Zoology 155. She completed a meteorology class during the same

semester as Zoology 155 that had an Internet component, but didn't feel that was a good experience at all. Judy noted "I'm sure I learned a lot about computing, but I can't think of any specifics. I have a higher general comfort level now. I'll try stuff!" (I3). She also talked at length about what she learned about her own learning style. "I learn better at night – I suck in the morning.. I learn better not in the presence of other students, but I do have to be told what to do. I can't do it without being told. I like to struggle on my own. .I hate it when I have to work with others. I don't mind people being there, but I don't want to talk to them unless I want to" (I3). Judy saw herself as highly motivated to study. "I read books all the time. I read when I have free time, and study whenever I get the chance. I make flashcards. Probably I read in my sleep!" (I3). She lists liking to learn as her motivation for studying. "I'm not very good at science or math, but I like to read about it" (I3). She also mentioned her sister again as a motivational push. "She's a 4.0" (I3).

Judy was a good communicator throughout the semester. Even when she was not participating in the lectures, she sent me e-mail to see how I was doing. "Kathleen – are you doing well? I haven't heard from you in a while. I was just wondering if you were all right?" (E – 11/6). Judy depended on those communications with me much more than in a regular class. "I don't e-mail other professors. I got to know you better through e-mail. I was forced to talk. It was not easy to talk and share ideas with classmates. I tried once in the beginning and no one answered" (I3).

In her final course evaluation, Judy noted the class was interesting, the content was explained well, and the format was not a deterrent. She went so far as to recommend the Internet section of this class to a friend. This friend is learning-impaired, and Judy felt the Internet section would be a good choice for her. Judy had indicated that she felt web classes work best for the organized student. "You have to be organized to get the class done. There are no real deadlines except for exams. If you are not motivated, it won't work. You have to schedule it in. I think being able to listen to the lectures over and over is helpful too. Those students who need it can use the lectures over and over" (I3). In light of these comments, I was pleased to see her sending her friend to see me about joining the class next semester.

Case 2 "Mitch"

Mitch was selected as a representative of the non-traditional student population. At the time of this study, Mitch was a 52-year old senior in the Bachelor of Liberal Sciences program, College of Liberal Arts and Sciences hoping to graduate in December. His grade point average was 3.7, but he graduated from high school in the lower half of his class. Mitch is the oldest of five children, with two brothers and two sisters. He has a 30-year old son, and is a grandfather to three. Mitch holds a full-time job as an Ames policeman, taking classes on nights and weekends to finish his degree. Because he works from 7 a.m. to 3 p.m., he is unable to enroll in most classes on campus. Mitch needed Zoology 155 to complete his science requirements for graduation. He had no prior science background, noting in his journal "This is a tough part because it has been so long since I have done anything with cells and DNA. When I was in high school, DNA was the basic function of life, but I sure don't recall anything about splicing" (J – 9/7).

Mitch had been exposed to computers in his police training. "I am trained in computer removal. That means I can take these computers out of this room without loosing the information stored on them. I know how to look for programs that will eat up the information on the drive if I turn off the computer, that sort of thing" (I1). Mitch did take a class in programming from Des Moines Area Community College. There he learned to write programs. Mitch's future plans are to continue his education and obtain a Master's in Liberal Studies. He hopes to join his wife teaching in a community college setting at a later date. The Internet section of Zoology 155 appeared to meet Mitch's needs: a college science course that he could take around his work schedule. At the time of this class, he needed only six science credits to graduate, and this class fulfilled three.

Like Judy, Mitch had a positive outlook on life. Each time we met, he was friendly and full of smiles. He is approximately 5' 10", and is slightly on the heavy side. While not physically tall, Mitch carried himself with confidence. Mitch is a gregarious man, quick to smile and quite comfortable with himself. He is a realist, admitting his limitations and also his strengths without hesitation. Mitch has a military haircut, and seems to fit the grandfather stereotype in appearance. He has gray-brown hair and a round face with smile lines earned from years of good humor. Perhaps due to his maturity, Mitch was always very courteous

when we talked. He felt uncomfortable calling me by my first name, and was careful to pull out a chair for me at the start of each interview. Mitch took pride in his appearance, dressing in nice pants and button down shirts most of the time. I ran across him once on campus wearing a t-shirt and shorts. He stopped to say hi and apologized for his clothing. Always punctual, Mitch would stand up when I entered the room for our interviews, and sit in the center of the chair as we talked. He did not appear uncomfortable, but also did not slouch. He remained formal in his communications with me when we were talking face to face. His e-mails and journal communications were less formal, and more revealing of the true student. Mitch typed his journal for me, and presented it in a binder like a term paper. His police training, as well as his maturity, made Mitch an interesting case.

I chose Mitch initially for two reasons: he was a non-traditional student, and he had an obvious sense of humor. In his first e-mail, I liked his response to the general request sent to the entire class "Tell me who you are and why you are in this section." His e-mail read "Hi. I am a non-traditional student. I am a senior in the BLS program. My wife sent me back to school so she can have control of the TV remote for a while" (E – 8/28). In the request to join the study I sent him, I addressed the message using his complete first name as it appeared on my class roster. His response was "First off it is [Mitch], only my wife and mother call me [Mitchell] and that is when they are mad at me and really want to get my attention. I would be glad to help out in the case studies you are doing – sounds fun" (E – 8/28).

Our first meeting was on September 3. I had to laugh when he told me he was "not shy". That was obvious in the initial e-mail! Mitch's police training was evident in his approach to this course. He was excited to begin this "challenge" (I1). He had no feelings of trepidation, nor a lack of confidence as he began the class. "I am looking forward to this course because not only will I find it challenging, but working my way around the web promises to prove challenging" (E – 8/28). He was most interested in seeing if he could get into the course, and was looking forward to following the links through the Internet (I1).

When asked about his feelings toward science, he replied "neutral. I don't have any preconceived notions of this. It will have to show me what it is" (I1). Unlike Judy, Mitch used a home computer exclusively for course access. He did not express any technology

fear, nor did he ever mention the technology in a negative light. His journal was positively devoid of negative comments about the technology. Even when he discovered he was not keeping up with the class as he thought, the technology was not blamed. "Sat down to do a lecture on the web and was checking the notes. I figured I was one class behind and realized that I was several lectures behind. So I will be putting in extra time on this class this weekend.. It is lucky I have been taking night courses and those classes consist of three and one half hour lectures so getting caught up will not be as hard for me as someone that is only used to doing 50 minute lectures" (J – 9/20). After discovering his error, Mitch continued to listen to three lectures at a time, consistent with his night classes.

Not only did Mitch enjoy the challenge of computer-driven lectures, he also displayed extreme confidence in the computer system. He never once questioned his submission of assignments. In his journal he noted "I have gotten the second assignment completed" (J – 9/20). This was the only time he even mentioned homework submissions. Of all the students I had enrolled in the Fall semester Internet section of Zoology 155, Mitch is the only one who asked me content questions. Before the course had gotten underway for most students, I received an e-mail from Mitch requesting a better definition of two terms mentioned in the first homework assignment. He did not ask me to give the definitions to him, rather "Can you give me an idea where to find these prefixes so I can figure out the meanings?" (E – 8/28). On September 22, he asked a long, in-depth content question over e-mail.

Mitch's biggest problem throughout the semester remained content. He felt the learning was going well (I2), but his background was "stale" (I3). Throughout the semester, Mitch lamented his lack of science background. "The most difficult topic to date has been general chemistry – atoms, molecules. I understood the sliding filament theory and nerve impulse transmission much better" (I2). "My problem with the class was that my background was stale. Some of the things I had in high school and even my 100 level biology course was only theory then and not the real thing like splitting genes, DNA and cloning" (J – 12/3). This difficulty with the content expressed itself in Mitch's studying and his exam scores. His journal records many hours of studying, listening to lectures again and again and spending many nights on Zoology. "September 29 and 30 – studied both nights for Zoology. October 1 – I spent the whole night and into the morning studying for the test" (J –

9/29, 9/30, 10/1). "November 2 finished reading the information covered on the test. November 3 – began making my note page for the exam on Friday. November 4 – worked on notes for the final and re-read some of the text and studied for the final. November 6 – I worked on notes and studied about 4 hours" (J 11/2, 11/3, 11/4, 11/6).

When we met for our second and third interviews, Mitch asked me content questions at the end of the interview. He noted he almost felt like that was cheating since none of the other students had that opportunity, but nonetheless he needed the help! (I2, I3). Unfortunately, this studying did not pay off for Mitch as he had hoped. "I took the Zoology test and all I can say is that is didn't go as well as I wished. Looks like as if I didn't study the right things and the things I did I couldn't remember. I think once we get past the atoms, cells, chemistry and into other things I plan for it to go a lot better" (J – 10/2). "Went in to ClassNet and found out that I flunked my first ever college test. While I guess that no one can say I had any help with it while I was taking the test and that I have only one way to go and that is up" (J – 10/8). "Well, you have the honor of writing the first test I flagged in college. Funny thing, after I looked at the answers it didn't even appear to be hard... even with the test score I still think this is a neat way to take a college course" (E – 10/9).

His frustration over his lack of basic knowledge was evident in his communications throughout the semester. "You have to remember that I still call the part of my elbow the crazy bone when I bump it knowing full well it is a nerve. Of course if the answers show up in the test that might make it awful easy. Now that might be my kind of test, however I still probably would find it difficult. Ttfn." (E – 9/22). "I did change one of my electives to a pass/no pass so I can spend more time on Zoology 155. Can't let your case study bomb out can I. Hopefully we will be away from the parts that I have trouble bringing back to the old LTM from 30+ from high school and 20+ from DMACC. I really do study..." (E – 10/14).

Mitch took his exams in his boss' office after hours. He felt it was necessary to tell me when he was taking the exams, just so we both were aware of his progress in the class. "Kathleen – I have arranged to flunk (hope I'm kidding) my second exam on Friday November 7 at 9:30" (E – 11/6). "Hi, hope you are having trouble with the grading of the test scores otherwise I will need to have you send me the new password for next semester" (E – 12/9). Even at the close of the semester, Mitch felt that his grade was affected not by the

computer technology, but rather by the "science technology – I just didn't know enough" (I3). His final grade was a reflection of this as well. "This was not an average grade for me – too low. I had no background. I'm older and so were my bio classes." (I3).

Just like Judy, Mitch enjoyed the case study homework assignments. In his case, I believe they boosted his confidence in his knowledge. "These are real fun to work out" (E – 10/30). "Could you check my work on those first cases – I am not sure I am right. The answers came from my life, not a text. If I am, that's great" (P – 11/2).

Throughout the course, Mitch was enthused about the technology. He began with great interest to challenge himself on the computer as well as with the content. He found the links to be interesting and helpful. "They are not tangents. It helps to see pictures and movement" (I2). He emphatically noted that the medium did "not at all affect my grade. I could go back and repeat lectures and study before tests. This was a good thing" (I3). He repeatedly noted that he was liking the class at the end of communications, even after failing an exam. "Even with the test score, I still think this is a neat way to take a college class" (E – 10/14). "This is going to be the way University classes are going. I'm glad I got the chance to experience it now" (I2).

Mitch actually felt that this class would have been harder for him "in the front row of lecture" (I3). When we discussed his knowledge of computers and his level of comfort with the Internet, he noted he was "getting there. I used it to a limited extent before. It may have helped to have one face-to-face meeting to go through the technical stuff. I didn't have trouble, but can see how others might. The Internet was a new experience" (I3).

Mitch did learn about himself through the class. "This is a totally personal experience. I was hesitant at first – motivation? This was the first course where you got down and studied. I had my mind made up. It takes a lot of people to change my mind. I was comfortable without classmates. The course is set up to get help if you need it" (I3). Although I did not sense his leaning on me as much as other students in the Internet section, Mitch admitted to being "quite reliant on the instructor. I re-listened to lectures, sent you lots of mail. I never felt out of touch" (I3). Mitch did note that motivation was a big factor in passing the class. He expressed concern for the average college student. "They can get lost easily. I got lost at first, then caught up. This is a benefit as well. You can get a week ahead

if you want" (I3). "Older students can get information off the web that they need. Younger students are used to computers and can get onto it easily. Self motivation may be a problem" (I2).

Although Mitch did not do as well as he hoped, he did better than the average student. He ended the semester with a B- and a positive attitude toward both the technology and the course content. When asked if he thought he learned the content, he replied "Yes, yes, yes! I don't know a lot, but I do know more than I did" (I3). Mitch has continued his correspondence with me via e-mail, and has purchased a newer, faster computer. "Just wanted to thank you for an interesting course and wish you well. Now that I took the computer course I thought it was time that I up grade my equipment so bought a new computer, so if you find something interesting on the I-net let me know. Thanks again" (E – 1 / 2).

Case 3 "Sara"

Sara was the last subject to agree to take part in this study. She was a senior when she enrolled in Zoology 155, with a 3.0 GPA. Her grade point average had dipped slightly in the past semester from a 3.5 due to "senioritis" (I1). Sara is a native of Bombay, India, and she speaks both Hindi and English fluently. She graduated from high school in the 50th percentile, and immediately enrolled at Iowa State University as a Business/Theater double major. Due to her low high school rank and her use of English as a second language, Sara was an at-risk student as Iowa State University. Sara describes herself as a "non-exceptional student who was on every school team she could" (I1). Her main interests in high school were sports and cultures. She did enjoy science in high school but did not take it in college. "I was afraid it would be too hard" (I1). She indicated that her parents turned her from science toward the family business. "I love chemistry, but I am not into physics too much" (I1). Both of Sara's parents attended college, and her family is quite well off. Her father went to the University of North Carolina at Chapel Hill and received two undergraduate degrees. Her mother didn't finish college and refers to herself as a domestic engineer/interior decorator. Sara has a half-brother and a younger brother. She speaks of her younger brother in glowing terms – "the best, really good" (I1).

Sara often discusses her American family as well as her true family. Her American family is her immediate support while she is in the US. They live in Iowa, come to her functions at ISU, and help with her day to day decisions. Sara lives off campus but not far from campus. She walks to class most days, and works on campus 10 hours each week. "I do skip more classes than I should" (P – 11/6). She is employed in the ISU Theater Department, where she helps to organize a story-telling conference. Her bachelor's degree will be in transportation logistics, but she has no idea what she wants to do after graduation. Her family is in the textile business, and Sara knows there are jobs available to her in that area. Zoology 155 will fulfill part of the science requirements for Sara's major. Without this class, she will not graduate on time. Sara's course load is remarkably heavy this semester. She is taking six classes other than Zoology. That is the reason this web section appealed to her. Her schedule is tight. Sara's prior science knowledge is limited; she had taken AP biology "at home" (I1) and Biology 109 her first semester at ISU. Her formal computer training was through Computer Science 207 at ISU.

I first became acquainted with Sara over the telephone. She called me at the start of the semester to beg for help getting her computer to work. I felt badly for her, as she was almost in tears over the technology. "Initially I was really excited about this class – a little nervous but when I logged on that was really smooth. Did the first homework, that was easy! Could it be that easy? Next day – went to lecture – no sound. Why? I tried everything – frustrated. Called Professor. She walked me through the process. STILL NO SOUND. I am frustrated. A friend said maybe you need a sound card" (J – 8/29).

Although Sara's accent is not terribly heavy, it was difficult to understand her through her frustration. She did not have the proper computer configuration for the class, so needed to purchase a sound card. The first card she purchased was defective. Again, I received a phone call from her, and she was very distraught. "I was ready to quit the class. Really upset. Made me feel stupid" (J – 9/2). This loss of enthusiasm plagued Sara throughout the course. "I was excited to begin. The freedom excites me. I can do it at 3:00 am if I want. This is the height of customer service. The best thing college can do for you. I'm not trying to keep up with you. At the same time it is scary. Am I doing this right or wrong? There is a loss of the personal touch" (I1). Sara had sent in her first homework, then got confused as

to how to interpret her score. "My scores came back with a zero. I was ready to give up" (J – 8/31). Sara sent me an e-mail requesting help with the interpretation of her first homework. In the response to that e-mail, I asked her if she would be the third case in my research. She was initially hesitant, but agreed. I think she was hoping I would be able to give her more attention through the research.

When Sara and I met face to face, I was initially struck by her beauty. She has long, thick brown hair, bronze skin and incredibly green eyes. She smiles a lot and is very physical. Immediately upon entering my office, she shook my hand and gave me a hug for helping her get started. As Sara talked, she maintained eye contact and presented a confident air. She is quick to laughter, and skilled at conversation. Each time we met, we spent much longer than anticipated together. She is at ease with others and immediately treated me as a friend. Sara asked my opinion on her choice of majors, her schedule, and her job interviews. "Well, on a happier note I have my first interview on the 8th of October for a job after I graduate. Can you believe someone may actually hire me? Ha ha ha!" (E – 10/1). I found her engaging and entertaining.

Unfortunately, I was not able to help her overcome her fear of the technology. On September 8 , I received both a phone message and an e-mail. "You cannot believe my excitement as I write you this e-mail at 11:16 p.m. I made it!! Finally!! I hear your voice echoing in my bedroom and all I could do was jump for joy. My boyfriend's sound card works. I had to share my joy with someone ... Take care" (E – 9/8). After this initial success, Sara felt much better. "This process toughens me up a lot" (J – 9/9).

Sara still had trouble with the technology. "Working really well except for the pictures. The real audio program takes forever to load, but it works. I really like the idea of a WWW class. I am in my PJ's listening to lecture. This is luxury" (J – 9/18). "I still haven't figured out how to get pictures without them looking deformed" (E – 9/22).

Sara's inability to get the technology under control again surfaced in late September. "This weekend has been incredibly frustrating with this class. Every time I log onto the lectures the real audio doesn't let me connect and says there is a network error. Then at about 7:15 pm Sunday night I tried to get on the ClassNet. It says there is a 500 server error. What am I doing wrong? HELP" (E – 9/23). "9/23 – server was down – this is getting annoying"

(J – 9/23). I forwarded Sara's e-mail description of her problem on to our technical assistant. He sent an e-mail back to her explaining how the Internet traffic gets pretty congested at times. His suggestion was to try to connect at various times throughout the day. Sara was using America On-Line as her carrier. There are some troubles with the volume of traffic on those lines. I did not hear from Sara for a few days after this, then she sent me another e-mail. "This class is driving me crazy. A couple of days in a row it says the server is down and my real audio had been uninstalled by some weird god .... I really don't know what to do. I am at my wits [sic] end trying to reload real audio. I went into frequently asked questions Q&A but I had NO luck ... please help me ... please...October 6 is good" (E – 9/29).

Eventually, Sara decided the problem was with her computer, and she took it to the "computer doctor" October 2 (E – 10/1). Her computer was fixed by the sixth, and she was back on-line with me. "My computer is back ... you must think I am completely incapable. I have lost all the email you sent me ... the good news is that the lectures work. It was a problem with the way I had the real player set up ... so keep your fingers crossed it should work. Thanks for your patience. PS I got another interview!!" (E – 10/6).

With these computer troubles in Zoology 155, Sara quickly lost confidence in what she was doing. She asked me to send out messages telling her where she should be in the lectures (I2). By October 7, she was only at lecture 5. Despite all the technology troubles, Sara felt "the material is well covered and systematic. The notes help. I rewind and go back a lot. The learning is going well" (I2). Not surprisingly, Sara asked to move the first exam back. We agreed she needed more time for that exam due to the troubles she had getting started. With some extra time, Sara began to listen to the lectures on a regular basis. She found time "in between school and work. I use it as background talk in my apartment. It is a technical subject with lots of words to remember" (I2).

Perhaps due to her rocky start in the course, Sara had difficulty feeling that she was really learning. "I do one lecture over and over again. I am not confident. There is no immediate feedback. I feel like I am groping. Anxiety – am I really learning? This is not a factor in normal classes" (I2). "I have lost confidence doing [the class] this way" (P – 10/8). Unlike Mitch, Sara does not follow any of the links. "Not productive. Once I did that and

the computer froze up and I got lost in the web. I'll never do it again" (I2). This anxiety shows up in all Sara's suggestions for improving the course. She told me she was afraid of the technology – "Afraid of what's going on. I thought I knew a lot before I started. I have learned a lot about computers. I think the lectures would be better if at the end of the lectures there was a self-quiz. Five questions to reassure that you are learning. The answers could be at the beginning of the next lecture" (I2).

As if to make this course even harder for her, Sara contracted chicken pox in October. She remained bedridden for three weeks then tried to return to classes. With her tremendous course load and the initial technical difficulties in Zoology 155, I was not surprised when she asked for an incomplete. On October 28, I received a call where she stated "I'm behind in everything. What can I do? I feel overwhelmed. I have been listening to the lectures. That is all that I can do these days. Can I take exam 1 and exam 2 at the same time?" (P – 10/28). After a brief discussion, we both decided that her best option was to take an incomplete and finish the course over winter break. This would not hinder her graduation, as she was planning to graduate spring 1998.

I did not hear from Sara again until January 7, 1998. "Dear Kathleen – I am alive and have finally gotten my new computer set up and ready to go. I would like to touch base with you before I start. So that I know I am on the right track" (E – 1/7). "I need to set some specific goals with you for Zoology so that I get the class done" (E – 1/8). We met January 9 and decided she should go through the lectures and take the exams as quickly as she felt she could. We also agreed to maintain frequent e-mail communication. She began sending her journal entries to me via e-mail.

Similar to her attitude in August, Sara began with a positive attitude. "Yesterday was the first day on the class with my new computer – it works well. I feel a lot more confident this time around for some strange reason. I know what I am doing (or at least I think I am). All the same anticipations are not there. I may actually like this Internet stuff" (J – 1/13). Her feelings of confidence did not last long. "The real audio server is down. Can you believe that. It hasn't worked all day today. Am I doing something wrong. This class is worse than PMS. At least with PMS you have a time frame here you never know what is nest. This is rough. Sorry to yell at you Kathleen" (J – 1/16).

Sara's first exam score was not good; she received 36 out of 60. I realized she would not be happy with the score, and may in fact drop the class. I sent her an e-mail with some encouragement, but got back "this is a horrible grade I am disgusted!!!!" (E – 1/22). The semester progressed without any forward movement on Sara's part. On February 12, she contacted me with "I am buried ... sunk in work. Yes I need to set a date for my next exam. I got a letter from the graduation evaluator's office saying that U had to have the class finished by the 6th of March in order to graduate in May. Therefore I am in panic mode" (E – 2/12).

Sara was not entirely defeated by this however. On the 13th of February I got a joke from her through e-mail. I phoned Sara later that day, and we discussed some options for getting her through the material without increasing her stress level. Eventually she opted for taking the last two exams on paper with bubble sheets, and reading the text and notes without the computer. I waived her homework assignments, as they required Internet discussions. Perhaps that was not the wisest move, as other students seemed to like those assignments, but I was more concerned that Sara get through the class and feel productive. My goals for her in Zoology 155 may have been achieved. "I really did learn a lot. I learned by looking stuff up. It was amazing how little I knew about the female reproductive system ... but now I know more ... Thank you" (E – 3/3).

In her final interview, Sara said "I would have done a lot better in a regular classroom. I wouldn't have gotten the I" (I3). She said "I'm impressed with what I know now about the Internet. Reload button, search engine, I can find stuff" (I3). Sara was not impressed with the use of technology as the only means of transmitting the class. She felt it was unreliable and difficult. "I think I learn better in groups. Maybe if I had been more comfortable with the subject, this would have gone better" (I3). She was not comfortable learning without classmates. "I thought I didn't need them, but I do. I had no idea what I was getting into. It was an experience ... I learned a lot from it" (I3). Sara was nervous not to have regular contact with the instructor. "I want to know I am learning the right thing. Friends in the traditional lecture thought the course was simple and they got more out of it – more personal interaction would have helped me" (I3). "The stuff is really interesting. I enjoyed it, but felt I was dealing more with the technology .. will it work?" (I3). Sara

completed the class feeling that she could have learned more in a traditional setting. She recognized that she lost interest in the subject not due to the material itself, but due to her troubles with the technology.

In an interesting twist, Sara felt that the course was good in that it required the students to mature and take charge of their own learning. "This class makes you grow up – no hand holding. It is like work. This is what you need to get done and there you go" (I2). Her biggest complaint was that the class lacked structure. "This class should have as much structure as a regular class. Sign on every day at a specified time – set up chat sessions. Send us check lists of what should be done every week" (E – 10/21). I was happy to see Sara graduate, but felt that her experience in Zoology 155 was not good. Unfortunately, her attitude toward science was less than positive to begin with. I feel I did her a disservice through this course.

Discussion

While generalizations were not the goal of this research, there are some themes that deserve attention. As mentioned in the methods section, several theories helped in the analysis of the students' experience.

In Judy's case, I found her distrust of the technology to be of paramount importance. Feminist theory in science education has received much attention, and there is a great deal of information on female attitudes toward science and technology. (Mullis & Jenkins, 1998; Nelson, Weiss, & Capper,1990). According to the 1986 National Science Foundation study, girls are more likely than boys to complete biology courses, but shy away from engineering and computer courses.

The environment created by this computer-based Zoology course seemed hostile to Judy. She had a difficult time overcoming her distrust of the medium. This same negative effect was seen in Sara's case. She did not enjoy the course at all and felt that was due entirely to the technology.

Both Sara and Judy had past success in science, and Sara went so far as to say she enjoyed the subject in high school. Another aspect of Feminist theory in science examines the social cultural variables that affect females. Sara's case is a textbook example of this. As

she moved into higher education, her family pushed her toward the family business and away from the sciences. She mentioned her stereotyping of the sciences as a masculine endeavor. This is well documented in the literature (Kahle, 1986). Martel and Peterat (1994) examined situations such as this in their research on margins of exclusion and transformation.

It was interesting to note that technology was not a barrier for the male in this study. Mitch did not complain about the difficulties associated with the technology, nor did he blame his performance in the class on technology. For him, it was a challenge rather than an obstacle. Judy also had mentioned her embarrassment over having the computers talk to her in a crowded study room (J – 9/29). This again can be examined in a feminist light. Mitch took his exams in his boss' office, and viewed lectures at work as well. He was more concerned with the inconvenience to his co-workers than with the embarrassment of having the computer talk to him. While Judy and Sara had different experiences with this class, some of the similarities of their experiences have been studied through feminist works.

The social aspects of these students' lives affected their performance in the class, and their perception of the learning environment. Sara felt "overwhelmed" (P – 10/28) after being ill, and Judy became very "stressed" (E – 11/15) when dealing with family troubles. These external variables altered both students' attitude toward learning and the technology. In both cases, this was a negative shift. I believe part of their frustration came from the conflict between what they originally expected from the class and the actual situation. At the start of the class, all three students were excited by the freedom it imparted. They were looking forward to setting their own schedules and studying when they wanted. As they moved through the class, it became apparent to them that there was a shift in assumed power from having autonomous control over their learning to my having the ultimate control again, similar to a regular class.

The dissonance caused by the shift from feeling that they were in control of their learning to realizing they held no more control than in normally presented classes was latent at the beginning of the class, becoming evident only toward the end of the semester. The end of the semester brought a sudden end to their freedom to study and learn the material at their leisure.

Critical theorists deal with power struggles and the associated effects on learning. There is definitely an aspect of this in all three cases studied. The students realized at the end of the semester that their feelings of control went only so far as regulating their study times within the bounds set by the semester and the University policies on completing courses in a timely manner. Also, the relationship between the learning environment and the social structure in which the learning occurs is of interest to critical theorists. All three students discussed their individual learning styles as they perceived them after completing this class. Sara was surprised by her dependence on others. Judy and Mitch both found affirmation in their ability to work independently.

I found Rogers Adoption/Diffusion theory (1986) to be helpful in analyzing the effects of this class on the learning environment created. In Mitch's case, the technology was adopted openly and enthusiastically. He reached immediately for the content, and worked well within the technological parameters. Mitch had adopted the technology and spent time showing others in his family and at his workplace the "neat way he was learning Zoology" (I3). He is what Rogers would call an early adopter, and worked toward assisting in the diffusion of the technology.

Judy's experience was not quite as positive, but she also adopted the technology with little question. She was not happy with her performance, therefore did not move toward diffusion of the technology with as much enthusiasm as Mitch. Judy did send a friend to talk to me about taking the course in the Spring semester.

Rogers (1986) discussed extensively anticipated and unanticipated effects of communication technologies. In this study, the participants experience anticipated and unanticipated effects of technology. As anticipated by the students and the researcher, all three students learned the course content at a satisfactory level and passed the course. Their attitude shifts toward computers and technology, as well as the insight they gained into their own learning processes were unanticipated results.

Constructivist theory describes the process of incorporating new knowledge into the students' existing knowledge base. In Mitch's case, it is evident that his prior science knowledge was limited. He did not have the schema needed to assimilate and accommodate the course content. An important component of the Internet-based Zoology 155 course were

the Internet links to related information. This type of instruction was exploited by Mitch who lacked the necessary prior knowledge. The Internet enables the efficient design of branched, non-linear instruction that can be molded to fit individual student needs. "If you can anticipate confusion and/or misconceptions, then you can create a trail of clicks that lead to a Web-based conclusion" (Brooks, 1997, p. 140).

The three case studies provide a look into the experience of the student while taking an Internet-based science course. Although each case was different, common themes did emerge. Keeping in mind that these themes are limited to the present study, it is interesting to summarize the findings. These include:

1. The technology was problematic for some, in this case for females. Students' confidence in and proficiency with the technology were important factors that contributed towards positive experiences in the Web class.
2. Instructor availability was important to all students regardless of their level of comfort with the technology.
3. Attitude towards the subject did not appear to be effected by the technology. In fact, students who scored low on exams still rated the class as "excellent" or "better than most".
4. Enthusiasm was high at the outset of the semester, and with instructor nurturing can be maintained throughout the term.
5. Motivation appeared to be the single most important factor related to student success in an Internet-based science course. Both internally and externally motivated students perform well.

The intent of the present study was to better understand the experiences of students who complete Internet-based science courses. In traditional, face to face teaching, representation of the content and self-representation is a tangible portion of the teaching routine. In creating an Internet-based class, that immediate tangible effect is lost. As Elizabeth Elsworth (1994) noted instruction is an act of interpretation. As such, teachers and students are active participants in the re-creation of knowledge. Removing the immediate contact between the teacher and students causes the contact between the spoken and written work to be removed. Thus, the learning environment becomes much more dependent on the

curriculum and the act of interpretation must be carried through the technology, and if done correctly distance learning produces learning that lasts, any time, any place (Barker, 1998).

As technology continues to impact education, issues of learning environment, motivation, and curriculum design will require serious thought. Hopefully this research will help shape the questions that need to be answered to effectively design and implement distance learning environments.

References

Atwater, M. M. (1994). Research on Cultural Diversity in the Classroom. In D.Gable (Ed.), Handbook of research on science teaching and learning (pp. 558 – 576). New York: McMillan Publishing Company.

Barker, T. B. (1998). Developing courseware for distance learning – any place, any time. 14th Annual Conference on Distance Teaching and Learning Proceedings (pp. 33-39).

Barker, P. (1999). Electronic course delivery, virtual universities and lifelong learning. Educational Technology Review (Spring/Summer), 14 – 18.

Bates, A.W. (1997). The impact of technological change on open and distance learning. Distance Education – An International Journal, 18(1), 47-54.

Berger, C.F, Lu, C.R., Belzer, S.J., & Voss, B. (1994). Research on the uses of technology in science education. In D.Gable (Ed), Handbook of research on science teaching and learning (pp. 466-490). New York: McMillan Publishing Company.

Bogdan, R.C. & Biklen, S.K. (1982). Qualitative research for education: An introduction to theory and methods. Boston: Allyn and Bacon.

Brooks, B.W. (1997). Web-teaching: A guide to designing interactive teaching for the World Wide Web. New York: Plenum Press.

Chute, A., Thompson, M., & Hancock, B. (1999), The McGraw-Hill handbook of distance learning. New York: McGraw Hill Publisher.

Clark, R.E. (1995). Media will never influence learning. Educational Technology Research and Development, 42(2) 21-29.

Clark, R.E. (1995). Media and Method. Educational Technology Research and Development, 42(3) 7-10.

Connick G. P. (1997). Issues and trends to take us into the twenty-first century. In T. E. Cyrs, Fall (Ed.), Teaching and Learning at a Distance: What it Takes to Effectively Design, Deliver, and Evaluate Programs (pp. 7-12). San Francisco: Jossey-Bass Publishers.

Creswell, J.W. (1994). Research design: Qualitative and quantitative approaches. Thousand Oaks, CA: Sage Publications.

Dede, C.J. (1991). Emerging Technologies: Impacts on distance learning. The annals of the American Academy of Political and Social Science, 514, 146-158.

Denzin, N.K. (1989). The research act, third edition. Englewood Cliffs, NJ: Prentice Hall.

Elsworth, E. (1994). Representation, self representation and the meanings of difference: Questions for educators. In Martusewicz and Reynolds (Eds.), Inside out: Contemporary critical perspectives in education (pp. 151-166). New York: St. Martin's Press.

Flick, U. (1992). Triangulation revisited: Strategy of validation or alternative? Journal for the Theory of Social Behavior, 22, 175-198.

Forsyth, D.R. & McMillan, J.H. (1981). Attributions, affect and expectations: A test of Weiner's three dimensional model. Journal of Educational Psychology, 73, 393-401.

Fraser, B. J. (1994). Research on classroom and school climate. In D.Gable (Ed.), Handbook of research on science teaching and learning (pp. 493-541). New York: McMillan Publishing Company.

Freidler, Y., Nachmias, R. & Linn, M.C. (1990). Learning scientific reasoning skills in microcomputer-based laboratories. Journal of Research in Science Teaching, 27(2) 173-191.

Freire, P. (1970). Pedagogy of the oppressed. New York: Continuum publishing company.

Fuhrmann, B. S., & Grasha, A. F. (1994). The past, present and future in college teaching: where does your teaching fit? In K. Feldman, & M. Paulsen Ashe Reader series (Eds.), Teaching and Learning in the College Classroom (pp. 5-20). Needham Heights, MA: Ginn Press.

Gibson, E.J. (1994). Has psychology a future? Psychological Science, 5, 69-76.

Gilbert, S. (1995). Why distance education? [Online] Available E-mail: aahesgit@list.cren.net. In Lui, D. Teaching Chemistry on the Internet.

Glesne, C & Peshkin, A. (1992). Becoming qualitative researchers. White Plains, NY: Longman.

Goetz, J.P. & LeCompte, M.D. (1984). Ethnography and qualitative design in educational research. New York: Academic Press.

Guba, E.G. & Lincoln, Y.S. (1989). Fourth generation evaluation. Newbury Park, CA: Sage Publications.

Hawkings, Stephen. (1988). A brief history of time: From the big bang to black holes. New York: Bantam Books.

Hawkins, J. (1991). Technology-mediated communities for learning: Designs and consequences. The annals of the American Academy of Political and Social Science, 514, 159-175.

Hochner, A. (1996). 2 of 2 distance education, AFT faculty role dialog [Online]. Available E-mail: aahesgit@list.cren.net. In Lui, D. Teaching Chemistry on the Internet.

Huberman, A.M and Miles, M.B. (1984). Innovation up close: How school improvement works. New York: Plenum.

Johnstone, S.M. 1991. Research on telecommunicated learning: Past, present and future. The annals of American Academy of Political and Social Science, 514, 49-57.

Jonassen, D. H. (1996). Handbook of Research for Educational Communications and Technology. Association for Educational Communications and Technology. New York: MacMillan Press.

Kahle, J.B. (1986). Retention of girls in science: case studies of secondary teachers. In J.B.Kahle (Ed.), Women in Science: A report from the field (pp. 264-267). Philadelphia: Farmer.

Kahle, J. B. & Meece, J. (1994). Research on Gender Issues in the Classroom. In D.Gable (Ed.), Handbook of research on science teaching and learning (pp. 542-557). New York: McMillan Publishing Company.

Kulik, C.L. & Kulik, J.A. (1986). Effectiveness of computer based education in college. AEDS Journal, 19, 81-108.

Lincoln, Y.S. & Guba, E.G. 1985. Naturalistic inquiry. Beverly Hills, CA: Sage Publications.

Lui, D. 1996. Teaching chemistry on the Internet: A qualitative case study. PhD Dissertation, University of Nebraska, Lincoln. Available at:http://dwb.unl.edu/dissertations.

Martel, A. & Peterat,L. (1994). Margins of excusion, margins of transformation: The place of women in education. In Martusewicz and Reynolds (Eds) Inside Out: Contemporary critical perspectives in education (pp. 151-166). New York: St. Martin's Press.

Martens, R.L., Valcke, M.M., Portier, S.J., Weges, H.G., & Poelmans, P. (1997). Research with interactive learning environments in three content domains: Descriptive statistics, continuous mathematics and substantive criminal law. Distance Education – An International Journal, 18(1) 26-34.

Martusewicz, R.A. & Reynolds, W.M. (1994). Inside Out: Contemporary critical perspectives in education. New York: St. Martin's Press.

McComb, M. (1994). Benefits of computer-mediated communication in college courses. Communication Education, 43, 159-170.

Merriam, S.B. (1988). Case study research in education: A qualitative approach. San Francisco, CA: Jossey-Bass.

Miles, M.B. & Huberman, A.M. (1984). Qualitative data analysis: A sourcebook of new methods. Beverly Hills, CA: Sage.

Mullis, I.V.S. & Jenkins, L.B. (1988). The science report card: Elements of risk and recovery. Princeton, NJ: Educational Testing Service.

Nelson, B., Weiss, I. & Capper, J. (1990). Science and mathematics briefing book, Volume II. Washington DC: National Science Teachers Association.

Papert, S. (1993). The children's machine: Rethinking school in the age of the computer. New York: BasicBooks, Harper Collins.

Phye, G.D. (1997). Learning and remembering: The basis for personal knowledge construction. In Handbook of Academic Learning (pp.47-64). New York: Academic Press.

Pintrich, P.R. (1995). Understanding self-regulated learning. San Francisco: Jossey-Bass.

Pressley, M. & McCormick, C. (1995). Advanced Educational Psychology for educators, researchers and policy makers. New York: Harper Collins College Publishing.

Reiser, R.A. (1995). Clark's invitation to the dance: An instructional designer's response. Educational technology research and development, 42(2) 45-48.

Rogers, Everett M. (1980). Communication Technology: The new media in society. New York, NY: The Free Press.

Simonson, M.R. & Thompson, A. (1997). Educational computing foundation 3rd Edition. Upper Saddle River, NJ: Prentice Hall, Inc.

Stake, R.E. (1994). Case studies. In Denzin and Lincoln (Eds.), Handbook of qualitative research (pp.236-247). Thousand Oaks, CA: Sage Publications.

Stake, R.E. (1995). The art of case study research. Thousand Oaks, CA: Sage Publications.

Tobias, Sheila. (1990). They're not dumb, they're different. Tuscon, AZ: Research Corporation.

Urban, W. & Wagoner, J. (1996). American Education: A History. McGraw Hill Publishing Company, New York.

Van Maanen, J. (1988). Tales of the field: On writing ethnography. Chicago: University of Chicago Press.

Wagner, E. D. (1997). Interactivity: From agents to outcomes. In T. E. Cyrs., Fall (Ed.), Teaching and Learning at a Distance: What it Takes to Effectively Design, Deliver, and Evaluate Programs (pp. 19-26). San Francisco: Jossey-Bass Publishers.

Wise, K.C. (1988). The effects of using computing technologies in science instruction: A synthesis of classroom based research. In J.D. Ellis (Ed.), AETS Yearbook (pp. 105-118). Columbus: The Ohio State University.

Appendix

Interview Questions for Study One

First interview questions

1) name and any particular choice for pseudonym
2) birth date
3) number and order of siblings
4) parental education level
5) social living arrangement now
6) work schedule
7) native tongue
8) birthplace and home now
9) HS rank, if known
10) Year in school
11) Degree program
12) GPA
13) Major
14) What do you want to do with this degree?
15) Course load this semester – what and when?
16) Number of science courses prior to this one
17) Computer courses prior to this one
18) Reason for taking this course
19) Reason for choosing the Web section
20) Overall feeling about science
21) General thoughts on starting this course
22) When and where course accessed
23) Questions for me?

Second interview questions

1) Where are you in the lectures?
2) How's the learning going? Any serious problems getting information off the Internet?
3) Have your times changed for viewing the lectures?
4) How many lectures do you view at one sitting?
5) Do you enjoy the lectures?
6) Do you feel you learn best from the spoken word? Writing things down? Seeing things in three dimensions? What works best for you?
7) How often do you follow the links provided in the lectures? Do you go off on tangents?
8) Do you post questions or add thoughts to the discussion groups often?
9) What do you like most about these lectures?
10) What so you like least about these lectures?
11) What has been the most difficult concept to date?

12) How would you improve the lecture presentations thus far?
13) Do you like the concept of ClassNet?
14) Have you taken an exam on the Web yet? Did you experience any test-taking pressures other than usual?
15) How would you improve ClassNet?
16) What type of student do you think the Web course is best suited to? Is this the same student you expect to find registering for the class?
17) (Set up time for observing lecture behaviors)

Third interview questions

1) What was your overall impression of the class?
2) How did the presentation affect your grade in the class?
3) Would you take a class over the Web again?
4) How comfortable do you now feel with the Internet? Has this class helped you with that?
5) What have you learned of computers through this class?
6) What have you learned about yourself and your learning style through this class?
7) Do you find that you need others to learn? Are you comfortable learning without readily available classmates?
8) How reliant are you on an instructor when you take a class? Did the lack of contact with the instructor have any effect on your performance in this class?
9) Do you know what your grade is in this class now? (DATE) Is this indicative of your performance as a student? Is it an average grade for you?
10) What have you learned about course content through taking this class?
11) How would you rate your motivation to study?
12) What is your motivation to study?
13) Physically did the class pose a problem for you? Was it difficult or challenging in any way to view the lectures?
14) What was the most difficult portion of the class? Where did you experience the most problems – content, testing, time scheduling, computer functioning, homework, discussion / class participation, other?
15) How important has it been for you to communicate with me? How heavily did you rely on my returning your e-mail correspondence and / or phone calls?
16) Did you put the same importance on the phone calls and e-mails to me as you would to a "normal" instructor?
17) Where were you most interested in the class – which lectures?
18) What would you like to see improved before you take another course over the Web?
19) What worked even better that you expected?
20) Any other comments / criticisms that will help with this class next semester?
21) Look over the presentation given November 3 – am I on the right track as far as you can see?

Student Informed Consent Form – Study one

Dear student:

I am in the last year of a Ph D program in Curriculum and Instructional Technology here at ISU. As part of my dissertation research, I am conducting a study of the effectiveness of my use of the WWW to teach Zoology 155. As a student registered in the WWW section of my course, I would like permission to include your data in my study. This is entirely voluntary. Specifically, I would like you to serve as one of three case studies in my class. A case study is a detailed "story" of one person's experience. In this case it would entail your sitting down with me at least once every two weeks for approximately 1 hour, and discussing your opinions of the WWW course. Included in our discussions would be some basic information about you, such as your age, marital status, year in school, major, GPA, high school rank, etc. Your name and Social Security number will NOT be included in the written report. The interviews will be relatively informal, and may be taped if I am unable to take adequate notes during our discussions. Any taped interviews will be erased within 2 weeks, and will not be heard by anyone other than me. Additionally, I will provide you with a pseudonym for the study. All information we discuss will be recorded under that name, with no link to you. If we find that face to face interviews are difficult to schedule, alternative communication methods (phone, e-mail, written messages) can be used.

Due to the personal nature of some of the questions, you may be uncomfortable talking with me. You are not required to discuss anything you do not wish to discuss, and can simply tell me you are not comfortable with that topic. If at any point, you wish to drop out of the study you may do so, with no adverse consequences. I do not expect this to happen, as most of the interview process will center around the course content and presentation mode. As a benefit to you, you will be getting personal attention in this class. You and I will meet regularly, and can talk about anything you wish. That includes the material we are covering in the class, giving you extra help with the difficult topics. It is beneficial to have a comfortable atmosphere surrounding the learning environment, and I believe this interview process will generate that for you. There will be a small monetary reimbursement for your time as well, totaling $50.00 for the semester.

I am available in person at 205 Science II, over the phone (294-8453) or through e-mail (flick@iastate.edu) to answer any questions you may have about this study. I am very excited about this research, and hope you will be too. In order to use your data, I need this form signed and dated. Thank you very much.

Kathleen Flickinger
Instructor

Last name First name SS #

Date

CHAPTER 3. THE IMPACT OF INTERNET-BASED SCIENCE INSTRUCTION ON COLLEGE STUDENTS' STUDY HABITS AND ACHIEVEMENT

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Kathleen Flickinger

Abstract

This paper represents an assessment of teaching college level science entirely via the Internet. Iowa State University has been offering Internet courses in both introductory and advanced biology through a program called ProjectBIO for the past two years. This study was undertaken to ascertain the effect, if any, this mode of presentation had on the students' acquisition of science. Zoology 155, Introductory Anatomy and Physiology, was the course studied. Students in both the traditional section and the concurrent WWW section were compared through demographics, achievement scores, and survey responses. Data on student attitudes toward science and study habits were collected during the semester. Success in content mastery, as well as critical thinking skills in the Anatomy and Physiology domain, were assessed via traditional exams and assignments. The WWW section was found to differ from the traditional section in study habits and achievement. In both instances, the WWW section excelled. Taken as a whole, these data begin to establish a basis for discussion of Internet instruction as experienced by the student. Improvements in the method of content delivery then can be tailored to this medium and hopefully enhance learning. The conclusion drawn is that science can be effectively taught via the Internet with positive results. Future research should address the level of interaction with the course content required in Internet instruction, changes in student attitude toward science and student aptitude in using scientific processes after taking such classes.

Introduction

Advanced technology and Internet availability are changing higher education (Thornburg 1998). As we move into the new millineum, higher education needs to carefully examine Internet-based instruction and its implications for the students and the institution.

The availability of information describing how to create Internet-based instruction makes the technical production of Internet courses relatively easy (Brooks, 1998). Journals are published expressly for the Internet instructor (i.e., Syllabus Magazine and WebNet), and the number of software applications that allow ease of Internet class manipulations continues to grow (i.e., WebCT, TopClass, ClassNet, FirstClass). Traditional institutions of higher education offer classes taught either partially or entirely over the Internet; and virtual universities, such as the University of Phoenix and the Western Governors University, are rapidly being created. As higher education continues to use Internet technologies, research needs to be done on the educational ramifications of Internet instruction. The purpose of this study was to examine student achievement and study habits in an Internet-based college science course, in comparison to a traditionally taught course.

Background

As new technologies are integrated into the classroom, researchers conduct studies aimed at evaluating the educational effects of the technology as compared to traditional teaching methods. Many such studies have been conducted in college science education; so many, in fact, that large meta-analyses have been published to provide a framework from which to examine technology in college science education (Berger, Lu, Belzer, & Voss, 1994; Roblyer, Castine, & King,1998; Weimer & Lenze, 1994). While comparison studies are important, there is some controversy over the emphasis placed on the research when comparing two types of technology (Pressley & McCormick, 1995). As there is no doubt that differing methods of instruction are inherently different, the question to be asked should focus on the efficiency of the learning that occurs with and without the new technology. This is the heart of Clark's 1995 discussion of media and methods. His articles (1995a, 1995b) demand that future endeavors in the field look not to a straight comparison of one technology over another, but rather to the efficiency with which each new advance allows learning to occur. This question of efficiency becomes critical in today's higher education institutions as they try to meet the needs of an increasingly diverse student population. The student population is different than it was in the past, with a higher proportion of older students returning for job enhancement and personal knowledge acquisition (McKeachie, 1994).

Institutes of higher education are now facing a global community rather than a local one. Consequently these institutes must meet different needs than in the past.

As with the advent of all educational technology, much is expected of the use of the Internet in the classroom (Bassi, Benson, & Cheney, 1996; Bailey & Luetkehaus, 1998; Bork, 1995; Jonassen, Campbell, & Davidson, 1995). Lacking at present are valid assessments of the educational implications of these Internet-driven courses. In this paper, Internet driven courses are defined as courses in which the regular use of the Internet by the students is required. There is anecdotal evidence that Internet instruction does not negatively affect learning (Barker, 1998; Brooks, 1997; Hazari & Schnorr, 1998); however more thorough research is needed to explore this assertion. Relevant research questions to be addressed include: What is the impact of Internet-based courses on student learning? How do the students perceive Internet-based courses? Is there a difference in the type of student who benefits from Internet instruction when compared to traditional lecture settings? Does the use of the Internet promote critical thinking skills, change study habits, or affect attitude toward content? (Berg, 1999; Brooks, 1998; Nesta, 1999).

McKeachie (1994) defined two parameters of learning that still hold true today. His self-proclaimed laws state that active participation is better than passive learning, and meaningful learning is more effective than rote memorization. The acceptance of his work indicates that research into the above questions is not only meaningful, but also necessary.

Some attention has been paid to the types of learning strategies or learning styles that are most successful in Internet-driven classes (Raferty & Bell, 1998; Shih, Ingebritsen, Pleasants, Flickinger, & Brown, 1998). Findings from these studies have been inconclusive and perhaps may be detracting from the issues of educational efficiency and effectiveness. Researchers have begun to focus on student behaviors and perceptions while engaged in computer-driven instruction (Black, 1998; Cassanova, 1996; Johanssen, Davidson, Collins, Campbell, & Haag, 1995; Williamson & Abraham, 1995).

Additionally, there is a great deal of information on female attitudes toward science and technology. (Mullis & Jenkins, 1998; Nelson, Weiss, & Capper, 1990). Evidence indicates that females tend to choose science less often, and are less likely to remain in science than males (Kahle, 1986; Kahle & Meece, 1994; Tobias, 1990). These findings are

of importance in the current study, as it is a combination of science and technology via an Internet-driven science course.

The Internet appears to have the power to create active, interesting forums for learning, and research is beginning to focus on virtual learning environments (McDaniel, 1997). The purpose of this study was to examine Internet learning environments by looking at student achievement and study habits during a semester long Internet-driven class. The research questions pursued attempt to look at the efficiency of Internet-based instruction.

Research Questions

The following questions were used to guide this study:

1) How does Internet-based science instruction affect student achievement?
2) How does Internet-based science instruction affect student study habits?
3) Do the students perceive Internet-based science classes differently than traditionally taught classes?
4) Do those students enrolled in Internet-based science classes perceive their education differently than do traditionally enrolled students?

The research questions pursued look at the efficiency of Internet-based instruction.

Methods

Setting and Participants

To address the research questions, Zoology 155, Introductory Human Anatomy and Physiology, was chosen as the science class studied. The course was divided into two sections: a traditionally taught section and an Internet section. During the semester studied, the Internet and traditionally taught sections of Zoology 155 were offered concurrently on ISU's campus allowing a unique opportunity for study.

Five hundred seventeen students participated in the study; 457 and 60 in the traditional and Internet sections, respectively. Demographic information for the participants was obtained from the registrar's office after the first week of classes, and included ACT scores, GPA, full time status, native language, college of enrollment, high school ranking and

state of residence. These data for the two sections are presented in the first two columns of Table 1. With the exception of the percent students enrolled as part-time students, the two sections were demographically similar.

In accordance with the University course registration procedures, students selected which section they preferred. This created two self-selected populations: those students who chose to take the traditional section, and those who chose to try the Internet-based section. Potential group differences resulting from this are addressed in the results section.

An additional problem arose in the early registration process. During registration for classes, the cap set on the Internet-based section was inadvertently removed. This allowed a larger number of upperclassman to enroll in the Internet-based section. When the instructor noticed the lack of control on class size, 90 students had already enrolled in the course. It was immediately closed to further enrollment, effectively shutting out those students who are required to enroll later in the enrollment sequence. The extent to which this skewed the enrollment in the Internet-based section toward upperclassmen is addressed in the results section.

Courses

The traditionally taught section was presented in a large lecture hall to upwards of 550 students. It met for 50 minutes three times a week and attendance, while not mandatory, was expected for successful completion of the class. The instruction was mostly lecture, using overheads and computerized graphics as visual displays. Students were often asked to come to the front of the class to perform skits dramatizing the physiological processes being learned. Exams were given in the lecture hall during regularly scheduled class periods. Due to the size of the class exams were multiple choice with no diagrams. Assignments were given in the class to be completed outside class hours. These assignments were more critical in nature than the exams, asking the students to synthesize information and draw conclusions from the readings and lectures.

By design, the Internet section of the class closely resembled the traditional section, containing a series of audio lectures cued to Web pages. The pages contained outline text and images similar to the visual projections used in the traditional lectures. The Internet

section was designed to follow the same schedule as the traditionally taught section, however no timetable was required of the Internet students. Students were asked to check into the discussion group from time to time, and student/instructor contact was maintained through e-mail. All lectures and course materials were available the first day of class. This provided the students with the freedom to schedule their class time as they saw fit. Exams and assignments were presented on-line for the students. Those students taking the Internet class from ISU's campus were asked to come to a computer facility to take their exams. All four exams were available the entire semester. A computer laboratory employee was given the passwords that allowed the students' access to the exams, allowing that person to act as a proctor. Those students taking the course from off-campus locations identified a proctor for the course. All passwords were sent to that proctor, maintaining exam security. In an effort to keep the Internet section as close as possible to the traditionally taught section, exams were multiple choice using many of the same questions as the traditional class. These exams were not identical due to the asynchronous nature of the Internet-based section. To avoid students sharing test information, the Internet-based exams were created on demand by a testing program pulling questions from an instructor-prepared question bank. Each question asked of the traditional students was written into the question bank of the Internet exams. An additional two to three questions covering the same material were added as choices for each question. The computer then randomly chose one of the three to four questions per topic for the Internet-based student exam. All other assignments were identical during the semester.

During the semester examined, the Internet-based course was taught by the researcher while the traditional class was taught by another instructor. This difference in instructors was recognized as a limitation to the study, and every effort was made to minimize the effect of this on the study. The two instructors worked closely together in creating assignments and exams. While not identical, teaching style was very similar for the two instructors. The instructor for the Internet-based class had taught the traditional section for over eight years at the time of this study, and was teaching the Internet-based section for the second consecutive semester. The instructor teaching the traditional class during this study had taken the traditionally taught class from the researcher, and patterned her lectures and demonstrations after what she had experienced. During the semester, both instructors met to discuss teaching

strategies and appropriate demonstrations or discussion materials for the two sections. The same note packet, created by the researcher (a more experienced instructor), was used in both sections.

Instruments

Three data sources were used to gather information on student achievement, study habits, and attitudes toward science. Each of these instruments is described in greater detail in the sections that follow.

Achievement

Student achievement in the traditional and Internet section of the class was assessed using grades earned on the exams and assignments. Four exams were given during the semester. The questions were multiple choice due to the size of the traditional class, and the ease of grading for both sections. Exams included 50 questions, organized in the order of topic presentation. The exams were not identical in each section, as the Internet section had three versions of each test, randomly distributed by the testing program. The questions posed to the traditional section were included in the exam questions given to the Internet section. All other assignments were identical between the sections. Three homework assignments were given during the semester. The first assignment was a list of 70 prefixes and suffixes used in the study of anatomy and physiology. The second and third homework assignments were designed as critical thinking assignments. The students were given 7 medical histories to analyze. The patients described in each case suffered from dysfunction of an aspect of physiology recently covered in the class. The students were to diagnose the patient and answer a series of questions posed at the end of the history. They were required to choose four of the seven cases to complete.

Study habits

Study habits were examined using a study habits survey. This instrument was adapted from a survey developed by Mohamed (1980). Mohamed's goal was to assess the affect availability of video presentations of Zoology 155 lectures had on the study habits of

students enrolled in the class. Slight modifications of this survey included changing the word "video" to "Internet" and deleting a few non-applicable questions. The resulting study habits survey was divided into two sections. The first section offered specific choices for 11 questions, dealing with behaviors such as number of lectures skipped, percent of study time spent with the book, and the number of help-sessions attended. In the second section, questions 12 through 35 pertained to the course itself and students' activities as they studied. These responses were presented using a Likert-like scale with 5 choices: A = strongly disagree, B = disagree; C = neutral; D = agree and E = strongly agree. This instrument was given with 3 weeks left in the semester.

Attitude toward science

The attitude toward science survey, referred to as the Attitude and Epistemology Survey, consisted of three parts (Hargrave, 1997). This survey was given in the second week of instruction so as to ensure attitude would reflect that coming into the class, not a change due to the class. The first portion of the survey included 8 multiple choice questions dealing with participant identification. Questions were asked concerning the gender of the participant, year in college, major and number of previous college science courses taken. The second portion of the Attitude and Epistemology Survey consisted of 75 questions. The second section used a four point Likert-like scale, with response options including "strongly disagree", "disagree", "agree" and "strongly agree". The first 57 questions dealt with the participants attitudes toward science and the learning of science. The remaining three questions probed basic beliefs about knowledge and knowledge acquisition. Copies of the Attitude and Epistemology Survey, as well as the Mohamed Survey, can be found in the appendix to this paper.

Results

Prior to examining the specific research questions, a comparison of the demographics of each class was necessary. Characteristics of both sections of Zoology 155 during the Spring semester 1998 are given in the first two columns of Table 1. T-tests were conducted to determine whether statistically significant differences existed between the two groups.

While the overall number is far larger in the traditionally taught section as compared with the Internet section (N = 457 versus N = 60), only one statistically significant difference existed between the two populations (student t test, alpha = 0.05). There was a significantly higher proportion of part time students in the Internet section of the course.

Students' education and Internet class perception

The Attitude and Epistemology Survey was given to ascertain student perceptions of education in general as well as science and specifically (Hargrave, 1997). The results, presented in Table 2, revealed no significant differences between the two sections (alpha = 0.05). The survey results were grouped into four categories based on underlying concepts: attitudes toward science usefulness, interest in the field of science, problem solving abilities (use of the scientific process in problem solving), and understanding of the scientific process. These survey results were analyzed using gender, year in school, reason for enrollment Zoology 155, and choice of Zoology 155 section enrollment as parameters for comparison. Regardless of which parameter was isolated, no differences between the two self-selected populations could be ascertained from the survey. These results are summarized in Table 2.

Study habit effects of Internet-based science instruction

The results of the statistical analysis of the Mohamed survey are presented in Table 3 (alpha = 0.01). When study habits were examined, differences between the two sections responses to individual items appeared. Separate t-tests were run for each individual question. Tests were run comparing Internet section responses with traditional section responses, as well as comparing male and female responses. Gender comparisons were made both within each section and between sections. Those enrolled in the Internet section reported skipping fewer lectures, reading the text more often, reading a higher percentage of the required readings, and having more faith that the readings were an integral and helpful portion of the class. The Internet students reported recognizing that their course allowed for different learning styles and self-paced learning, something not seen as available to the traditionally taught section. The freedom to arrange study schedules around other classes was appreciated in the Internet section, while seen as indifferent in the traditional section.

Responses to questions concerning the use of tutors, notes taken during the class, or outside resources such as experts or libraries did not significantly differ between the two sections. The bottom of the survey included an area for the students to add any comments they felt helpful. It was interesting to note the number of students from the Internet section who commented on the appropriateness of the question on skipping lectures. They thought this was an odd question - the idea of skipping an Internet lecture presentation available to them whenever they wished seemed ridiculous. Comparatively, the traditionally taught students had no problem with the concept of not going to a few regularly scheduled lectures. In fact, this population did not feel the lectures to be a necessary ingredient for success in the course. The Internet students reported the lectures to be useful and important to their success. The Internet students also reported a higher degree of satisfaction with the lectures and the lecturer than those in the traditional section. This is surprising in light of the fact that these students never met with their instructor other than electronically.

To further investigate the differences seen, the data was analyzed using gender as a variable. To examine the study habit data by gender, the mean responses of males in the Internet section were compared to those in the traditional section. These data are presented in Table 3. Males in the Internet section skipped fewer lectures and relied more on the text than did the males in the traditional section. The males in the Internet section reported an increase in interest in the subject due to the class, and an appreciation of the freedom allowed by the class. This same pattern was also evident when comparing mean responses in the two female populations. Those females enrolled in the Internet section differed significantly from their traditionally taught female peers in that they skipped fewer, relied more on the instructor-prepared notes and the textbook, found the lectures and readings more useful, and appreciated the freedom to schedule their studies. It is worth noting that both females and males rated their instructor's teaching ability consistently higher in the Internet section than in the traditional section. The instructor variable certainly played a role in this particular question, but should not have affected study habits of students enrolled in the two sections.

When grouping all males together and comparing their responses to all females, no significant differences were seen. This lack of significant differences along gender lines was

evident when comparing responses from males and females in the traditional section, males and females in the Internet section, or all males and all females in the study.

Student achievement effects of Internet-based science

The final research question addressed was the effects of Internet science instruction on student achievement. The analyses involving achievement are summarized in Table 4. Overall course grades were slightly higher in the Internet section of the class. Scores on the cumulative final exam were significantly higher in the Internet section. Retention rates, analyzed by percent drop at midterm, were also different between the two sections. The Internet section lost a higher percentage of students than the traditional section . Achievement was not adversely effected by the use of the Internet in course content delivery.

Conclusions

Without getting involved in the on-going debate between Clark and Kosma (1995), this research lends credence to Clark's position. He strongly believes that the medium does not affect the learning. Clark defends the use of media only as one of many efficient means of presenting information. He does not agree with the notion that media can inherently create better learning or deliver a better "product" (1995). In this study, the Internet has not created a "better" way to teach, but seems to have facilitated the use of instructional design methods that move the student toward more interaction with the material. The benefits seen are not inherent in the medium, but rather they are due to the effective use of the properties of the medium. With the protocol used to put Zoology 155 on the Internet, the environment created by the delivery medium does not seem to adversely affect learning. In fact, the results of this study indicate that students are enthusiastic about this type of course. They take advantage of other means of studying, altering their study habits and using the text much more than usual.

The students report a more positive experience with the instructor over the Internet, even with no face to face contact. This is surprising, and may be due in part to the difference between the two instructors. The Internet-based instructor was more experienced in teaching this material, and may have demonstrated more confidence while teaching. An analysis of the student-completed teaching evaluations for that semester indicated high student approval

rating of the teaching they received from the traditional classroom. The rating given the new instructor were similar to those received by the more experienced Internet-based instructor during her first semester's teaching. A direct comparison of the departmental instructor and course evaluation forms at the end of the semester indicated little difference between the two instructors.

Instructional designers and constructivist theorists are continuously looking for ways to involve students in the learning process, actively engaging their minds to initiate assimilation and accommodation of the content. Through this research it appears that Internet instruction can do just that. The students take more responsibility for their learning, use the resources provided by the instructor, and in the case of this class at least, enjoy the material being presented. In short, the students taking the course over the Internet seem to be far easier to teach because they actually exhibit the behaviors we hope to encourage (Cross, 1994; Pressley & McCormick, 1995). Students enrolled in the Internet section of this college science course demonstrated more efficient study habits such as spending more time interacting with the material, using the text and ancillary materials, and attending the lectures. Their content retention was better than those students taught in the traditional lecture, and their study habits more closely resembled those proven to lead to success (Lawson, 1994; Piaget, 1977; Pintrich, 1994; Posner, Strike, Hewson, & Gertzog, 1982).

While this research is promising in that it shows effective instruction and student content retention is possible on-line, it raises many new questions concerning the effect of Internet-based instruction in higher education. It is difficult at this juncture to isolate the cause of these improved study habits. It may be that the Internet-based section attracted students with better study habits. The self-selection issue needs to be further investigated, as does the reason for the higher drop rate in the Internet-based section. While the medium does not create a better course, it may serve as a selection mechanism for removal of those students who do not study well.

References

Bailey, M.L., & Luetkehaus, L. (1998). Ten great tips for facilitating virtual learning teams. Proceedings of the 14th Annual Conference on Distance Teaching and Learning (pp 19-26). Madison, WI: University of Wisconsin.

Bassi, L.J., Benson, G., & Cheney, S. (1996). The top ten trends. Training and Development, 50(11), 28-42.

Berg, G. A. (1999) Changing and staying the same. Webnet Journal:Internet Technologies, Applications, and Issues, 1(1), 5–6.

Berger, C. F., Lu, C. R., Belzer, S. J., & Voss, B. E. 1994. Research on the uses of technology in science education. In D. Gabel (Ed.), Handbook of Research on Science Teaching and Learning (pp. 466–490). New York: McMillan Publishing.

Black, Deb (1988). The role of live online collaboration in distance learning. Proceedings of the 14th Annual conference on Distance Teaching and Learning (pp. 73-78). Madison, WI: University of Wisconsin.

Bork, A. (1995). Distance learning and interaction: toward a virtual learning institution. Journal of Science Education and Technology, 4(3), 227-244.

Brooks, D. W. (1997). Web teaching: A guide to designing interactive teaching for the World Wide Web. New York: Plenum Press.

Cassanova, J. (1996). Computers in the classroom - What works and what doesn't. Computers in Chemical Education Newsletter (Spring), 5-9.

Clark, R.E. (1995). Media will never influence learning. Educational Technology Research and Development, 42(2), 21-29.

Clark, R.E. (1995). Media and method. Educational technology research and development, 42(3), 7-10.

Cross, K.P. (1994). Teaching to improve learning. In K. Feldman & M. Paulson (Eds.), Teaching and Learning in the College Classroom (pp. 683–692). Needham Heights, MA: Ginn Press.

Jonassen, D.H., Campbell, J.P., & Davidson, M.E. (1995). Learning with media: restructuring the debate. Educational Technology Research and Development, 42(2), 31-39.

Jonassen, D., Davidson, M., Collins, M., Campbell, J., and Haag, B.B. (1995). Constructivism and computer-mediated communication in distance education. The American Journal of Distance Education, 9(2), 7-26.

Lawson, A.E. (1994). Research on the acquisition of science knowledge: Epistemological foundations of cognition. In D. Gabel (Ed.), Handbook of Research on Science Teaching and Learning (pp. 131–176). New York: McMillan Publishing.

McDaniel, T.R. (1997). On chickens and colleges: A provost's reflections on perceptions. The Teaching Professor, October.

McKeachie, W. J. (1994). Research on college teaching: The historical background. In K. Feldman & M. Paulsen (Eds.), Teaching and Learning in the College Classroom (pp. 21–42). Needham Heights, MA: Ginn Press.

Mohamed, N. A. A. (1980). An analysis of the phase achievement system using Zoology 155 at Iowa State University. PhD Dissertation, Iowa State University.

Mullis, I.V.S. & Jenkins, L.B. (1988). The science report card: Elements of risk and recovery. Princeton NJ: Educational Testing Service.

Nelson, B., Weiss, I. & Capper, J. 1990. Science and mathematics briefing book, Volume II. Washington DC: National Science Teachers Association.

Nesta, F. (1999). Beyond walls and onto your desk. Webnet Journal:Internet Technologies, Applications, and Issues, 1(1) 7-8.

Piaget, J. (1975). From noise to order: the psychological development of knowledge and phenocopy in biology. The Urban Review, 8(3) 209.

Pintrich, P.R. (1994). The dynamic interplay of student motivation and cognition in the college classroom. In K. Feldman & M. Paulsen (Eds.), Teaching and Learning in the College Classroom (pp. 597–608). Needham Heights, MA: Ginn Press.

Posner, G.J., Strike, K. A., Hewson, P.W., & Gertzog, W.A. (1982). Accommodation of scientific conception: Toward a theory of conceptual change. Science Education, 66(2), 211-227.

Pressley, M. and McCormick, C. (1995). Advanced educational psychology for educators, researchers and policy makers. New York: Harper Collins College Publishing.

Raferty, S, and Bell, D. (1998). Online learning: Does bloom's taxonomy have relevance? Proceedings of the 14th Annual Conference on Distance Teaching and Learning (pp. 297-299). Madison, WI: University of Wisconsin.

Roblyer, M. D., Castine, W. H., & King, F. J. (1998). Assessing the impact of computer-based instruction. Computers in the Schools, 5, 1–149.

Shih, C., Ingebritsen, T., Pleasants, J., Flickinger, K., & Brown, G. (1998). Learning strategies and other factors influencing achievement via web courses. Proceedings of the 14th Annual Conference on Distance Teaching and Learning (pp. 359-366). Madison, WI: University of Wisconsin.

Thornburg, D. (1998). The future of schools: Disintermediation and beyond. 19th Annual National Educational Conference Keynote Speech.

Weimer, M. & Lenze, L. F. (1994). Instructional interventions: A review of the literature on efforts to improve instruction. In K. Feldman & M. Paulsen (Eds.), Teaching and Learning in the College Classroom (pp. 653–682). Needham Heights, MA: Ginn Press.

Williamson, U.M. & Abraham, M.R. (1995). The effects of computer animation on the particulate mental models of college chemistry students. Journal of Research in Science Teaching 32(5), 521-534.

Table 1. Demographic data

Demographic Variable	Traditional Section	Internet Section
N	457	60
% female	64%	57%
ACT score male	23.1	24.2
ACT score female	23.1	22.8
GPA average	2.54	2.4
Average standing	sophomore	sophomore
High school standing	71% tile	69% tile
Part time	1.50%	8.00%
Non-english speaking	1.50%	2.00%
Out-of-state	14.90%	11.00%
College of LAS	52%	58%
College of Education	24%	21%

Table 2. Attitude toward science results (mean; standard deviation)

	N	Usefullness of science (r = 0.69)	Interest in science (r = 0.44)	Problem solving skills (r = 0.68)	Understanding of science (r = 0.40)
Combined scores	399	36.96; 4.46	28.03;2.45	33.26; 3.95	27.46; 2.46
Traditional section	345	36.85; 4.27	27.98; 2.27	33.12; 3.66	27.49; 2.16
Internet section	54	37.67; 5.44	28.35; 3.33	34.09; 5.42	27.24; 3.85
Combined sections:					
Males	134	36.94; 4.44	28.17; 2.38	33.81; 3.96	27.41; 2.67
Females	264	36.97; 4.46	27.96; 2.48	32.97; 3.92	27.48; 2.34
Freshman	178	36.58; 4.56	27.89; 2.72	32.57; 3.52	27.52; 2.60
Sophomores	118	37.23; 4.23	28.03; 2.33	33.54; 4.30	27.11; 2.48
Juniors	55	37.36; 4.10	28.16; 1.90	33.84; 4.30	27.64; 1.99
Seniors	37	37.24; 5.22	28.11; 2.24	34.54; 4.06	28.03; 2.27
Other	11	37.27; 3.52	29.36; 1.55	34.04; 3.58	27.27; 1.86
Reason for enrollment:					
Required	179	36.90; 4.35	27.88; 2.57	33.05; 4.12	27.34; 2.32
Choice from list	97	36.87; 4.46	28.20; 2.23	33.23; 3.74	27.20; 2.06
General ed requirement	45	35.51; 3.97	27.60; 2.45	33.00; 3.63	27.84; 2.87
Other	22	36.55; 3.41	27.86; 1.94	33.00; 3.06	27.68; 1.87
Combined interest in subject	56	38.66; 5.16	28.66; 2.44	34.27; 4.19	27.89; 3.156+

Table 3. Study Habits Survey Significant Results by Gender

Traditional Section	Internet Section	T test; p value
MALES	MALES	
3-5 lectures skipped	1-2 lectures skipped	2.249; .027
class increased interest in content (3.43)	class increased interest in content (4.17)	2.876; .005
readings important to success (2.64)	readings important to success (3.78)	3.563; .001
0 - 20% total study time spent reading (1.74)	40-60% total study time spent reading (2.89)	4.250; .000
freedom to schedule study time (3.63)	freedom to schedule study time (4.50)	4.777; .000
lectures not useful (2.85)	lectures not useful (2.17)	2.354; .021
FEMALES	FEMALES	
3-5 lectures skipped (3.26)	0-2 lectures skipped (2.03)	4.914; .000
0-20% use of Instructor notes (1.92)	40-60% use of Instructor notes (3.43)	5.315; .000
lectures not useful (2.94)	lectures not useful (2.17)	3.450; .001
course allows for different learning styles (3.18)	course allows for different learning styles (3.97)	4.001; .000
freedom appreciated (3.55)	freedom appreciated (4.10)	3.226; .001

The numbers in parentheses are the Likert-like scale average responses from each population. The scale ran from 1 = strongly disagree to 5 = strongly agree. Student t-tests were run, assuming equal variance. Alpha was set at 0.01.

Table 4. Achievement and Retention

	N	Cumulative final score	Course grade	Drop rate
Internet section	60	65.70%	73.60%	17%
Traditional section	457	60.00%	69.40%	11%
t-test; alpha		4.243; 1.001**	3.087; 1.002**	

Appendix

Study Habits Survey (Adapted from Mohamed, Nadia Abdel Azeme ISU 1980)

Print your name and Social Security numbers in the appropriate boxes on the answer sheet. Blacken in the spaces corresponding to the letters and numbers in the columns beneath. Fill in the course and section number – Section A is live lecture; Section B is WWW.

The use of evaluations comes in improving the course offering to future students. In this case, we would like to use your study habits and study skills as starting points for helping the course better serve others with your same habits. These questionnaires will be completely analyzed after course grades are assigned, and your responses will in no way affect your final score. Please be honest in your responses.

1. How many hours per week did you spend on this course outside of lecture?
(A) 1 hr – 3 hrs; (B) 4 – 6 hrs; (C) 7 – 9 hrs; (D) 10 + hrs; (E) 0 hours

2. How many lectures did you skip so far this semester?
(A) 0 lectures; (B) 1 – 2 lectures; (C) 3 - 5 lectures; (D) 6 – 8 lectures; (E) more than 9 lectures

We are interested in specifically how you spent your time outside of class, Assuming that all outside time spent is equal to 100%, what % of your outside study time went toward the use of:

3. Lecture notes provided by Kathleen Flickinger
(A) 0–20%; (B) 20-40%; (C) 40-60%; (D) 60-80%; (E) 80 –100%

4. Lecture notes prepared yourself during or after lecture
(A) 0–20%; (B) 20-40%; (C) 40-60%; (D) 60-80%; (E) 80 –100%

5. Textbook reading
(A) 0–20%; (B) 20-40%; (C) 40-60%; (D) 60-80%; (E) 80 –100%

6. Help sessions, tutoring services, Instructor or TA meetings
(A) 0–20%; (B) 20-40%; (C) 40-60%; (D) 60-80%; (E) 80 –100%

7. Use of the Internet, either viewing lectures again (section B) or using the resources available on the Internet to clarify lecture topics
(A) 0–20%; (B) 20-40%; (C) 40-60%; (D) 60-80%; (E) 80 –100%

8. Use of outside resources (library books, experts in the field, etc.)
(A) 0–20%; (B) 20-40%; (C) 40-60%; (D) 60-80%; (E) 80 –100%

9. Approximately what fraction of the suggested textbook readings have you read during the semester thus far?
(A) 0–20%; (B) 20-40%; (C) 40-60%; (D) 60-80%; (E) 80 –100%

10. How many semester hours credit have you had in other college level biological science courses concurrent with or prior to this course?
(A) none; (B) 3-7 credits; (C) 8-12 credits; (D) 13-16 credits; (E) above 17 credits

11. Are you currently enrolled in the companion lab Zoology 156?
(A) yes; (B) no

Please use the following scale to indicate your opinion on each of the following statements. Mark your answers on your answer sheet. Do not leave any blank spaces.

(A) = strongly disagree; (B) = disagree; (C) = neutral; (D) = agree; (E) = strongly agree

12. I feel that I have to do all of the assigned readings in order to do well in this course.
13. Compared to other courses at ISU, these tests are more threatening.
14. Too much emphasis is placed on testing and grading in this course.
15. During this course, my interest in Human Anatomy and Physiology has increased.
16. Cramming for tests has been the most effective means of obtaining a high grade.
17. The tests have been an accurate measure of my knowledge and will allow the instructor to assign me the grade I deserve.
18. The grade standards in this class are too high.
19. I think this is one of the better courses I have had in science.
20. I have adjusted my study habits during this course according to the grades I have received.
21. I feel that I have had the freedom in this course to arrange my study schedule to accommodate my interests and the demands placed on me by other courses.
22. Frequent attendance in class, or regular Web session (section B), is essential to good learning.
23. Compared to other courses I am taking this semester, I spend too much time on this course for the credit assigned.
24. The lectures are not useful.
25. This course forces me to regard myself as being unable to comprehend the basic concepts of zoology.
26. This is a very difficult course.
27. I feel that I am learning the relevant content of this course.
28. My final grade will be limited because I lack a science background.
29. I would recommend this course to other students.
30. This course has enough flexibility to help all kinds of students to learn.
31. The format of this course allowed me to learn at my own pace.
32. The instructor contributes to my interest in the subject.
33. The instructor makes good use of examples and illustrations.
34. The instructor does not stress important material.
35. The instructor has given me new viewpoints and appreciations.

On the back of this page, feel free to make any comments you would like us to know. We are specifically interested in your study habits and how successful you feel they are.
THANKS FOR YOUR INPUT!

Informed Consent Form – Study Two

January 1998

Dear Student:

I am in the final stages of a Ph. D. ion Curriculum and Instructional Technology here at ISU. As a part of my dissertation research, I am conducting a study of the comparative effectiveness of the use of the WWW versus traditional lectures to teach Zoology 155. As a student registered in Zoology 155, I would like permission to include your data in my study. This is entirely voluntary. Specifically, I would like to use data obtained from the survey results you will be taking in class. These surveys will provide information on your attitude toward science, your study habits, and your learning style. Personal identifiers such as your name and Social Security number will not be included in any written report. You may have access to your results at any time during the semester, and may change your mind concerning the inclusion of your data at any time prior to the end of April 1998.

Should you have any questions or concerns, please feel free to contact me at 294-8453 or flick@iastate.edu. I am very excited about this research, and hope you will be too. In order to use your data, I need this form signed, dated and returned to me.

Thank you for your time –

Kathleen Flickinger

Please indicate below what may be done with your data.

_____ YES, include my data in your analysis.

_____ NO, do NOT include my data in your analysis.

Last name First name SS #

Appendix

Zoology 155 Student Survey

The purpose of this survey is to gather information from students currently enrolled in Zoology 155 about their background and attitudes toward science and learning. This survey contains three sections: (I) identification and background, (II) attitudes about science and (III) learning and epistemological beliefs.

Your participation in this survey is voluntary. All of your responses on the survey will be kept confidential. Only group data will be reported; no individual respondent will be identified in any reports. The survey will take approximately **20 minutes** to complete. Thank you for your participation!

I. Identification and Background

The purpose of this section is to gather general information about you, your major area of study, and the college science courses you have completed. Please answer each question by marking the appropriate space on your answer sheet.

Enter you name on the answer sheet;
Last name first, then first name
Enter your Social Security Number in the
IDENTIFICATION SECTION of the Answer Sheet*(web student, just put you name and SS# here - this will ensure that you get credit for this!)**

1. What is your gender?
   a. Male
   b. Female

2. What year in college are you?
   a. First year
   b. Sophomore
   c. Junior
   d. Senior
   e. 5th year Senior

3. What is you major course of study?
   a. Agronomy
   b. Computer, physical or biological science
   c. Education or social science
   d. Engineering or business
   e. Other

4. What is you minor course of study?
   a. Agronomy
   b. Computer, physical or biological science
   c. Education or social science
   d. Engineering or business
   e. Other

5. Will you earn a teaching license as part of your degree program?
   a. Yes
   b. No

6. Why are you taking Zoology 155 (Choose **one**)?
   a. It is a required course for my major
   b. It is one choice from approved science electives for me
   c. It is part of my general education requirement
   d. I am interested in the subject
   e. Other

7. How many college science courses have you completed?
   a. None b. One c. Two d. Three e. Four or more

8. How old are you?
   a. 18
   b. 19
   c. 20
   d. 21022 or older

II. **Attitudes about science and learning science**

The purpose of this section is to gather information about your attitudes toward science and learn science. Using the scale below, mark the item that most closely corresponds to your first reaction to each statement. ***There are no "right" or "wrong" answers.***

A = Strong Disagree B = Disagree C = Agree D = Strongly Agree

9. I enjoy learning science	A	B	C	D
10. Science will be of little use when I get out of school	A	B	C	D
11. A firm mastery of science is needed for my future work	A	B	C	D
12. To understand science concepts, it is not important to understand how one variable affects another variable	A	B	C	D
13. People need science for their careers	A	B	C	D
14. There are too many variable to manipulate to understand most science concepts	A	B	C	D

15. Knowing science will help me earn a living	A	B	C	D
16. Zoology is not really a science	A	B	C	D
17. I do as little work in science as possible	A	B	C	D
18. When I don't understand how to solve a science problem I just guess randomly until I find a solution	A	B	C	D
19. Science is a worth-while subject	A	B	C	D
20. Once I start a science experiment, I find it hard to stop	A	B	C	D
21. When solving science problems, I use the same approach each time	A	B	C	D
22. Understanding broad scientific concepts can help in understanding life	A	B	C	D
23. Solving science problems is a guessing game	A	B	C	D
24. Science is used in many ways in everyday life	A	B	C	D
25. Most professions incorporate many science concepts	A	B	C	D
26. I have a specific approach I use when solving a a science problem	A	B	C	D
27. I find it hard to really understand science concepts	A	B	C	D
28. The study of science is useful	A	B	C	D
29. Zoology is a science that is easy to understand	A	B	C	D
30. Learning science is like learning a foreign language	A	B	C	D
31. Science is a waste of time	A	B	C	D
32. Science is a subject that is rarely used in daily life	A	B	C	D
33. I use a systematic way to solve science problems	A	B	C	D
34. When solving a science problem, I begin by trying to to understand how each variable affects the solution	A	B	C	D
35. It is not important for me to do well in science classes	A	B	C	D
36. When a science problem arises that I can't immediately solve, I stick with it until I have the solution	A	B	C	D
37. If you apply yourself, understanding science is simple	A	B	C	D

38. I would rather have someone give me the solution to a Difficult science problem then work it out for myself	A	B	C	D
39. Science will not be important in life's work	A	B	C	D
40. When solving a science problem, I start with a guess and then try to understand what occurred	A	B	C	D
41. I am challenged by science problems that I can't understand immediately	A	B	C	D
42. Science experiments are boring	A	B	C	D
43. Even when I really apply myself, I rarely understand science concepts	A	B	C	D
44. Science is a stimulating subject to me	A	B	C	D
45. Trial and error is the best way to solve problems in a science class	A	B	C	D
46. When a question is left unanswered in science class, I continue to think about it afterwards	A	B	C	D
47. When solving a science problem, I usually guess until a reasonable solution appears	A	B	C	D
48. I approach problems in science systematically	A	B	C	D
49. Figuring out science problems does not appeal to me	A	B	C	D
50. I don't understand how some people can spend so much time on science and seem to enjoy it	A	B	C	D
51. For the most part, I really enjoy learning science concepts	A	B	C	D
52. Once you understand the basics, science concepts are easy to learn	A	B	C	D
53. Science experiments have too many details	A	B	C	D
54. Science is too complex for me to understand	A	B	C	D
55. Identifying and recognizing patterns is the key to understanding science concepts	A	B	C	D
56. Science concepts are easy for me to understand	A	B	C	D
57. I don't have a specific approach to solving science problems	A	B	C	D

III. EPISTEMOLOGICAL BELIEFS

The purpose of this section is to gather information about your beliefs about knowledge and knowledge acquisition. Using the scale below, mark the item that most closely corresponds to your first reaction to each statement. ***There are no "right" or "wrong" answers.***

A = Strong Disagree B = Disagree C = Agree D = Strongly Agree

58. For success in school, it is best not to ask too many questions	A	B	C	D
59. Successful students understand things quickly	A	B	C	D
60. I try my best to combine information across chapters or even across classes	A	B	C	D
61. Going over and over a difficult textbook chapter usually won't help you understand it	A	B	C	D
62. Genius is 10% ability and 90% work	A	B	C	D
63. Being a good student generally involves memorizing facts	A	B	C	D
64. Wisdom is not knowing answers, but knowing how to find answers	A	B	C	D
65. Most words have one clear meaning	A	B	C	D
66. If a person can't understand something within a short amount of time, they should keep on trying	A	B	C	D
67. If professors would stick more to the facts and do less theorizing, one would get more out of college	A	B	C	D
68. It's a waste of time to work on problems which have no possibility of coming out with a clear - cut and unambiguous answer	A	B	C	D
69. You should evaluate the accuracy of information in a textbook if you are familiar with the topic	A	B	C	D
70. Often, even advice from experts should be questioned	A	B	C	D
71. Some people are born good learners, others are just stuck with limited ability	A	B	C	D
72. The really smart students don't have to work hard to do well in school	A	B	C	D

73. Working hard on a difficult problem for an extended period of time only pays off for the really smart students	A	B	C	D
74. If a person tries too hard to understand a problem, they will most likely just end up being confused	A	B	C	D
75. Students who are "average" in school will remain "average" for the rest of their lives	A	B	C	D
76. The best thing about science courses is that most problems have only one right answer	A	B	C	D
77. Today's facts may be tomorrow's fiction	A	B	C	D
78. You will just get confused if you try to integrate new ideas in a textbook with knowledge that you already have about a topic	A	B	C	D

CHAPTER 4. THE CHANGING ROLE OF THE INSTRUCTOR IN INTERNET-BASED TEACHING

A paper accepted for publication in MSET - Journal of Mathematics and Science Education, February, 2000.

Kathleen Flickinger and Dr. Constance Hargrave

Abstract

Teaching on-line can be an entirely different process than teaching face-to-face. Faculty members asked to teach on-line many times feel they are not given proper credit for the time and effort that goes into Internet instruction. This research examines the experience of two science instructors as they teach a class on-line. The instructors represent both ends of the spectrum in terms of distance education experience, from complete novice to well experienced. Using qualitative inquiry, a description of both instructors' feelings and frustrations during one semester is outlined. Their level of satisfaction with both the course and their personal performance is included. Although general conclusions can not be drawn from this type of research, the findings here indicate that the workload is much higher for Internet instruction than face-to-face instruction. That workload does not diminish with experience. Interestingly, the more experienced instructor found that job satisfaction does increase after the first semester. There may be two reasons for this. Perhaps the increase in satisfaction is due to an acceptance of the shift in instructor responsibilities that both instructors reported experiencing. It may also be due to the instructor knowing what is expected in the class, and being aware of the pitfalls and how to avoid them. The increased communication between faculty and students was noted in both cases to be a pleasant surprise. The overall feeling of the instructors was that this is not a perfect solution to distance education, but the Internet does have value in the teaching arena. Both were keen to try it again, with improvements.

Introduction

The goal of instruction is student learning. As new technologies are developed, the educational community has attempted to move them into the curriculum. The field of

instructional technology has grown around the desire to improve student achievement through the effective use of technology in the classroom. The latest of these technologies is the Internet. It is currently viewed as the ultimate instructional technology, the pinnacle of technological integration (Allen, Stecher and Yasskin, 1998). The use of all communications/technologies, including the Internet, is seen to be advantageous to the students.

Research as to the effectiveness of Internet instruction is beginning to make its way into the literature (Brooks 1997, Ingebritsen, 1998). As more classes are offered either as Internet enhanced versions of traditional lectures or as entirely Internet-driven distance education options, data regarding student perceptions and achievement are increasing. With continued positive reports from the analysis of Internet-based educational opportunities, it seems likely that Internet instruction will be included in the assigned duties of faculty throughout the educational community. For many, this is a frightening realization. Not only will faculty have to create, update and monitor courses in ways unfamiliar to them, but also administrative offices will have to assign appropriate release time to the development and teaching of these courses. This research was undertaken to provide guidance and a starting point for the decisions that must be made regarding the administration of Internet instruction. Faculty time on task, as well as job satisfaction and student interaction were investigated to better understand the issues surrounding the creation and maintenance of Internet instruction.

Faculty teaching on the Internet

Teaching on the Internet is growing, and institutions of higher education are increasingly adopting interactive technologies (Rogers, 1986; Boetcher 1998). The integration and success of these technologies many times falls on the shoulders of the faculty asked to use them (Cini and Vilic, 1999; Ben-Jacob, 1998). Ben-Jacob and Tucciarone (1997) investigated faculty experiences teaching college level courses via distance technologies. They found that instructors needed to act as models and facilitators to provide meaningful experiences in the distance learning environment. The study stressed the difficulties associated with assuming the role of facilitator and presented a model for teaching via distance. The model suggests the professor act as the hub of a wheel composed

of students as the spokes. As the semester progresses, the professor should remove him/herself from the center of the wheel and serve in a consultative capacity. Stimulating dialogue and posing questions were revealed as important to a successful distance delivery. A follow-up study (Ben-Jacob and Levin, 1998) stressed the changing role of the faculty member in Internet courses. A college level mathematics course and an ethics class, both taught on-line, were investigated. One of the conclusions of this study was the need for students to be given a clear understanding of what is expected of them and the objectives and outcomes of each activity. The loss of non-verbal communication between instructor and students was seen to create new challenges, as the student was unable to demonstrate uncertainty of discomfort with the course management. This requires a change in the duties of the professor. Ben-Jacob and Levin suggested altering the concept of the instructor, moving the professor toward administrative control of collaborative student groups. This is difficult to do for many faculty, trained as they are in traditional teaching methods. While some faculty happily jump into the new technologies and incorporate them into their classrooms, others are overwhelmed by them (Collis, 1993). According to Hsu and Sammons (1998), teaching at a distance, using the Internet, cable TV, videos or audio delivery, can be a bewildering experience. The way in which courses are configured must be reconceptualized. Hsu and Sammons (1998) focused on real-time communication in college level classes taught via teleconferencing systems. In comparing the experiences of teleconferencing distance teachers to traditional teachers, they noted many "uncomfortable and unforeseen" difficulties for faculty in the distance classes. In their interpretation of these communication difficulties, Hsu and Sammons concluded that distance faculty need to be prepared for the lack of face to face contact through workshops and mini-courses. The "border elements" of the traditional classroom, including body language, facial expressions, and tone of voice of the instructor, are lacking in teleconferencing systems. It is the job of the instructor to bridge that gap, presenting the students with a comfortable learning environment. This is difficult to achieve, and requires faculty training and support (Hsu and Sammons, 1998).

The literature reports many studies that indicate the use of multimedia presentations are far more engaging and increase subject interest and retention beyond that found in single

mode deliveries (Felder and Silverman, 1988; Daily and Daily, 1994; Rutz and Hajek, 1998). Lectures should be shorter, and study materials and handouts must be far more self-explanatory (Adams et al., 1998). Ideas become the main focus of the learning environment, rather than the potentially distracting border elements of appearance, physical handicaps, gender or race. (Kruger et al., 1998). The professor should be able to remove him or herself from the center of the course and act as a consultant or facilitator of the information. (Ben-Jacob and Tucciarone, 1997). In all, changes in teaching style are needed if students are to actively participate in the distance learning process (Hajek, 1995). The courses taught via distance media evolve into something entirely new for the instructor, causing professors to face entirely new challenges. (Burgstahler, 1997).

Adams, Bicknell-Holmes and Latta (1998) analyzed the current state of distance teaching at the University of Nebraska, Lincoln, which offers a large number of classes via distance media. Adams et al. investigated the challenges posed the University by having a substantial increase in the number of distance students as well as faculty involved in teaching these classes. While many of their conclusions dealt with the upgrade and enhancement of library resources for the distance student, they emphasized the need for faculty training and additional clerical support. Faculty required additional informational support staff in order to offer learning experiences that allow the distance student to exercise independent learning skills. Adams et al. (1998) noted that while faculty may be well versed in the use of technology in the traditional classroom, they were ill-prepared for the administrative and managerial duties required of them in the distance setting. To alleviate faculty workload, a coordinator position within the libraries was created solely for distance faculty support. Faculty development personnel and librarians dedicated to teaching via distance has been a critical piece in the successful distance education offerings of the University of Nebraska. The constant novel challenges faced by the distance instructor were acknowledged and anecdotal information presented as to how faculty member job satisfaction was affected (Adams et al., 1998). It has been proposed that the more time that is spent up front, working with faculty, the greater the degree of comfort and confidence they show while teaching (Bergman and Raleigh, 1996).

Thompson and Stringer (1998) reported that today's educators are expected to adapt teaching and facilitation techniques to the new technologies available from which to instruct. In their opinion, this shift in teaching paradigms from traditional methods to that which is available via distance media does not come easily. It is a very different experience from providing face-to-face instruction (Sherry, 1996).

Schauer et al. (1998) looked into the need for faculty education, assistance and support in distance education at the University of Nebraska. The research questions posed for this study were: "What kind of educational opportunities do faculty want to help them incorporate distance learning? What kind of assistance do they need? And What kind of support do they want? A survey was given to 30 administrators and 207 faculty who had distance education classes as a portion of their assigned duties. The survey was a 39-item questionnaire designed to uncover educational assistance and support needs for distance learning. Faculty results indicated that this group feels it is most important to obtain further education about, assistance with, or support for (a) developing interaction, (b) developing instructional materials, and (c) applying selected technologies. Additionally, clerical managerial help in running the course was listed as important. Administrators did not see the need for additional faculty support, but did acknowledge the need for policy and procedural changes relating to faculty compensation and copy write issues. They found that faculty specifically wished for preparation prior to teaching at a distance in the following areas: providing students with interactive learning experiences, designing and improving the curriculum, marketing of the distance courses, assistance in the form of funds for graduate student help, education in technical processes, workload support as evidenced by a decrease in credit workload or an increase in monetary compensation, and improved student services for these courses. These issues were reported as very real for the faculty members, but were often seen as less than necessary by the faculty's administration. With the exception of the need for policy revisions, the faculty concerns were reported as minor troubles to the administration, thereby justifying the reduction of funds available for distance teaching support at the University of Nebraska.

SchWeber, Kelley and Orr (1998) discussed training and retaining faculty for on-line courses. They came to the same conclusions as Schauer et al. (1998), specifically that the

institutions need to offer a tremendous amount of support to distance or on-line faculty. The Graduate School of Management and Technology at the University of Maryland provides course managers for each distance offering, in addition to the faculty member assigned the class (Schreiber, 1998). This has alleviated the troubles associated with what has been coined as "Administrivia" in on-line education. The course manager takes on the responsibilities of maintaining student roles, contacting students concerning course information, guiding students through the use of the course-required technology and posting grades and assignments via technology (Schreiber, 1998). Few other universities have recognized this need (Schweber, Kelley and Orr, 1998). In the University of Hawaii system, there is currently a movement to petition for faculty release time when teaching distance education classes. As spokeswoman Pricilla Millen noted in her original petition: "The premise, as I understand it, is that, since of load of weekly preparation of lectures and their presentation is absent in the re-broadcast of lectures, the instructor will have additional time to invest in another section of students. This I have found not to be the case. If anything, a section of DE equals, if not exceeds the demands of in-class instruction by live lecture." Faculty workload is a very real problem, which demands research in order to deal with effectively (Slocum and Hallongre, 1998). In the succinct words of Urven, Yin and Bak (1998) "Distance learning is more time intensive per student for the faculty as compared to traditional classroom instruction."

The Research Statement

Iowa State University offers an Internet teaching environment created through the Zoology Department. Four years ago a template was created allowing courses to be taught asynchronously using Internet technology. The template, referred to as ProjectBIO, provides a means for instructors to prepare and teach entirely Internet driven classes. During its existence, ProjectBIO has steadily increased the number of courses offered over the Internet. The purpose of this study was to examine instructional issues related to the implementation of college level science instruction via the Internet, and to address administrative questions concerning appropriate faculty compensation when creating and teaching Internet classes. Specifically, the guiding question for this study was "How does internet-based instruction

impact the tasks of the instructor and the instruction itself? To examine this, two faculty members were chosen from those using ProjectBIO. The time they spent on the class, as well as their comfort level with their workload, course product and teaching effectiveness were all investigated. Data was obtained through interviews and observations during the Spring 1998 semester.

Methods

As in the previous study included in this manuscript, collective case study was chosen as the paradigm from which data was collected. The research participants in this study were two male instructors already involved in the ProjectBIO teaching effort during this study. At the time, there were a total of 7 faculty members teaching science classes via ProjectBIO. All involved faculty members were notified of the study, and were asked to indicate their interest in the project. One faculty member was on the verge of retirement, and did not want the added responsibility of tracking his time. The founder of the entire ProjectBIO effort similarly indicated no wish to take on more work. One of the instructors never responded to the original request, and one indicated no interest in "knowing how much extra work I am doing!" All the remaining three were enthusiastic about the study. The one not followed in this study was the researcher herself. The two participants had been teaching in the Zoology Department at ISU for at least 4 semesters prior to joining ProjectBIO. Both were full-time employees of the University, although neither held tenure-track professorial positions. Both participants held earned Doctoral degrees in science. At the time of the study, they were both married with children. The ages of the two instructors were comparable as well, both being in their early 40's.

The participants were selected because they represented two different perspectives in Internet teaching, ranging from novice to experienced on-line instructors. One male had been with ProjectBIO for more than two years, and was teaching his Internet science class for the fourth consecutive semester. The other male instructor was new to the entire experience, setting up and running his first Internet offering. Both instructors were asked to participate in this study prior to the start of Spring semester 1998. They joined the study willingly, expressing interest in the research questions.

Data Collection Instruments and Procedures

Data collection included observations taken during ProjectBIO meetings, formal interviews with the instructors and their significant others, journal entries provided by the instructors, and e-mail correspondence between the researcher and the participants. Both were asked to complete weekly time sheets designed to track the amount of time spent individual tasks assiciated with Internet-based instruction, but neither was able to complete these. Data was handled by first organizing the interview responses by subject. The data was further divided into themes that were indicated by the question asked. Any supporting information from e-mail or journal entries was added to the appropriate theme. The data was then re-read for content and an outline of the case was prepared. As the semester progressed, data was read, grouped, re-read and added to the developing outline. In typical inductive fashion, the final report was not completed until after the end of the semester, when all data had been collected, read and grouped. The final report headings below are those themes that were seen to be important during the data handling phase.

Interview questions asked of the instructors were aimed at uncovering the instructor's views on the efficiency of Internet instruction, their satisfaction with the teaching they were able to accomplish on-line, and their overall impressions of the effectiveness of teaching science via Internet. Typical questions asked during this interview include "Is your time on the WWW section well spent? Do you feel that you are able to accomplish as much over the Internet in an hour's time that you can in a traditionally taught lecture hour presentation?"; and "Do you view the teaching of a WWW section as a positive, negative or neutral portion of your job?" These interviews were conducted on February 25, 1998 with the more experienced instructor and on April 29, 1998 with the less experienced instructor.

Supporting information was obtained by interviewing the person closest to the instructor during the Spring 1998 semester. This protocol was suggested by Fontana and Frey (1994) when discussing how to choose an informant. They specifically recommend finding an informant who is an insider to the group being studied. Someone willing to guide and translate the events in question is of paramount importance. Patton (1990) notes that the selection of informants should be purposeful and logical. He also suggests choosing an experiential expert, termed intensity sampling. The example he gives of such a choice

included interviewing long-term patients of nurses as well as those the nurses live and work with when analyzing patient / nurse relationships. In Miller's (1994) reflective work on teaching as a female, she interviews her own mother as a source of triangulation for her findings. This choice was defended by stating that her mother was that person closest to her, and therefore best able to interpret her thoughts. The choice of interview participant in this study was an attempt to locate that person with whom the case study subject would be most familiar and open in his views on teaching. Initially the department secretary was approached, but she felt that she had not enough background on the two subjects to be of help to the study. In this study, open-ended interview questions of the participants spouse were aimed toward gaining an understanding of the instructors' attitude toward teaching in general and any outward indications of job satisfaction or stress exhibited by the three instructors. Typical questions asked during this interview include "Have you noticed any change in attitude toward teaching during this Internet teaching period?"; and "Is your associate demonstrating excessive signs of stress?" These interviews were conducted on April 15, 1998 (more experienced instructor) and May 7, 1998 (less experienced instructor). Full transcripts of interview questions asked of both the Instructors and their associates can be found in the Appendix.

No attempt was made to question students or analyze teaching effectiveness in any way. All interview questions were limited to gaining an understanding of the Instructors level of satisfaction with this experience, and an understanding of the instructional tasks involved in Internet instruction.

Direct quotes pulled from interviews will be identified by an I and the date of the interview. Comments provided during interviews with the Instructors spouses will be labeled SI. Those from journals will be designated J with the corresponding date.

Case 1 – The Voice of Experience "Dr. Jenson"

Dr. Jenson was the more experienced of the two subjects in this study. He had been with ISU for many years, joining the Zoology Department within the past 6 years. At the time of this study, Dr. Jenson held a staff position for which he was paid a salary. Teaching responsibilities were added to his duties, with additional monetary compensation and / or

lessening of staff duties as a result. The course Dr. Jenson taught using the ProjectBIO protocol was an introductory Biology course for non-science students. This course, Biology 109, was geared toward the freshman level student with little or no biology experience. The course itself consisted of spoken lectures with typed outlines presented on-line. There were images incorporated into the class, usually two or more per lecture. As with all ProjectBIO classes, the student had access to the entire semester's work at the beginning of the semester. All lectures were prepared ahead of time, and ready for student use. Despite the ability to allow students asynchronous completion of the course, Dr. Jenson required that students remain on a fairly uniform schedule for exams and homework assignments. Graded work consisted of homework assignments and exams presented to the students on-line. Dr. Jenson's assignments always included at least one written question requiring the students to assimilate and accommodate coursework and then construct an answer based on the information presented. Dr. Jenson was conscious of his effect on student learning and retention. He regarded essay questions as the best way to assess student understanding, and frequently challenged students to go beyond fact recall, trying to use the information in Biology 109 to construct possible answers to current political and public issues (I 2/98). He spent a good portion of each week reading current journals on teaching research and Internet instruction (SI 4/98). Dr. Jenson took pride in his ability to relate to students in a productive manner, and consistently offered suggestions in ProjectBIO meetings on how to reach these students more effectively.

Dr. Jenson had taught his biology course on the Internet using the ProjectBIO protocol three semesters including a summer session. Spring 1998 represented his fourth run of this course through ProjectBIO. He had an enrollment of 70 students in his Internet section during Spring 1998. While not particularly outspoken, he attended all ProjectBIO meetings and presented issues for group discussion many times. Dr. J's input on teaching strategies and administrative routines was sought after and respected by the ProjectBIO staff.

Case 2 – Overwhelmed and Confused "Dr. Douglas"

The second case was that of Dr. Douglas. He was hired into ISU's Zoology Department in 1995 as a spousal appointment. At the time of this study his position, like Dr.

Jenson's, was defined as staff. His original duties included coordinating and instructing upper level laboratories, so few changes were necessary when Internet instruction was added to his responsibilities. The Internet course was seen as equivalent to teaching one laboratory section. Dr. Douglas was given one third of a sophomore level Biology class for majors to instruct over the Internet. Dr. Douglas was first and foremost a scientist, feeling that teaching was but one part of his job. According to his spouse, Dr. Douglas spent no time reading articles on teaching, and did not know nor care to know much about educational pedagogy. She noted that he worried about the effect his teaching had on student retention, but did not follow current literature on teaching methodology (SI 5/98).

Spring 1998 was the first semester Biology 202 was offered on-line. Dr. Douglas' portion was the final third of the course, requiring him to instruct the last month of school. At the start of the semester he had nothing prepared for Internet delivery, however he had taught the course previously in a lecture hall on campus and felt confident in his experience with the material. The course structure was already in place when Dr. Douglas began on-line teaching. He had little choice in lecture style or image count. Unlike the previous two participants' courses, Biology 202 was not ready in its entirety at the start of the Spring semester. Dr. Douglas' lectures were not prepared until they were needed by the students, restraining students from working entirely asynchronously.

Dr. Douglas was present for approximately two thirds of the ProjectBIO weekly meetings, but he clearly felt frustrated by the time consumed in administrative discussions. Due to his lack of experience with the course format, Dr. Douglas' role in the ProjectBIO meetings was mostly that of an advanced student. He learned from those already working on the Internet, while providing insight that was not apparent from within the system.

Findings – Time on Task

Quantitative data on the time spent on WWW teaching was not provided by either Dr. Jenson or Dr. Douglas, despite repeated requests and promises. To compensate for that, the issue of time was discussed during the interview. "I spend much more time working on my WWW section. The preparation is very time-consuming. I spent 3 to 4 weeks working incredibly hard on getting my lectures done. It takes longer to do a lecture – it costs more to

prepare" (Dr. D I 3/98). When talking with his spouse, Dr. Douglas' level of involvement with his Internet course was indicated. "He is demonstrating excessive signs of stress. He's not sleeping ... staying up late several days a week. He writes out all his lectures, then reads them verbatim. He also does all his own graphics ... spends one hour per figure and has 5 to 6 per lecture. He wouldn't do that for live lectures" (Dr. D SI 4/98). This high level of time commitment was indicated again when Dr. Douglas' spouse reported "I have hardly seen him for weeks. This definitely cuts into family time. He should have started in a more timely manner. Spring Break he began in earnest" (Dr. D SI spouse; 4/98). In Dr. Douglas' defense he experienced a "severe shoulder injury at the beginning of the semester which interfered with his ability to type for three weeks. [He] is digging out of a hole" (Dr. D SI 4/98). In Dr. Douglas' opinion, he spent "longer on the WWW, and my time was not well spent. I had the entire lecture written out and tried to sound animated. I went back and edited mistakes – I fixed lectures because it's there and people hear it 3 or 4 times" (Dr. D I 4/98). He created his own lectures, but did have help with HTML cue points and other technical aspects of web delivery. Learning these skills again required more of his time than he anticipated "I spent more time piddling around with the Web resources" (Dr. D I 4/98).

At the other end of the spectrum, Dr. Jenson was involved not with creating lectures, but with "maintenance and fixing to make it better" (Dr. J I 2/98). Dr. Jenson felt that "editing took an incredible amount of time. I had to do lectures all over again. You have to be more efficient and careful about what you are saying. I want the product to be good quality – this takes a fair amount of time. ... Just the audio took a lot of time" (Dr. J I 2/98). After the initial creation, Dr. Jenson planned to go back and fix up the lectures. "I haven't yet. I would like to add new stories and change the information that's in there. ... The development phase is long. Once its developed there's maintenance ... well, more than that. It requires attention. New exam made up. I type all the exams in myself ... I now know HTML ... this is a nuisance that takes a while. Far longer than regular lectures ... I should be tweaking the course, but I have no time" (Dr. J I 2/98). Dr. Jenson felt bogged down in such administrative course duties as answering e-mail and grading in a timely fashion. He was still experiencing troubles transferring grades from the testing program used by ISU Internet courses to his own spreadsheet program even after 4 semesters. "I worked Sunday

from 9 PM to midnight just grading the last exam and putting the grades in [the class management program I use] for the students to review. This takes much more time than traditional grading ... yeah, oh yeah ... testing and evaluating, e-mails, grades and importing ... in a regular class I have undergraduate helpers. With the WWW that is too difficult. I wish I had been tracking time like you asked – regular versus the Web. The regular course doesn't take as much time. Three hours of lecture a week. I never do any prep for [traditional] lectures. It's fresher and more interesting without preparation. Administration time is less – UG helpers, Testing and Evaluation Services, secretaries ... I make up tests for both sections. Traditional section, I give a Word file to the secretary. For the WWW section, I also format and edit the exam. That takes more time. Images in traditional classes are easy. They are NOT easy on the Web" (Dr. J I 2/98). Dr. Jenson ended the interview with a smile and a shrug. "I'd like to be putting time into make the lectures better – more exciting. The majority of my time is spent on administrative bureaucratic work" (Dr. J I 2/98).

In talking with Dr. Jenson's spouse, she indicated the WWW section was still monopolizing his time. "I think [Web teaching] takes up more of his time. Last night he spent three hours on clerical stuff. That was more time expended ... the Web takes more clerical stuff and e-mail ... Lots of e-mail" (Dr. J SI 4/98). When specifically asked about her spouse's stress level while dealing with the Internet class, she laughed and said "a lot to do and too little time" (Dr. J SI 4/98).

Job Satisfaction

Both instructors talked about their feelings of job satisfaction while teaching on-line. They reported similar experiences. "I do get frustrated doing all this. I feel I'm not using my time most effectively. With my experience and knowledge I don't need to be doing this [administrative work]. I'm not teaching [repeated twice]. In traditional classrooms, you feel like you are teaching. You have tried to communicate and some may have gotten it. With the Web, there's no immediate feedback. The e-mail has nothing to do with content at all. I'm not really teaching .. the sense of personal satisfaction is a problem" (Dr. J I 2/98). "I generally dealt with only two things – all procedural questions. No course information,

almost no content questions. I had only one or two questions on each assignment – was the paper available or is the content relevant? Student feedback is not enriching" (Dr. D I 4/98). Dr. Douglas' spouse indicated "He is unsure of whether this is a good thing. He misses the interaction with the students ... doesn't get e-mail and worries that students are not getting what they should be. He still likes teaching as a job – just can't tell how well the students are doing" (Dr. D SI 5/98).

Internet Student Interactions

The experienced Web instructor was surprised by the level of interaction between student and instructor that this format provided. "The students e-mail me constantly, telling me things that I don't usually hear in traditional lectures" (Dr.J I 2/98). "I feel like I know these students personally, much more so than I do with traditional students." (Dr. J I 2/98) Even his spouse was able to see the relationship that developed between Dr. Jenson and his Web students. "He talks more about his Web students. He has more contact with those students. It's weird ... especially the off-campus students" (Dr. J SI 4/98). Dr. Douglas was not far enough along in his Web teaching experience to notice many differences in the student attitude, but he did notice there were fewer "no hope-ers" in his WWW class than he'd been seeing in his traditional classes. He found "not much feedback from these students. I posted grade comments, but no one signed on to the forum after the assignments were turned in. No two-way interactions" (Dr. D I 4/98).

Internet Education Potential

Despite the acknowledged increase in administrative work associated with this particular mode of distance education experienced by all three instructors, their overall impression of this teaching format was positive. Dr. Jenson's spouse noted "He has been excited about the possibilities of teaching in this way all along. He sees a lot of potential in on-line teaching" (Dr. J SI 4/98). Dr. Douglas noted that "the on-line experience could be positive – it has the potential to be positive. I would like to do it again and do a better job" (Dr. D I 4/98).

According to those closest to him, Dr. Douglas was initially unsure of the positive effects of WWW teaching. His spouse noted "His opinion of Internet instruction has changed. It may be more positive than it was" (Dr. D SI 5/98). Dr. Douglas surprised himself at the end of the semester. "I want to continue this. The effort may average out. I'd like the course to be better. Right now the stuff on the WWW is less good than my traditional teaching" (Dr. D I 4/98). Later in the discussion, he admitted "the Web class is nowhere close to what I'd like. It is almost a taped lecture with not quite Power Point slides. I'd like to improve the Web usage. The potential is there" (Dr. D 4/98). This closely matches the findings of Dillon and Walsh (1992), in which it was seen that faculty involved in distance education acquired more positive attitudes as their experience with distance education increased.

Dr. Jenson remained positive throughout the semester. He has approached this mode of instruction with enthusiasm from the outset. His spouse said "He finds this whole experience to be positive and exciting. He sees tremendous potential for WWW teaching (Dr. J SI 4/98). When asked if he would do it again, Dr. Jenson enthusiastically replied "I am doing it again!" (Dr. J I 2/98).

Conclusions

While conclusions are difficult to draw from qualitative research, a few observations do stand out. The time spent on creating, monitoring and administrating an Internet course is higher than traditional courses. This is reflected both in actual time usage and in instructor opinion of time usage. "Lecture for lecture, the Web is inordinately higher in time demands" (Dr. D SI 5/98). This expenditure of time does not diminish with teaching experience. The administrative and secretarial duties absorb much of the Instructor's time. This seems to be a function of the support provided by the individual departments (Cini and Vilic, 1999; Adams and Latta, 1998). Traditional instruction is accompanied by large, integrated support systems. Perhaps as Internet instruction becomes more widespread, the necessary support infrastructure will be put in place. The most recent of the technology usage scales addresses this very issue (Boetcher, 1998). Institutions are ranked using Boetcher's scale based on their commitment to technology as demonstrated by their usage of technology in the

classrooms and their support of that usage through administrative personnel. The level of Institution-wide support is seen as an indicator of the degree of confidence the administration has in moving toward a truly technologically integrated curriculum (Boetcher, 1998).

As can be seen in these cases, the role of the instructor changes in asynchronous Internet delivery. The Instructor moves from primary information source to clerical support personnel for their own course. This can lead to loss of job satisfaction as the instructor looses the direct connection between their instruction and student understanding. However, the interpersonal communication between instructor and student is higher. This brings rewards of a different sense. Students bond more personally with the instructors and maintain this relationship beyond the course. Dr. Jenson has students from past semesters that continue to e-mail him (Dr. J E 3/99, Dr. J E 4/99). These students ask scheduling advise, career choice advise and sometimes just stay in touch as a personal friend. In other words, mentoring is facilitated. The instructors also demonstrated an increase in interest in Internet teaching as a result of their efforts. Undoubtedly WWW teaching holds great potential for instruction. Currently, additional funding, support personnel and release time are necessary to truly optimize Internet instruction.

Similar conclusions were reached by Allen, Stecher and Yasskin (1998) when they analyzed Texas A and M's web-based mathematics course. As Judith Boetcher (1998) relates, there is a trend toward the use of technologies on campus. Whether or not it is billed as distance learning, on-line education is here and growing. This study is an attempt to help faculty and administration understand how on-line instruction will affect their positions, their time expenditure and ultimately their budgets.

References

Adams, K., Bicknell-Holmes, T. & Latta, G.F. (1998). Supporting distance learners and academic faculty teaching at a distance. Proceedings of the 14th annual conference on Distance teaching and learning. August 5–7, (pp. 3-8).

Allen, G. D., Stecher, M. & Yasskin, P. B. (1998). The Web-based mathematics course. Syllabus, 12(4), 62-65.

Bailey, M.L. & Leutkehans, L. (1998). Ten great tips for facilitating virtual learning teams. Proceedings of the 14th annual conference on Distance Teaching and Learning. August 5–7, (pp. 19-28).

Ben-Jacob, M.G. (1998). Teaching mathematics, science and technology on the Internet: A workshop (description) for educators in the new millenium. Proceedings of the 14th annual conference on Distance teaching and learning. August 5–7, (pp. 49–55).

Ben-Jacob, M.G. & Levin, D.S. (1998). Collaborative Learning: A critical success factor in distance education. Proceedings of the 14th annual conference on Distance teaching and learning. Madison, WI, August 5–7, (pp. 57–60).

Ben-Jacob, M. G. & Tucciarone, J. (1997). Distance learning and the virtual university: Technology and its effects on University and College courses. Proceedings of the 22nd international conference on improving University teaching. London, England. (pp. 44-51).

Bergman, M. and Raleigh, D. (1996). The Accordion curriculum: Training instructors for distance education in a higher education environment. Proceedings from the 12th annual conference on distance teaching and learning. Madison WI, August 7-9, (pp. 13-18).

Boettcher, J.V. (1998). Taking off with distance learning: Are we there yet? Syllabus, 12(4) 22–27.

Brooks, B.W. (1997). Web-teaching: A guide to designing interactive teaching for the World Wide Web. New York: Plenum Press.

Burgstahler, S. (1997). Teaching on the net: What's the difference? T.H.E. Journal 1997.

Cini, M.A. & Vilic, B. (1999). Online teaching: Moving from risk to challenge. Syllabus, 12(10) 38-40).

Collis, B. A. (1993). Evaluating instructional applications of telecommunications in distance education. Educational and Training Technology International, 30(3) 266-274.

Daily, B. & Daily, M. (1994). Effectiveness of a multimedia televised distance education program for engineering majors. Journal of Engineering Education, 8(4) 383-387.

Dillon, C. L. & Walsh, S. M. (1992). Faculty: The neglected resource in distance education. The American Journal of Distance Education, 6(3) 5-21.

Felder, R. M. & Silverman, L. K. (1988). Learning and teaching styles in engineering education. Engineering Education, 674-681.

Fontana, J. H. & Frey, A. (1994). Interviewing: The art of science. In (Ed. N. K. Denzin & Y. S. Lincoln), Handbook of Qualitative Research (pp. 361–376).

Hajek, B. K. (1995). Teaching NE courses via live TV: Style changes are needed. In E. Rutz & B. Hajek (Eds.), 1998 Collaborative distance learning using interactive video: lessons learned from the University of Cincinnati/Ohio State University experience. Proceedings of the 14th annual conference on Distance Teaching and Learning. Madison, WI, August 5–7, (pp. 315-320).

Hsu, S. & Sammons, M. (1998). The invisible barriers to teaching at a distance. Proceedings of the 14th annual conference on Distance Teaching and Learning. August 5–7, (pp. 179-186).

Ingebritsen, T. I., & Flickinger, K.A. (1998). Development and assessment of web courses that use audio and video technologies. Proceedings of the 14th annual conference on Distance teaching and learning. August 5–7, (pp. 195–201).

Kruger, L. L., Porter, C. W. & Burke, D. (1998). Asynchronous education: A blueprint for the future of adult learning. Proceedings of the 14th annual conference on Distance teaching and learning. August 5–7, (pp. 203-207).

Millen, Pricilla, (1999). A request for reasonable distance education workload. U H Faculty Senate minutes, April 14. (personal communication)

Miller, J. L. (1994). Solitary spaces: Women, teaching and curriculum. In R. Martusewicz & W. Reynolds (Eds.), Inside / out : Contemporary critical perspectives in education. New York: St. Martins Press.

Patton, M. Q. (1990). Qualitative evaluation and research methods (2nd ed.). Newbury Park, CA: Sage.

Rogers, Everett M. (1980). Communication Technology: The new media in society. New York: The Free Press.

Rutz, E. & Hajek, B. (1998). Collaborative distance learning using interactive video: lessons learned from the University of Cincinnati/Ohio State University experience. Proceedings of the 14th annual conference on Distance Teaching and Learning. August 5–7, (pp. 315-320).

Schauer, J., Rockwell, S. K., Fritz, S. & Marx, D. (1998). Education, assistance and support needed for distance delivery: Faculty and administrators perceptions. Proceedings of the 14th annual conference on Distance teaching and learning. August 5–7, (pp. 321-330).

Schreiber, D.A. (1998). How to maximize use of technology and institutionalize distance learning efforts. Proceedings of the 14th annual conference on Distance teaching and learning. August 5–7, (pp. 331–340).

SchWeber, C., Kelley, K. B. & Orr, G. J. (1998). Training, and retaining, faculty for online courses: Challenges and strategies. Proceedings of the 14th annual conference on Distance teaching and learning. August 5–7, (pp. 347-352).

Sherry, L. (1996). Issues in distance learning. International Journal of Distance Education, 1(4) (pp. 337-365).

Slocum, P. J. & Hallongre, E. (1998). Faculty compensation issues in distance education. Proceedings of the 14th annual conference on Distance Teaching and Learning. August 5–7, (pp. 367-370).

Thompson, J.S. & Stringer, S. B. (1998). Evaluating for distacen learning: Feedback from students and faculty. Proceedings of the 14th annual conference on Distance Teaching and Learning. August 5–7, (pp. 401-406).

Urven, L. E., Yin, L. R. & Bak, J. D. (1998). Integration of live video and WWW delivery systems to teach university level science technology and society in High Schools. Proceedings of the 14th annual conference on Distance Teaching and Learning. August 5–7, (pp. 407-412).

Appendix

Interview Questions for Study Three

Principle subject questions

1) How many students are you dealing with over the Internet this semester? Is that a change from previous semesters?
2) Are you comfortable with the course as a product right now?
3) Are you in the process of creating lectures, or substantially rewriting / re-speaking lectures?
4) Is your time on the WWW section well spent? Do you feel that you are able to accomplish as much over the Internet in an hour's time that you can in a traditionally taught lecture hour preparation?
5) Do your WWW students react as you expect when you give out assignments, exams, etc.? (What are your expectations?)
6) Is there any noticeable difference between the attitudes of WWW students and traditionally taught students?
7) Do you feel that your attitude toward WWW students is similar to your attitude toward traditionally taught students?
8) How much time do you feel that you spend on the administration of the WWW class as compared to traditional classes?
9) In relation to the traditional courses, how much energy do you spend on your WWW section?
10) Do you view the teaching of a WWW section as a positive, negative or neutral portion of your job?
11) How satisfied with your use of the current technology in teaching over the WWW are you?
12) Given the experiences you are having now, would you do it again?
13) What would you change about the WWW sections? Why?

Person associated with WWW instructor questions

1) How long has your associate been teaching over the Internet?
2) Does your associate enjoy the process of teaching?
3) Does he / she spend time reading articles on teaching skills?
4) Use terms like pedagogy? Worry about the impact his / her teaching is having on the students? Give examples.
5) Have you noticed changes in attitude toward teaching during this Internet teaching period?
6) Is your associate demonstrating any excessive signs of stress?

7) Do you find your associate discusses the WWW teaching experience more often than "regular" teaching?
8) Does he / she present WWW teaching in a positive, negative, neutral, or other fashion?
9) Does the WWW section interfere with your time with your associate to a greater or lesser extent than regular teaching assignments?
10) Do you feel that your associate spends an equal amount of time on the Web section as regular section teaching assignments?
11) Do you see this as a positive, negative or neutral part of your associates job? Why?
12) If this is not the first time your associate taught this class, has your opinion of your associate's views on Web teaching changed? Is he/she more comfortable, less comfortable, more irritable, less stressed?

CHAPTER 5. GENERAL CONCLUSIONS DRAWN FROM THE DISSERTATION RESEARCH

After completing all three research paradigms and compiling the data, some general conclusions can be drawn concerning teaching Anatomy and Physiology over the Internet. It appears that the use of the Internet does create a slight excitement at the beginning of the semester. This heightened sense of anticipation was evident not only in the collective student case studies, but also in the quantitative survey data obtained in study two. The Internet section did not draw a significantly different audience from the traditional section either semester of the study, indicating that students apparently enrolled in the course based on factors other than mode of delivery. Self selection was not a factor in the population taught over the Internet. Due to Iowa State's timing of course enrollment, there was a preponderance of upper level students in the on-line class the first semester. Again, this was attributed to the enthusiasm with which students met the idea of Internet accessible classes. The Internet section filled up much more quickly than the traditionally taught section, closing it out to first semester freshmen. This difference could easily be overcome by saving a few slots during registration for those who must register at the end of the period. Once enrolled in the Internet section of the course, students found they did have to adjust their mode of studying. Good study habits, including reading the assigned portions of the text, going over notes and lecture materials, making use of supplements to the course and reviewing tests to correct errors, were all seen by the students as important to the success of the Internet class. Most of these habits were reported as not occurring at all, or in such low frequency as to be non-representative of the class as a whole in the traditionally taught section. Students noticed their personal motivation to succeed was far more important to success in the Internet section of the class than in other, traditionally taught classes. The apparent lack of social interaction with peers and the instructor was not seen as a deterrent in the Internet section, despite original fears voiced by case study students that perhaps they would be isolated. In all three studies, it was seen that students actually felt more in touch with their instructor on the Internet than in traditional classes. There was some concern voiced by both students and instructors that students in the class did not converse much on-line, but this was not seen to be a major detriment to the learning environment as reported by the students. Grade

distributions indicated that this was not paramount to success. There was a slight increase in student drop rate for the Internet courses as compared to traditionally taught classes. This may be where the student – student lack of interaction manifested itself. These drops occurred early in the semester, and were attributed mostly to technology failures and frustrations, but perhaps peer interaction also played a role. Alternatively, perhaps less instrumental peer to peer interaction takes place in traditionally taught classes than Instructors choose to believe?! From the Instructor point of view, it is apparent that Internet instruction requires a larger demand on time, and a shifting of roles. All three instructors studied were intrigued by the possibilities of Internet instruction, and wanted to continue despite the extra effort required. Internet instruction was seen as a positive experience for both the students and the instructors, with many ways to increase productivity and learning.

In all, these glimpses into the phenomenon of Internet instruction provide a positive starting point for further work. The students appreciate the freedom to learn at their own pace and on their own time. They also gain valuable study skills that will certainly help in future academic endeavors. The instructors enjoy the creative component of producing the course, as well as the personal contact with the students via e-mail. Changing from the "front of the class" provider of information to each student's personal content coach and mentor seems to have an appeal for the instructors once they experience it. Comparison of grades and other traditionally accepted methods of assessment indicate no loss of comprehension or retention in the general student population using the Internet as compared to traditional teaching methods. According to the criterion examined in this work, Internet instruction is not only feasible but productive. So far, it seems to be a good match between technology and education. Future research should be aimed at fully assessing the motivational factors involved in successful Internet instruction, both from the students' aspect and the instructor or originating department. As newer technologies are added to the Internet offerings, these should be assessed for effectiveness and learning environment impacts in a fashion similar to the studies presented here.