A QUALITATIVE CROSS-CASE ANALYSIS OF POSTSECONDARY STUDENTS' PERFORMANCE IN ASYNCHRONOUS MECHANICAL SYSTEM LABORATORIES

A Record of Study

by

KIM THOMAS HAYS

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

December 2006

Major Subject: Agricultural Education

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ABSTRACT

A Qualitative Cross-Case Analysis of Postsecondary Students' Performance in

Asynchronous Mechanical System Laboratories. (December 2006)

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Asynchronous education activities have grown rapidly through popular distance education delivery techniques. This rapid growth has precluded science, technology, and engineering. Practice oriented disciplines have considered laboratories as key components of the curriculum. The laboratory is the difficulty of teaching such subjects through distance education.

Studies have indicated that independent asynchronous study is not suitable for everyone. A qualitative study investigating two cases and utilizing a cross case analysis was performed with the goal of establishing some characteristics found in individuals who are successful, and those who are challenged by asynchronous laboratory study. Also considered were key factors which could aid or impede asynchronous laboratory studies. Case One involved a course on agricultural mechanical systems taught at a Texas four-year university with 13 participants. Case Two involved a course on electrical controls taught at the technical center of a Texas community college with 18 participants. Data were collected from observation - journaling, performance scores, and a questionnaire – interview process; then analyzed using the constant comparative method. To insure trustworthiness; credibility, transferability, and dependability were addressed. The cross-case analysis found no conflicts and reinforced the findings.

The findings yielded a list of characteristics of individuals who were successful using asynchronous laboratory studies. Successes represented an elite student profile and support the suggestions of Lemckert and Florance (2002). Students were more likely to be successful when they (a) were autonomous self directed learners; (b) had a prerequisite knowledge framework; (c); had prerequisite technical skills; (d) had high reading and comprehension skills; (e) held intrinsic value for the educational experience; and (f) sought and used instructional resources. The factors discovered which aid or impede asynchronous laboratories are course design and curriculum issues. Asynchronous laboratory studies are more likely to be successful when they (a) provide a responsive system of feedback; (b) introduce study as small, step-wise experiences; (c) do not introduce independent complex concepts; (d) provide sufficient instructor time; (e) standardize computer software and applications; and (f) pilot-test and field-test laboratory equipment and activities.

Conclusions drawn indicate limited applications of asynchronous laboratories for select prepared individuals with a critically designed curriculum.

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How do you remember and acknowledge all the people who have asked if you are writing and encouraged you to do what it takes and get it done? I do owe a debt to so many who have encouraged and to those who have patiently waited. From the beginning I have been grateful to the teachers in the Doc@Distance program and for a most helpful and encouraging committee.

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CHAPTER I

INTRODUCTION

Background of Study

Sociological changes have created a movement towards the democratization of higher education, towards the notion that anyone, anywhere, at any time should have access to learning (Feisel & Peterson, 2002). Current social and educational trends indicate the demand for the student to be more flexible in participation times and settings (Moore, 2003). In this age, these goals may be accomplished through asynchronous activities via a distance education medium. Distance education is now well over 100 years old regardless of the beginning event that you choose. The meaning of distance education has changed and thus the defining criteria have evolved. Keegan (1996) is recognized for his efforts to define the elements of distance education which he states as:

1. The quasi-permanent separation of the teacher and learner.
2. The influence of an education organization both in planning and preparation of learning materials and in the provision of student support services: This distinguishes it from private study and teach-yourself programs.
3. The use of technical media, print, audio, video or computer to unite teacher and learner and carry the content of the course.

This record of study follows the style of the *Journal of Agricultural Education.*

4. The provision of two-way communication so that the student may benefit from, even initiate dialogue: This distinguishes it from other uses of technology in education (p. 50).

Moore (2003) sees that there is a psychological separation of teacher and learner as well as the physical separation, and thus in the United States what is most commonly described as distance education, was called "Independent Study" for many years. This term was especially promoted by Charles A. Wedemeyer, formerly of the University of Wisconsin at Madison, for university-level distance education programs. Current literature recognizes that many students, possibly living on campus in a dormitory room, are utilizing such an educational system as described by Keegan (1986), but without the separation, either physical or psychological. These students simply work on their own schedule and possibly at their own pace. Some schools now allow continuous enrollment and begin a new session each month, thus there are many schedules and stages of completion at any one time. Students may interact with one another or with the teacher. With the separation factor diminished we now have "Asynchronous Studies" appearing in literature. As we perceive newer technologies to have advanced potential and as our culture adapts to communications which offer less personal interaction, it is often believed that there is a possibility of diminished psychological separation. Moore (1991) describes his theory of transactional distance as referring to a distance in distance education that is more than simply a geographic separation of learners and teachers, but also includes a distance of understanding and perceptions. Moore (1991) has come to recognize that there is some of this transactional distance even when teachers and learners meet face to face.

Just a few of the other labels now in vogue for this developing, ill defined era of education include; e-learning, distributed learning, blended learning, home study, non-traditional learning, out-of-school learning, external studies, independent studies, teaching at a distance, off-campus study and open learning (Keegan, 1996). During the 80's British and Australian literature used labels such as "extended" and "tertiary" (Roberts, 1984). Asynchronous in this study will refer to independent asynchronous distance education.

At this time we are still in the initial stages of an apparent sudden and new acceptance of asynchronous study compared to previous attitudes toward education outside the college campus setting. Gooch (1998) discusses delivery systems used by the University of Wisconsin starting in 1891 and points out that the University of Wisconsin had established an extension program by 1906. By 1911 the two largest units in the correspondence program were the engineering and business administration programs, and reports from that era were already stating:

> Those who would belittle correspondence study contrived chants such as:
>
> Pooh! Pooh! Harvard!
>
> Pooh! Pooh! Yale!
>
> I got my education through the mail! (Gooch, 1998, Independent Study section, para. 6)

Verduin and Clark (1991) state, “The Educational Resource Information Center (ERIC) did not begin to use “distance education” as a descriptor until 1983” (p. 9).

Moore (2003) looks at the reason, need for, and acceptance of current educational trends in the statement:

> With adult education, distance education from the earliest times has shared three distinctive and often interlocking views of purpose and direction. The first (and simplest to detect and record) is the vocational; the second is the drive for equity of individual opportunity, the third is social change. All three came together in one powerful manifestation in the early 1970s in the form of the Open University in the United Kingdom and subsequent worldwide embrace of distance education, often under the rubric of “open learning” (p. 3).

Moore (2003) points out that we often describe asynchronous studies by their mode of delivery technology and suggest that the different technologies may share many of the same attributes, thus we can learn from lessons learned with previous mediums or modes of delivery.

Among the unanswered questions in distance education is the role of laboratory instruction (Forinash, 2001). Holmberg, Liston, and Carter (1998) state that in the area of science the difficulty with distance education boils down to one word, “labs”. Because of the difficulties of distance education laboratories Holmberg, Liston, and Carter (1998) state:

> Although the number of institutions in Canada and the United States that offer university courses at’a’distance has tripled in the last two decades, the fraction

> that offer even moderate numbers of basic science courses (i.e. biology, chemistry, geology, and physics) has remained about one-third (p. 166).

This disparity is usually attributed to the difficulty with the laboratory component of such subjects and the continued need for such components in these subjects.

Moore (2003) found the first and simplest purpose and direction of distance education to be vocational. Early correspondence courses often addressed subjects concerning new technologies such as electricity and often taught “how to” do things, such as repair appliances or build something. Gooch (1998) speaking of the history of the University of Wisconsin Extension system noted:

> Of the 18 correspondence course texts in use before World War I, 16 were engineering-related. Advertising for these courses invited road laborers, foremen, inspectors, high commissioners, engineers, and government officials to enroll and take advantage of the benefits of correspondence study, including increased chances for promotion. Some of the 1911 correspondence study ads pointed to Abe Lincoln, Thomas Edison and Henry Ford as examples of men who had succeeded via the home study route. (Independent (Correspondence) Study section, para. 9)

Hands-on trades have often been the focus of asynchronous studies from the beginning.

In practice oriented disciplines, laboratory studies have been considered key components of the curriculum (Feisel & Peterson, 2002). However laboratories are expensive, hazardous, require large areas per student, have low student-to-teacher ratios, receive low utilization because they are not adaptable to other classes, and compete inequitably for school resources; but few in agriculture, engineering, science, and technology fields see an alternative. Over twenty years ago in a study to seek efficiency in science laboratory utilization, not alternatives, Graham (1982) stated:

> Despite the agreed importance, there are serious problems related to laboratory instruction. One of the most serious of these is large capital investment required to acquire modern equipment. Dean Robert Page of Texas A&M University has estimated that an investment of $17,409 for each engineering Bachelor's degree awarded in 1980/81 is necessary for updating laboratory equipment. Faculty are finding it difficult to devote the time required for proper laboratory development and students often feel that they do not gain much for the time required in laboratories. (p. 148)

Holmberg and Bakshi (1982) suggest five alternatives to conventional laboratory arrangements:

> 1. Elimination of laboratory attendance altogether.
> 2. Make the laboratories available at times convenient to the student.
> 3. Arranging for the use of local (relative to the student) laboratories.
> 4. Forwarding experimental kits directly to students.
> 5. Substitution of laboratory work with alternative material (eg. CAL packages, videos, etc.). (p. 203)

Many jobs mandate that those involved in such professions have exposure, practice and experience; eliminating the first alternative for practice oriented fields. Considering the expense and supervision required to keep a laboratory open 24-7 the second alternative of convenience to the student is generally not feasible. The third alternative of utilizing local laboratories brings the student out of the asynchronous studies paradigm, thus outside the consideration of this study. Limited applications of the fourth alternative of individual laboratory material and the fifth alternative of substituting alternative media materials are used in this study.

Recognizing that there may be few alternatives for developing the technical skills or acquiring familiarity with equipment that we expect in some professions; this study has focused on the cognitive understanding, application, analysis and problem solving that are commonly part of laboratory goals. What are the factors that allow for successful alternatives to the conventional laboratory experience in these areas? Many alternatives appear to dilute the academic standard in the name of expediency or efficiency.

In 2001 the Accreditation Board for Engineering and Technology Education (ABET) along with the Alfred P. Sloan Foundation began considering distance education issues for technology and engineering; especially the challenges of laboratories. They held a colloquy in 2002 which represented a wide range of disciplines and all type of schools. At their 2003 annual meeting they presented a list of laboratory instructional goals and objectives to their body of members for consideration and input. This represents a comprehensive effort to define, document, and evaluate laboratory instruction. Their goal is to develop a taxonomy of laboratory instruction that will help define and evaluate conventional laboratories and at the same time allow standards to be developed for application in distance education (ABET, 2003). It is hoped that once defined, some laboratory practices which do not require the hands-on component, can be shifted to classroom or similar distance education activity; those practices that are left can be classified as adaptable to distance education or requiring other alternatives. This should be seen as a very positive effort on behalf of distance education since ABET's membership has the expertise and knowledge to move forward decisively, independent of many other factors influencing the development of distance education and the practice of laboratory instruction.

Trammell (2001) compiled a collection of bulletin board postings in response to questions about laboratories in distance education. In this collection, Dietmar Kennepohl, Associate Professor of Chemistry at Athabasca University, Canada, states:

> We do not have formal criteria for the laboratory components, except that it should be equivalent (not necessarily the same) to courses at traditional universities in Canada. Because many of our students are visiting students and are only taking these courses to transfer them to other institutions it encourages us to maintain a bone fide lab component. These courses above are all transferable to other universities in Canada. So in fact this becomes our acid test. Do other institutions recognize the chemistry course (including labs) as being equivalent to their own course? (Trammell, n.d., 2nd reply to posting)

This seems to be the common attitude or assumption, if someone else will accept a course, it must be good. Are other universities going to refuse to accept these courses for transfer with the Prime Minister waving the flag for the institution? How else could innovation proceed without making some assumptions? Surely maturity will bring standards. In recognition that such programs have pioneered asynchronous laboratory development, this study seeks to advance support for such programs by contributing to the understanding of some factors that might predict success in the asynchronous laboratory.

If we look at agriculture alone we find some agreement on curriculum content, and even some limited agreement on laboratory curriculum, but there is little documented consensus on laboratory objectives or goals. Therefore ABET will be considered as a large respected technical organization which has conducted surveys, set standards, and made recommendations for what they call “practice-oriented disciplines” and the objectives for laboratories in such fields of study. Is agriculture a science or a technology, or is it where the two meet in such a practical manner? Either way, the objectives for technical and science education seem congruent with agricultural education.

Thus far this discussion has focused on, the somewhat negative view, “can we really do it and do it right”. At the same time budgets are tighter, important information and skills for every discipline are increasing, the face of the student body is changing, and students often view laboratories as a waste of time (Graham, 1982). These factors mandate that we must seek alternatives to conventional laboratories, and do so without extreme investment in teacher skills. This is a descriptive qualitative study utilizing two case studies to reflect on the factors which affect the adoption of distance education for laboratory training.

Statement of the Problem

Laboratories traditionally serve as periods of directed hands-on-learning. Mezirow, Freire, and Kolb often called this experiential learning and recognized stages of experience, reflection, and experimentation (Kelly, 2001). Are there ways to effectively involve the student in asynchronous laboratory sessions that will approximate the effect of a traditional hands-on laboratory? Will material learned from such sessions transfer to other applications and will it be utilized in problem solving just as information garnered from traditional laboratory activities? Few educators would argue that one teaching methodology is best for every situation. Are asynchronous studies suitable for everyone, everywhere, every time? If not what characteristics describe the ideal application for asynchronous studies?

A survey of major independent study programs as listed and defined by Moore (2003) reveals that subject matters being taught by asynchronous study are typically the same as those taught using only traditional classroom methods of text, lecture, or illustration. Such subjects range from accounting to women's studies with a small number of science courses and few if any technical subjects. The addition of instructional laboratory sessions is applied to subjects taught for practice-oriented professions requiring the personal interaction with equipment, tools and individuals leading to the accumulation of knowledge and skill (ABET, 2003). The purpose of the current study is to compare the fulfillment of laboratory goals of acquisition, retention, transfer, and application of knowledge by utilization of demonstration - practice when presented through moderated simulation in an asynchronous setting and in a face-to-face traditional demonstration / practice setting. Specific goals are the establishment of the characteristics of individuals who were successful in the acquisition, retention, transfer, and applications of knowledge learned in asynchronous studies; and the establishment of factors that compounded these goals.

Questions to Guide Discovery

To initiate this study the following questions were asked:

What characteristics describe learners who are more successful when experiencing asynchronous studies than students who are challenged by this instructional strategy?

What characteristics describe learners who are more successful when experiencing traditional face-to-face synchronous studies than students who are challenged by this instructional strategy?

What key factors aid in the success of asynchronous laboratory studies?

What key factors impede the success of asynchronous laboratory studies?

Limitations

It is recognized in the design of this study that limitations exist. Social complexities inhibit individuals and groups, and played a significant part in the outcomes. The timeframe in which the modules of instruction under study were performed exaggerate some attitudes. Being the first time some of these modules of instruction had been taught, it is recognized that the instructional design had not been developed to it’s potential. It is also recognized alternating groups with different subject matter is not an equal test of performance. As a qualitative study seeking to describe observations within case boundaries, results can not be generalized. These factors are acknowledged and may be adjusted in future studies but are typical of a qualitative study.

Significance of Study

This study was conducted in an effort to bring an understanding of some of the student, instructor, and curriculum issues in asynchronous laboratories. The results are stated to contribute to the future of laboratory instruction and its potential in the asynchronous environment. There is a gap in the literature concerning success factors in asynchronous laboratory instruction. The findings of this study contribute to the discussion of such factors. It is hoped that organizations will seize the opportunity to fill in the gaps and consider the outcomes as an impetus for future research.

Definitions

Asynchronous Demonstration / Practice – may include distance education, remote delivery, asynchronous studies, individualized studies, online studies or supplemental course studies. – Refers to studies conducted independently of class location and time, without face-to-face interaction with students or instructors. Often computer or Internet aided.

Experience - active participation in events or activities, leading to the accumulation of knowledge or skill. A lesson taught by experience. The knowledge or skill so derived. (Dewey, 1963)

Interview, interview questionnaire, and transcribed interview comments – A combination of tools for gathering data during the final interview. An interview questionnaire was used to set the stage for the individual interviews and it also addressed universal questions resulting from recent observations. The questionnaire was handed to the researcher at the time of the individual interview. A quick scan of key questions gave direction to the semistructured interview. A general interview protocol was used along with additional probing questions. Responses were noted on the questionnaire. A voice recorder supplemented data collection with limited satisfaction. Data from these sources were combined to form the nominal interview.

Laboratory studies – The laboratory component of a curriculum devised for practice oriented disciplines such as scientific or technical studies. These studies are in preparation for professions which require exposure, practice and experience.

Observed journal – Field logbook of observation, design concerns, questions, reminders, discoveries, and insights. An assembly of student indexed pages used by the researcher in the laboratory and class setting, for field notes.

Observed performance score – A scoring method common to technical training which reflects an individual's skill level in performing a task. Not related to a grading system, but utilizes a competency scale. Normally matched to major outcome objectives.

Traditional laboratory – may be referred to as stand up instruction, conventional laboratory instruction, face-to-face laboratory – Refers to interactive laboratory exercises conducted within a structured, suitably equipped environment as described by Lemckert and Florance (2002).

CHAPTER II

REVIEW OF LITERATURE

Introduction

We will consider the literature concerning asynchronous studies, the no significant difference phenomenon, laboratory instruction, and asynchronous laboratories.

Asynchronous Studies

Moore (2003) gives a history of the development of independent and distance study practices from 1881 to the 1990's, but more importantly points out:

> Into the 1980's, however, occasional voices continued to lament the lack of a clearly defined paradigm for research. . . . Coldway (1988) performed a literature review and found little "planned-for" research, that is, research conducted in a reportedly systematic, empirical manner. He concluded that it was impossible to analyze data in current research for important effects, the magnitude of effects, and the generality of results because of the less-than-rigorous methods. (p. 34)

Moore (2003) emphasizes that much of the limited research dealt with completion factors and reasons for the appeal of such training and points out that the rigor varied tremendously among these studies even through the 1990's. All of this points to an immature field of research (Moore, 2003).

No Significant Difference Phenomena

Verduin and Clark (1991) published a list of studies that made a comparison of the academic achievement of all types of independent study programs in higher education; most were in support of the hypothesis called the *no significant difference phenomenon*. Through all the struggling development of independent study practices one thing has always risen to the top, the no significant difference phenomenon. In a book by the same title, Russell (1999) compiled and briefly described 355 research reports, summaries, and papers which supported the no significant difference findings. Bates (2000) goes so far as to say that straight comparison studies are not helpful, especially since we have known from the 1970's there is "no significant difference". Russell's web site – nosignificantdifference.org - continually updates and comes up with a few reports showing some advantage of face-to-face teaching, but just as many declarations for all modes of instruction. Clark (1983) in his conduit theory suggest that any medium is a vehicle of delivery which has no more to do with student achievement than the truck that delivers our food has to do with nutrition. Clark (1983) and Russell (1999) pose the question of why we should use any higher level of technology or more expensive medium than the minimum required if they all produce the same results.

Main and Riise (1995) and Murphy (2000) brought up a common error in distance education research, that of self selection. Few studies have assigned people to distance education alternatives for a given class. Generally the studies have been conducted between those who desired the distance education medium or had no alternative, and those who chose or only had contiguous instruction available. This has probably worked to the advantage of distance education because those enrolled in such classes were motivated by such instruction and felt responsibility for their actions. Another factor that supports this concept is the high attrition rate or non-completers found in many distance education courses. Holmberg and Bakshi (1992) point out that, in distance education, there is a common administrative practice of counting only students who have completed the first assignment or examination, as enrollees. Even with this practice there are very poor completion numbers and many of the studies dealt with completers (Moore, 2003). Holmberg and Bakshi (1992) concluded that the key factors for higher completion rates depended on highly motivated students, sufficient prerequisites, “good” learning material and delivery system, and strictly observed deadlines (Hough, 1984; Roberts, 1984). These realities indicate that we have been only studying our successes.

Murphy (2000) followed up with non-completers and found that the majority of them were not prepared for the rigor of the class; another way to say it was harder than they anticipated. If we remove those who are not able or willing to commit to the study it will elevate the results for the class as a whole, and should improve the teaching experience as well. Holmberg and Bakshi (1992) conclude “A hazard of distance education courses is that they require more work of students than do instructor delivered courses” (p. 33). Garland (1993) found that while most non-completers used the socially acceptable excuse “I didn’t have time,” there were more specific reasons which most often included lack of prerequisite knowledge and lack of commitment to perform extra work to succeed independently.

Moore (2003) notes that in Wedemeyer’s 1971 book, *Independent Study*, he introduced the idea that distance education learners are not only able to exercise independence in regard to when and where they studied, but also had considerable independence in controlling how they studied. As an adult educator, Moore (2003), called this “autonomy.” He found reinforcement from Howard McCluskey, Carl Rogers, and Abraham Maslow; and was supported by the works of Malcolm Knowles, Cyril Houle, and Alan Tough (Moore, 2003, p. 23). Moore’s continued observation led him to recognize that adults were often more self-directed learners even in group studies. Dille and Mezack (1991) found that students in distance education settings tended to outperform traditional students, and that their greater age and experience were contributing factors. Does autonomous self-directed learning come with age? Is autonomy what we see in completers?

Laboratory Instruction

Coppola (McKeachie, 2002) attributes the birth of laboratory instruction to historical apprenticeship systems. Gokhale (1991) considers a more recent influence toward the development of the current standard of laboratories in science and technology education to the writings of John Dewey and his pragmatic view that learning happens as a result of doing and experiencing things in the world. Dewey (1938) also wrote that laboratory experience where physical activity is suffused with the mental is an effective learning medium. If we consider the works of Dewey from 1910 till his death in 1952 and consider the time of development of modern education in science and technology, we can see the correlation of the Dewey influence and customary practices in these areas today. Hofstein and Lunetta (1982) look back 100 years and share a quote of Griffin in 1892: “The laboratory has won its place in school; its introduction has proven successful. It is designed to revolutionize education. Pupils will go out from our laboratories able to see and do" (p. 202). Hofstein and Lunetta (1982) state:

> The laboratory has long been a distinctive feature of science education. In 1970 the Commission of Professional Standards and Practices of the National Science Teachers Association thought that the case for school science laboratories was too obvious to argue . . . Less than 10 years later, the case for the laboratory in science instruction was not as self-evident as it once seemed. Science laboratory requirements are currently of special concern because there is now a trend to retreat from student-centered science activities . . . (p. 201)

Another influence toward student-centered laboratory activities is that of Kolb (1984) and his experiential learning theory. Kolb (1984) acknowledges the work of Rogers, Jung, and Piaget in the 1900's and asserts that learning is the result of a cycle composed of four stages. In this cycle "immediate or concrete experiences" provide a basis for "observations and reflections". These observations and reflections are integrated into "abstract concepts" which suggest new action which can be "actively tested" in turn creating new experiences.

Considering laboratories are an opportunity for experience, and experience begins a cycle where observations and reactions are "assimilated", "distilled", "integrated" in one's mind, Vygotsky's (1997) translations often posit that knowledge is "constructed" individually. Vygotsky (1997) would say that such knowledge is gradually internalized and would point to learning past what one knows while being supported through collaboration with a more capable peer. Wood, Bruner, and Ross (1976) termed the tutorial interaction as scaffolding. Scaffolding is combined with Grow's (1991) theory, that mature learners should be self-directed, in the work of McLoughlin as she works with Hollingsworth (Hollingsworth & McLoughlin, 2001) to develop online science instruction.

When good practices and teaching theory for laboratory instruction are considered the words used to describe laboratory goals often match the hierarchy found in Bloom's Taxonomy. Bloom (1976) and his colleagues categorized educational objectives as cognitive, affective, or psychomotor. Laboratory instruction normally addresses the cognitive domain for comprehension, analysis, and synthesis. Laboratories for practice oriented disciplines focus on the psychomotor domain for complex overt response, adaptation, and origination.

This study focuses on laboratory instruction in post-secondary education, and adult education theories are applicable. Knowles, Holton, and Swanson (1998) list core adult learning principles as (a) learners need to know, (b) self-concept of the learner, (c) prior experience of the learner, (d) readiness to learn, (e) orientation to learning, and (f) motivation to learn. Knowles, Holton, and Swanson (1998) and Grow (1991) recognize that adult education principles and self-directed learning traits may change with time, settings and conditions. Lave and Wenger (1991) stress the need to enroll a homogenous group and develop a learning community. The learning community accommodates individual shifts of traits.

Currently, in all areas of education, research and journal articles dwell heavily on the issues of distance education. With all this attention, the subject of laboratory instruction in distance education is sparse. The emphasis is so strong to achieve success in distance education that there appears to be a willingness to overlook the once important laboratory component.

Murphy (2000) in evaluating a distance education course for general soils noted in the design phase that a weekly lab exercise was determined to be essential to the mastery of the instructional objectives. In his conclusions, he noted that enrollment in the laboratory sections failed to contribute significantly to the achievement of students in the recitation sections. Murphy (2000) referenced McKeachie (1994) as instructing that laboratory instruction should be measured using outcomes including (a) retention, (b) ability to apply learning, and (c) actual skill in manipulation of materials (p. 136). Since Murphy's study did not attempt to measure these outcomes, the value of the laboratory sections for this class was undetermined, but the final grades did not support the need for such a lab.

The New York Times (Biology, 2004) carried an article which announced that nine states now require public schools to offer an alternative to dissection in biology classes, which is causing consternation among teachers. The article states that Argentina, India, and Israel are among nations that have banned dissection in schools. This is definitely a possible new trend away from the typical science laboratory experience.

When we look at the proposed criteria for laboratory objectives from a variety of disciplines we find lists which are normally not subject specific, and which are very similar regardless of the source discipline. Graham in 1982 discussed laboratory efficiency and getting the most from laboratory exercises from a perspective of cost, not thinking of alternate delivery methods, but simply promoting laboratory work that covered things necessary for the laboratory and leaving other instruction to more efficient means. Some of the generic objectives considered for emphasis include:

1. Knowledge of relations between theoretical and experimental studies.
2. Knowledge of operating characteristics of specific instrumentation.
3. Appreciation for planning and preparation.
4. Competence in conveying information by use of the written word.
5. Competence in compiling a neat, presentable report.
6. Knowledge of procedures for obtaining accurate experimental data.
7. Knowledge of some sources of error.
8. Knowledge of some techniques for measuring physical quantities.
9. Knowledge of some precautions in interpreting experimental data.
10. Knowledge of some methods of error analysis. (Graham, 1982, p. 148)

These may not be the first things that an agricultural science teacher or technology instructor would express, but as a teacher they could identify.

Lemckert and Florance (2002) summed up the points made by Graham as gathering knowledge relating to (a) experimental procedures, (b) types of equipment, (c) methods of data analysis, and (d) report writing (p. 99). This range of learning objectives can only be fully achieved by students participating in a broad range of interactive laboratory exercises conducted within a structured, suitably-equipped environment (Lemckert & Florance, 2002, p. 99). They go on to emphasize the primary goal of gaining practical, hands-on experiences using apparatus. This is the only objective that they consider unachievable by common distance education practices, which would make asynchronous laboratories most appropriate for the mature-age student who has significant experience with mechanical devices (Lemckert & Florance, 2002, p. 100). They propose accomplishing this by utilizing advanced technology that would allow the student to remotely manipulate equipment, assuming the speed (bandwidth) of the Internet increases.

Asynchronous Laboratories

As ABET began the process of considering independent laboratory instruction they held a colloquy to determine through consensus a taxonomy of laboratory learning objectives (Feisel & Peterson, 2002). The process was begun by charging the members of the colloquy with three objectives:

1. Define the attributes developed in the graduate by the laboratory experience.
2. Identify the learning objectives achieved or enhanced through traditional laboratory instruction.
3. Initiate experiments in distance delivery programs that demonstrate the achievement of these learning objectives and that assess the quality of these programs.

Before being released to consider this charge, these educators, who may not have had formal education training, were instructed on the cognitive, affective, and psychomotor domains of learning; as well as Kolb's experiential learning cycle, problem-based learning, and subject-based learning. At their 2003 annual meeting ABET presented 13 laboratory objectives to their membership for prioritization and consideration of which ones could be accomplished through distance education laboratories. These objectives according to priority include:

Essential

- Ethics
- Data Analysis – collect, analyze, and interpret data
- Communications – oral and written
- Teamwork

Very Important

- Models – theory vs. real-world behaviors
- Experiment – specify appropriate equipment
- Instrumentation – tools and software to measure physical quantities
- Safety

Important

- Sensory Awareness – judgment – real-world problems
- Psychomotor
- Learn from Failure
- Design – build, assemble – equipment and materials
- Creativity – independent thought – real world problem solving

At this point the organization needs to agree on which of these have a place in asynchronous studies, begin experimenting with distance delivery programs, and determine how to assess them.

Another recent effort to determine the choices for integrating a laboratory with a distance education science course are discussed by Naber and LeBlanc (1994). Naber and LeBlanc at this date still considered that practical distant education laboratory alternatives still fall under a ranking established in 1982 for correspondence courses. At that time Kember stated three alternatives which include (a) require students to travel to campuses with existing facilities, (b) local centers that provide facilities and tutors, and (c) home lab kits. The concerns that Naber and LeBlanc addressed in developing their laboratory exercises were credibility, safety of students working in their homes, transporting materials and apparatus, finding ways to teach the psychomotor skills and procedures involved in the use of laboratory equipment, providing adequate student support, and finding ways to meaningfully assess student learning while holding students individually accountable for their performance.

Forinash (2001) states that from his experience, three key factors determine if a distance education laboratory compares favorably with an in-residence laboratory. These include:

1. Students must have enough control of lab equipment to start and stop an experiment and make appropriate adjustments.

2. The experiment should be no more difficult to conduct than with the equipment physically present.

3. Students need appropriate feedback.

Research on feedback usually focuses on student evaluations of the teacher. Student feedback is also recognized as the tool instructors use to determine the level of understanding when giving examples or explanations. Response from the instructor to the student, “instructor feedback”, is a natural expectation in the traditional laboratory setting. Corrective feedback is a valuable component of instruction (Bloom, 1976), but this instructional procedure does not easily lend itself to Web-based instruction (Smith & Tillman, 1999). Earley (2003) found one of the most salient needs to emerge from asynchronous study was that of timely instructor feedback about performance. Riccomini (2002) found that student performance was significantly better when they received instructor delivered corrective feedback.

Shih and Gamon (2002) looked for factors that determined success in web-based courses, and the only significant factor that explained achievement was learning strategies. Shih and Gamon advocate teaching leaning strategies as part of any web-based course, but they state that students were more interested in checking their grades online instead of interacting with the class. Miller and Pilcher (2002) tried offering instruction on learning strategies and found that it was rejected by those who may have been able to benefit most.

Summary and Conclusion of Need for the Study

Laboratories were important. Learning outcomes had shown no significant dependence on the medium of instruction for some content. There was significant agreement on the desired outcomes of laboratory instructions. The lists of necessary requirements for success in an asynchronous environment were congruent. There seemed to be some indication that learner characteristics were a compounding factor in distance education. Having stated these postulates and their application to laboratory studies, this study returned to the problem as stated; are there ways to effectively involve the student in asynchronous laboratory sessions that will approximate the effect of a traditional hands-on laboratory? Specifically, what characteristics describe learners who are more successful when experiencing either the synchronous face-to-face studies or asynchronous studies? What key factors aid or impede the success of asynchronous laboratory studies?

CHAPTER III

METHODOLOGY

Introduction

This study employed naturalistic inquiry or qualitative research. “Qualitative methods can be used to uncover and understand any phenomenon about which little is yet known” according to Strauss and Corbin (1990, p. 19). Hoepfl (1997) adds that “Thus, qualitative methods are appropriate in situations where one needs to first identify the variables that might later be tested quantitatively . . . (p. 3).”

“Qualitative research is an umbrella concept covering several forms of inquiry that help us understand and explain the meaning of social phenomena with as little disruption of the natural setting as possible” (Merriam, 1998, p. 5). Merriam (1998) lists the essential characteristics of qualitative research as: the goal of eliciting understanding and meaning, the researcher as primary instrument of data collection and analysis, the use of fieldwork, inductive orientation to analysis, and findings that are richly descriptive (p. 11).

Several writers have defined specific qualitative strategies. Berg (2001) discusses ethnographic field strategies, action research, historiography and oral traditions, and case studies. “A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” Yin (1994, p. 13). Merriam (1988) describes qualitative case study as “an intensive, holistic description and analysis of a single instance, phenomenon, or social unit” (p. 21), but goes on to state that she sees the case as a thing, a single entity, a unit around which there are boundaries (Merriam, 1998, p. 27). Berg (2001) considers case studies as exploratory, explanatory, or descriptive (p. 230), while Merriam (1998) uses the terms particularistic, heuristic, and descriptive. “Particularistic means that case studies focus on a particular situation, event, program, or phenomenon. The case itself is important for what it reveals about the phenomenon and for what it might represent” (Merriam, 1998, p. 29). Merriam (1998) describes the strengths of qualitative case study research as:

> a researcher selects a case study design because of the nature of the research problem and the questions being asked. . . . The case study offers a means of investigating complex social units consisting of multiple variables of potential importance in understanding the phenomenon. . . . Because of its strengths, case study is a particularly appealing design for applied field of study such as education. . . . Case study has proven particularly useful for studying education innovations, for evaluating programs, and for informing policy. (p. 41)

Merriam (1998) gives her explanation of Donmoyer’s (Eisner, 1990) three specific advantages of case studies as:

> First is the advantage of accessibility. ‘Case studies can take us to places where most of us would not have an opportunity to go’ (Donmoyer, 1990, p. 193) [In Eisner (Ed.), 1990]. Case studies allow us to experience situations and individuals in our own settings that we would not normally have access to. A second advantage to case studies is seeing through the researcher’s eyes. By this Donmoyer means that case studies may allow us to see something familiar but in

> new and interesting ways. The third advantage he identifies is decreased defensiveness. 'Vicarious experience is less likely to produce defensiveness and resistance to learning' (Donmoyer, 1990, p. 196) [In Eisner (Ed.), 1990].

Along with these strengths of qualitative case studies one must recognize the limitations of such an endeavor. First on the list of limitations is time and money, beyond this "the product may be too lengthy, too detailed, or too involved for busy policy makers and educators to read and use" (Merriam, 1998, p. 42). Guba and Lincoln (1981) declare:

> case studies can oversimplify or exaggerate a situation, leading the reader to erroneous conclusions about the actual state of affairs. . . . they tend to masquerade as a whole when in fact they are but a part – a slice of life. (p. 377)

Guba and Lincoln (1981) also point out a limitation that speaks not only of the methodology but of the human subject as well as the observer:

> at all levels of the system what people think they're doing, what they say they are doing, what they appear to be doing, and what in fact they are doing, may be sources of considerable discrepancy. . . . Any research which threatens to reveal these discrepancies threatens to create dissonance, both personal and political. (p. 186)

Recognizing the merits and confines of particularistic case study, this study will be discussed following the goals and addressing the characteristics described for qualitative research. This study was undertaken to compare the fulfillment of laboratory goals of developing the acquisition, retention, transfer, and application of knowledge by utilization of demonstration - practice when presented through moderated simulation in an asynchronous setting and in a face-to-face traditional demonstration - practice setting. Specific goals were the establishment of the characteristics of individuals who were successful in the acquisition, retention, transfer, and applications of technical knowledge learned in asynchronous studies; and the establishment of factors that compounded these goals.

In this discussion consideration is given to basic qualitative characteristics and how this study followed that framework. The nature of the particularistic case study includes: (a) a suggestion to the reader of what to do or not to do in a particular situation, (b) examination of a particular instance but provide understanding to a general problem, and (c) recognition of the influence of the researcher’s bias (Merriam, 1998, p. 30). Recognition of the emergent development of the research design is discussed.

This was a descriptive qualitative study which involved two particularistic cases. Two cases were involved to examine asynchronous laboratory learning in a diversity of settings, students, material, delivery systems, and school environments. Each case was examined independently and then a cross-case analysis was made between cases.

Case Descriptions

The current study was made up of two different courses, taught in different programs at two different schools over a 14 –week semester to two different types of students. Each course was handled as an individual case. Both of these courses had large lab components which made them adaptable to the training considered. Using an online research randomizer (Appendix A), students in each case were assigned to one of two groups. It was predetermined that within the last few class sessions of each case, two modules of instruction would be taught with an asynchronous alternative. Each of these modules of instruction contained advanced subject matter, which was estimated to be of equivalent difficulty. Each group was assigned one of the asynchronous sessions. Thus only one-half of a class would meet for one of these modules of instruction while the other half was excused and would perform their study asynchronously online. The next module would alternate the groups. Each module was followed by a practical exam which would allow for reflection, observation, questioning, and demonstration of understanding and skill. Serving as observer and having spent the semester as instructor, the researcher was able to score performance based on previous experience in class and overall ability. Also having spent this much time with the group allowed the researcher to gain knowledge of individual backgrounds, previous experience, interest, goals, study habits, diversions, and subject knowledge.

Case One was established around a course on agricultural mechanical systems taught at a Texas four-year university. The technical emphasis of this course was small engines and related basic mechanical practices.

Case Two included two sections of the course on electrical controls taught at the technical center of a Texas community college. This course was taught in the morning and again in the evening of the same day of the week. This allowed some changing between sections for individuals whose work schedules interfered with school schedules. Since there was some alternating between groups, content was the same, and population was similar, these groups were considered as one case. The technical emphasis of this course was electrical equipment controls and related basic electrical practices.

These courses were chosen because they contained content which required the mastery of tools, understanding of new concepts, decision making, trouble shooting / problem solving, and physical activity suffused with the mental. These courses and the described characteristics fit the laboratory model as described by Dewey (1938). Also a great advantage for this study was the wide diversity of students, both within these groups and between groups. This diversity included students who had taken courses online as well as those only slightly familiar with computer hardware, software, and related devices. There were no asynchronous alternatives to these courses and the majority of the students in Case Two had not participated in any form of asynchronous study. The majority of Case One students had received grades via computer, taken test online, or submitted assignments asynchronously. Both courses were taught the same semester, meeting once a week, with one course taught on Thursday and the other taught on Friday of each week, and with approximately the same school schedules for starting, ending, holidays and interruption dates.

Learner Descriptions

Case One consisted of 13 students who were available and consented to participate. Students in this program were typical single full time students ranging in age from 20 to 27. All Case One members were of White ethnic origin, and three were female. Students in this group were from a wide geographic area of West Texas, Eastern New Mexico, and Southeastern Colorado, with only a few having known each other prior to arriving at school. The majority of the individuals in this group had part-time employment or an outside business. These students were in their second year of the agricultural education program and had bonded strongly, making a very tight group. They responded well to activities in support of the program or class, and over half were included in most group activities outside of class. Case One students were eager to work with the instructor and had a “get the job done” attitude. Only one student was unable to finish because of an injury.

Case Two consisted of 24 students who were available and consented to participate. All were male, had full time jobs or businesses, over half were members of households with children. Only two enrolled for just this one class and the remainder sought completion of a program even though only five qualified as full time students this particular semester and three were enrolled as continuing education students. The ethnic description of the group yields 17 White, 3 Hispanic, 2 from India, and 2 of mixed origin. Of the 24 who were available and consented to participate earlier in the semester, 2 did not complete the semester, leaving 22 for consideration. Another complicating factor was the lack of regular attendance by 4 of the 22 between the time that the consent form was signed and the end of the semester. These 4 failed to receive instructions and did not participate in the assigned modules and were removed from the study which left 18 for final consideration. The age range for this case was 19 to 52 with an estimated mean of 34. Educational background ranged from seventh grade in Mexico to B.S. degree. Experience ranged from none to Masters Electrical License. Three of the students spoke moderate English and poor Spanish. Having taught in this program area for 13 previous years, the descriptions and completion factors for Case Two students were considered typical of technology student at the time.

The characteristics used to introduce these groups were not comprehensive or exclusive descriptors of observation criteria used in this study. Descriptions were introductory and not measures, predictors, or evaluations.

Sampling

For this study the cases were chosen purposefully, as described under case description, with the goal of balancing the objectives of laboratory instruction with a diversity of students and the availability of an online delivery system. Convenience sampling was used to select individual subjects for the study by soliciting the total enrollment of the two classes described in the individual cases (Trochim, 2001, p. 56; Berg, 2001, p. 32). Case One had 1 non-completer, 1 who chose not to participate, and 1 who had a conflict with class schedules at the time that the selected modules were taught. Case Two had 5 who chose not to participate, 5 who had a conflict with class schedules at the time consent was sought and group assignments were made, 2 non-completers, and 4 who had work conflicts at the times that the selected modules were taught. These individuals are not included in the described numbers or considered in the results. All who agreed to participate signed a letter of consent as approved by the Institutional Review Board and retained a copy for themselves (Appendix B).

Instrumentation

Data Collection

Naturalistic design is emergent and emphasis is adjusted as discoveries occur. Processes tailored for data collection included: observed performance scored within a rubric; observations, discoveries, and assessments recorded in a journal; and a final interview questionnaire and transcribed interview comments. The emphasis and design of each instrument changed in an evolutionary process which is well described by Erlandson, Harris, Skipper, and Allen (1993, p. 71). Lincoln and Guba (1984, p. 41, 102) pointed out that this is only achieved through interaction.

Observed Performance Evaluation. Performance of activities related to the modules of instruction involved in the study was scored using a six rank rubric. The rubric matrixes and the common explanation of the scoring for each case are found in Appendix C. Rankings were scored from an observation of final performance for each module connected to the study whether performed synchronously within class or asynchronously. At least one additional module of instruction from an introductory or basic area was included within the rubric as a reference score for each individual and as an indicator of overall performance and participation. A copy of the rubric was also scored by the students at the time of interview as an indication of self perceived accomplishment. This evaluation ranking allowed for a final competency status without the biased influence of judgments concerning techniques used to achieve said competency. These abbreviated matrixes represent a portion of a normal competency matrix utilized in technical and laboratory intensive courses and serves as a subjective evaluation tool. While this did not represent a grade, it referred to a skill level without the frustrations or complexities of the school setting.

Journaling. A journal of observed insights, discoveries, reminders, and reflections was kept with a page for each student. At the beginning of the course a page for each student, course objectives, randomized listings for groupings, and a scoring matrix for each student was assembled in a journal that could be available for the researcher in class or labs. Where possible, notes from early sessions were made to establish skill levels or interest brought to class from life experiences or previous training. Lincoln and Guba (1984) support the power of observation and the utility of the human as an instrument and declare that the validity of data gained from such sources depends on "privileged access" and "sufficient intensity and duration" (p. 193). These characteristics are the foundation of what they describe as "prolonged engagement" and "persistent observation" (Lincoln & Guba, 1984). Guba and Lincoln (1981) maintain that observation is where the researcher is able to grasp motives, beliefs, concerns, interest, unconscious behaviors, customs, and the like (p. 193).

Questionnaire and Interview. According to Merriam (1998):

> In all forms of qualitative research, some and occasionally all of the data are collected through interviews . . . interviews can be defined as a conversation – but a 'conversation with a purpose' . . . Interviewing is necessary when we cannot observe behavior, feelings, or how people interpret the world around them. (p. 71, 72)

A semistructured interview was used at the end of the course at a time generally dedicated to a final exam. In lieu of an exam, a questionnaire (Appendix D) was used as a method of engaging the group and occupying those not initially engaged in an interview. The questionnaire served as an opener for the interview and allowed student reflection and unopposed honesty. As each student was interviewed the questionnaire was brought to the interviewer and some of the key questions were reviewed as the structured portion of the interview. The questions which followed were open-ended with a conversation format. This allowed the questionnaire to serve as an interview guide and the following questions to be probing in nature, as suggested by Merriam (1998, p. 75). Students were only available for interviews or questioning during scheduled class times and the questionnaire was tried as a tool to spread out the activities and guide thoughts, but the concept proved to be useful as a means of allowing the student time to make a statement then asking them to justify or elaborate on their comment. Notes from the interviews were added to the questionnaires, comments were dictated to the voice recorder, and additions were transcribed into the journal.

A voice recorder was worn by the researcher during class sessions following asynchronous assignments as well as during interviews. These recordings resulted in very large files covering over twenty hours of interaction. Operating in less than formal surroundings with background laboratory noise, simultaneous multiple student interactions, and compound equipment issues; much of the content of these recordings was not of sufficient quality for individual evaluations or journaling. Often students brought their issue or problem back to class and were demonstrating a perceived malfunction, or they were eager to demonstrate success and receive acknowledgement. Much time was spent in the computer lab demonstrating what they saw or thought they had done. During the recording periods they were also asked to demonstrate their proficiency for scoring. These events presented long periods of silence or conversation with other students mixed with some short valuable comments. Instead of transcribing the total recordings, the files were edited and blocked into significant discussion groups. The recorder also served as a convenient tool for the researcher to record journal comments. Individual statements, confessions, confrontations, and interview questions were transcribed to a section of the journal. While the recordings were moved down on the value list from their initial expected significance, it is hard to describe their significance as they brought back a flood of the emotion, setting, and atmosphere that existed. During editing and transcribing, the background issues, technical problems, and occasional student panic came alive and apparent.

Data Analysis

Merriam (1998, p. 151) explains that while the data are being collected analysis begins and guides further data acquisition. With a volume of data complete the researcher must process and exhume trends, categories, and threads of common factors. This is a procedure that began with nothing but raw data and developed principles which eventually lead to the writing of a theory. This was not data reduction, but data induction (Lincoln & Guba, 1984, p. 333). This analysis was done using the constant comparative method as conceived by Glaser and Strauss (1967, p. 105) and as applied by Lincoln and Guba (1984, p. 339). While the constant comparative method is a continuum, it can be viewed in four stages. The data at this point consisted of the observed performance evaluations; individual journal pages to which had been added the partial transcription of the interviews; and the interview questionnaires.

The first stage of the constant comparison technique was comparing incidents applicable to each category. This was done by studying the data and coding what appeared to be similar incidents. This was done before the categories were defined and served as a “jumping-off point” to get something started. It was stated that the categories will emerge as the coding proceeds (Lincoln & Guba, 1984, p. 340). The emergence was a pattern or trend that could be seen after some amount of data were coded. Consider the name of this naturalistic data processing technique, “Constant Comparative.” Constant comparative implies that as the process evolves the researcher continually compares incidents and categories with other incidents and categories of the same and other groups (Lincoln & Guba, 1984, p. 341). This constant comparison is the first rule of the constant comparison method. Initial categories were assigned from tacit knowledge or feel, but as data are coded and there become conflicts with categories the second rule of the constant comparative method was applied. Stop; write memos of your ideas. The memo writing served to define the categories and set rules which allowed the coding process to proceed. The initial coding was done with margin symbols to identify themes.

The second stage of the constant comparison technique was integrating categories and their properties. There was not a cut off point from stage one to stage two, but a shift as the process continued. Now that we had rule defined categories; the volume of data being constantly compared was large; comparison and reevaluation of original coding continued; and coding now was a judgment of where incidents fit, while categories and subcategories were scrutinized. At this point a document was developed as an instrument which allowed for the grouping of responses and observations. The instrument was modified and data was transferred as the categories changed. Questions and observations were combined and then groupings were developed on individual pages for specific categories. After three iterations of the instrument and re-entering the data, the modifications were handled by hand writing the changes on the instrument and adding notes. The entries in this instrument utilized the aliases assigned to the individual participants. Case One was divided into two groups A and B, and Case Two was divided into C and D. Each case alternated groups with the asynchronous modules. The aliases utilized the group letter and a randomly assigned number. A5 was a student which belonged to group A in Case One and was assigned the number 5.

The third stage of the constant comparison technique was delimiting the theory. Lincoln and Guba (1984, p. 343) asserted that:

> Delimiting begins to occur at the level of the theory or construction, because fewer and fewer modifications will be required as more and more data are processed…Second, as delimiting occurs the original list of categories will be reducible in size because of improved articulation and integration; options need no longer be held open.

This was another of the emerging, continual development concepts. There was not a point in time when this stage is called for and everything stopped. Delimiting was an evolutionary step in the development of the theory.

The fourth and final stage was writing the theory. This was developed in the following chapter and was a process of tabulating and evaluating categories.

Trustworthiness Criteria

Lincoln and Guba (1984) spend much time debating the meaning of terms and standards used to justify “traditional” or “quantitative” research, and to develop alternate postulates for the qualitative paradigm (Chap. 5, 11). Erlandson, Harris, Skipper, and Allen (1993) condensed these concepts, organized them in tables, and concentrated on the “how to’s” (Chap. 7). The following sections will consider these criteria and their application to this study.

Credibility

Triangulation. “Triangulation leads to credibility by using different or multiple sources of data …” (Erlandson, Harris, Skipper, & Allen, 1993, p. 137). Triangulation is a result of design and is a process that is used during data analysis. “No single item of information (unless coming from an elite and unimpeachable source) should ever be given serious consideration unless it can be triangulated” (Lincoln & Guba, 1984, p. 283). In this study the constant comparative method was utilized to code and compare data from three sources: an observed performance evaluation, an observer journal, and from an interview questionnaire and transcribed interview comments.

Prolonged Engagement. Erlandson, Harris, Skipper, and Allen, (1993) explained prolonged engagement and what it would do for credibility as:

> Prolonged engagement provides a foundation for credibility by enabling the researcher to learn the culture of an organization or other social setting over an

extended time period that tempers distortions introduced by particular events or by the newness of researchers and respondents to each other's presence. Prolonged engagement also helps the researcher build trust and develop a rapport with the respondents. (p. 133)

This study covered a 14-week semester of meeting once a week for approximately four hours. The researcher served as instructor and had taught many of the students in a similar setting the previous semester. Rapport was high and respondents were open and honest.

Persistent Observation. Lincoln and Guba (1984) stated:

persistent observation adds the dimension of salience to what might otherwise appear to be little more than a mindless immersion. . . . the purpose of persistent observation is to identify those characteristics and elements in the situation that are most relevant to the problem or issue being pursued and focusing on them in detail. If prolonged engagement provides scope, persistent observation provides depth. (p. 304)

Erlandson, Harris, Skipper, & Allen (1993) stated:

While prolonged engagement serves to temper distortion caused by the researcher's presence, persistent observation accentuates that presence by actively seeking out sources of data identified by the researcher's own emergent design. . . . It is not passive; it contains a strong sense of purposefulness and assertiveness on the part of the researcher . . . Persistent observation helps the researcher sort out relevancies from irrelevancies and determine when the atypical case is important (p. 136-137).

The researcher engaged in the emergent design of this study from the beginning of the course and worked to establish scales of characteristics which could possibly be attributed to the success or failure of individuals in areas related to the study. Journal pages included sections devoted to background, experience, personalities, ability, tendencies, responsibility and maturity. Observations included attitudes and responses to modules of instruction outside the study as a means of determining the focus and concentration of final observations and interviews related to the modules of instruction studied. The final questionnaire and interview protocol was modified repeatedly prior to their deployment. As the course progressed new issues came to light and gained significant weight.

Member Checks. “No data obtained through the study should be included in it if they cannot be verified through member checks” (Erlandson, Harris, Skipper, & Allen, 1993, p. 31). Erlandson, Harris, Skipper, and Allen (1993) point out “data analysis is closely tied with data collection” (p. 114). A list was then developed of all the ways that member checks could be accomplished, including reviewing perceptions at the end of interviews (Erlandson, Harris, Skipper, & Allen, 1993, p. 142). In this study contact time following the study was limited, so researcher concepts were reviewed with participants at the end of each interview and through informal conversations with class members.

Transferability

Thick Description. Merriam (1998) showed the need for and described thick descriptions as:

> Thick description is a term from anthropology and means the complete, literal description of the incident or entity being investigated (p. 29-30) . . . Rich, thick description – providing enough description so that readers will be able to determine how closely their situations match the research situation, and hence, whether findings can be transferred. (p. 211)

The descriptions given in Chapter IV will present information allowing the reader to identify with applicable settings and thus determine the appropriateness of stated findings.

Dependability / Confirmability

Reflexive Journal. Lincoln and Guba (1984, p. 327) described a reflexive journal as a kind of diary which contains logistical information, personal reflection, and a methodological log. These served to describe why decisions were made in the emergent process and served as an audit trail. In this study the format followed a weekly semester schedule and allowed for weekly entries and adjustments to be maintained in conjunction with the class roster. Typically misjudgments and compounding issues were recorded here.

Cross-Case Analysis

Merriam (1998, p. 194) called for multiple case studies to be performed in two steps; first the "within-case analysis" followed by "cross-case analysis." Data were gathered and analyzed, conclusions derived, and results reported independently. “Once the analysis of each case is completed, cross-case analysis begins. A qualitative, inductive, multicase study seeks to build abstractions across cases” (Merriam 1998, p. 195). The researcher attempts “to build a general explanation that fits each of the individual cases, even though the cases will vary in their details” (Yin 1994, p. 112). Miles and Huberman (1994, p. 204-205) described cross-case analysis as tricky and requiring a careful look at complex configurations of processes within each case. Merriam concluded that “Ultimately, cross-case analysis differs little from analysis of data in a single qualitative case study” (1998, p. 195). Merriam (1998, p. 195) eased the process by suggesting that the results could vary from a unified description across cases, meaning that reinforcement was found across cases; to new categories, themes, or concepts; or substantive theory from an integrated framework.

For this study the researcher completed the individual cases as will be described in Chapter IV and in due course utilized the two instruments which were developed to categorized, tabulate and analyze the individual cases as windows to compare and give insight for the cross-case analysis. The diversity of the two cases allowed for reconsideration of the categories and opportunity for renewed insight.

CHAPTER IV

FINDINGS

Introduction

The findings of this study are presented as two particularistic case studies followed by a cross-case analysis. Merriam (1998) describes a qualitative case study as "an intensive, holistic description and analysis of a bounded phenomenon such as a program, an institution, a person, a process, or a social unit" (p. xiii). Initial questions to guide this study were:

What characteristics describe learners who are more successful when experiencing asynchronous studies than students who are challenged by this instructional strategy?

What characteristics describe learners who are more successful when experiencing traditional face-to-face synchronous studies than students who are challenged by this instructional strategy?

What key factors aid in the success of asynchronous laboratory studies?

What key factors impede the success of asynchronous laboratory studies?

A system of alpha numeric aliases will be used to designate individuals in both discussion and tabular form. The following discussions will include examination of class events, group observations, perceptions, and assumptions. Initial focus will be on the group as a whole, followed by consideration of noteworthy individuals as they pertain to the research questions. Case One, being a very homogeneous group, will have less individual discussion. Case Two, being very diverse, will have lengthy individual discussion. The second item of discussion will be the Observed Performance Evaluation. The third item will be discussion of data to convey the results of interviews and questionnaires. The fourth part of each case discussion and the cross-case analysis will specifically address the research questions.

Case One

In a small machinery shop on the back of a show barn located at a working ranch which is part of the University Agriculture Division, Case One students sat up the initial lab classes for a start-up Agricultural Education Program. These students were part of the first group in a new program and, as such, they were the initial students in each class they had taken in the program. These students quickly bonded as a group and seemed to gladly accept their role of "building the program," which often required extra effort or patience. Request for supplementary help was met with a surge of volunteers. Given the number of classes these students had taken together as well as the hours of extra work requested, strong leaders had assumed their roles and a hierarchy of leadership was apparent. The Agricultural Education students, which formed Case One, spent large amounts of time together outside class. This, coupled with the hierarchy mentioned, consistently affected class performance, completion of assignments, and test preparation; as well as providing a unified justification or strong defense for shortcomings. The affects of these relationships were positive when unity, group dynamics, accountability, and support were needed. The affects of these relationships were negative when independence, individual initiative, personal effort, independent thinking, or spontaneity were sought. As a unit, Case One students had learned to use the strength of numbers and unity and had come to expect the acceptance of group pleas or requests, such as setting schedules for test, leaving early, or what constituted an acceptable absence.

In-class activities were considered a “holding time" until they could get to lab and “do something.” Yet time in the laboratory was considered inferior to other activities, and the need for attendance and participation was challenged with the attitude and occasional comment that “it’s just a lab.” Class time for Case One was on Thursday afternoons and most of the students did not have class on Fridays, which reinforced this attitude. Even with the location and time issues, attendance was punctual and participation was exceptional. Everyone took their turn at the dirty tasks and got involved in clean-up and tool count at the end of class. The students in Case One exhibited a strong work ethic and held one another accountable.

Ownership of projects was hard to establish. Laboratory work was assigned to student pairs and they were content to swap groups each week. Completion of projects or ordering parts for completion were not priorities. Personal projects or equipment brought from home were set out each week, but efforts were often diverted to another team.

Group Observations

Technical Skills. Considering the Millennial generation of Case One, requirements of other classes, and mention of other activities led to an assumption of literacy of computer hardware, software, and related devices. With the student schedules being open on Friday, there had been warnings that many were expecting to make an early exit the week prior to spring break. The online portion of the class had been set up through the distance education program at the university which maintained a self developed version of online course management tools. It had been decided that this potentially short class period would be utilized to confirm that all students were able to login and had some familiarity with the online class system. As class began the students left their vehicles idling in anticipation of an early exit. Horses and equipment had been loaded and the intent was obvious. When it was announced that we would be returning to campus and check our logins there was some slight grumbling, but a quick dash to campus occurred where everyone had their particular illegal parking place that would accommodate their horse trailers. When the class gathered in the student computer center the supervisor opened a partition and gave us our own room. Without direction the group was seated in a seemingly rehearsed manner and computers turned on as though the class had been meeting in this area previously. As everyone gathered in, they obtained an abnormal seating pattern which was discovered to be their standard for computer work. This pattern put them in proximity to watch and receive reminders from individuals perceived to be more knowledgeable. These individuals (B6, A7, B2) had limited online class exposure, but their overall technology experience was not any greater than others. It was observed that the group immediately checked their emails, checked some grades and looked up other class assignments; and in general immediately calmed down as they waited on my instructions and the opportunity to test their login and the class assignments. When the tests were finished the group slowly broke up with no sense of urgency, and they lingered as they discussed shortcuts and preferences for similar assignments. As a group, they had lost their anxiety about leaving for home.

The login test activity reinforced the expectation of comfort and persistence with technology as well as the assumed competency with computer hardware, software, and related devices. In this setting the leadership role balanced to a certain degree, but the performance expectations also lowered to a uniform mediocre standard. Case One students in the computer center setting made continual comments such as; “you don’t have to read that, just do it this way;” “Jim showed me how to do this and we have been getting by;” “we all turned ours in without the references and he didn’t count off.” The few printed material or instructions were left in the printer as the class departed. As this event unfolded almost spontaneously, the researcher had very little interaction with the whole class and was free to observe and interact with small groups of individuals. As some individuals looked at other class projects it was observed that in general Case One students lacked basic skills in producing documents following any style, utilizing either a word processor or spread sheet. The ease which Case One exhibited with technology was not based on skill or training, but on a narrow familiarity with a few applications and their success at “getting by.” This event proved to be a paradox and was followed by an assignment requiring the production of a document and additional questions for the questionnaire and interview. The assignment and specific questions confirmed generally crude skills in the production of documents with the exception of A7 and B3.

The observations and comments mentioned were the most perplexing of the course and some of the meanings of this setting did not become apparent until the selected modules were taught and the questionnaire – interview process began. Further meaning will be developed in context with these data sources. At this point the issues which appeared relevant were: group manipulation of challenges; confidence based on escapes; leadership shift to fit the situation; group dependence; and group acceptance of mediocrity with only an occasional individual challenging the minimal standard or daring to upset the group. This setting gave the feeling of being engaged with a culture as described by Merriam (1998, p. 13) and D'Andrade & Strauss (1992, p. 230) where values and attitudes structure a groups behavior. One reason for selecting the afore mentioned experience and observations for discussion was to emphasize the degree of group culture possessed by Case One students while establishing technical proficiency concerns.

Mechanical Skills. As the weeks passed and the first module of the study which involved carburetors was completed, the following week was scheduled for a reunited group to score the Observed Performance Evaluations. In other words, it was the time to find out what was learned by both the traditional class group and the asynchronous group. There had been many discussions with random individuals about the difficulties encountered, and the researcher was aware of the probable rate of success. A short question and answer session was used for terms and basic concepts. Five participants (A6, A5, A1, B6, B2) gave satisfactory responses to rote questions, and none responded to troubleshooting issues or gave insight into any operational issues.

Most of the laboratory projects were coming back together at this point and at least two projects brought in by students were ready to have the carburetors checked, installed, and engines started. This activity would allow for some hands-on demonstration of knowledge and skills practice. As the group worked in the laboratory to ready the projects for completion and test runs, B5 had his engine totally assembled and nonchalantly, slowly pulled the rope one time. None of the students, especially B5, were prepared as his engine immediately started and ran at top governed speed. The group was so excited and everyone suddenly had hope of finishing something they had lost interest in. The key to this exercise came as B5 attempted to slow his engine down after a few seconds. The engine stopped. It restarted instantly and again ran at top speed, but would not idle. This was the perfect opportunity; a textbook example with everyone's attention and full interest. This was happening just as the module on carburetors had been taught and the laboratory was focused on the application of skills with carburetors and the application of some technical knowledge for troubleshooting. A perfect setting and a classic example had presented itself. The group was instructed to gather around and observe. Requests were made for individual single efforts to explain what was happening and to try to adjust the carburetor as it had been instructed the previous week. After 30 minutes the excitement had worn off, B5 had made a half hearted effort to adjust his carburetor, A6 and B2 had experimented some and expressed an idea of what was wrong. The group was then instructed to retrieve the drawings presented during the demonstration. The material presented to the asynchronous group contained a video, instructions and illustrations to print out, and each had taken home a similar version of the same carburetor found on B5's engine. The traditional group was presented with the same demonstration and given the same illustrations as the asynchronous group. The traditional group had been shown a variety of carburetors and spent time disassembling and tracing the paths through the carburetors. The asynchronous individuals were to have done the same. None of the asynchronous group had printed their illustrations or had them available. Two of the students in the traditional group had notebooks with the material from the previous week and furnished drawing so the class was able to review carburetor operations and discuss the possible problems. A5, A6, B6, B2, and B5 quickly came up with a suggested course of action. Others quickly agreed and seemed to understand. B5’s project was brought to class from his landlord and B5 was responsible for its safe return with sound repairs. B5 announced at this point that his landlord had plenty of carburetors and the landlord could change it. B5 then proceeded to pick up his project and load it in his vehicle. When challenged to complete the project and utilize the remainder of the semester to apply the final modules of instruction, B5 announced that he was through, and that his work was good enough. There appeared to be a universal acceptance that B5 was justified and the goal of the project had been met. Both sessions had emphasized the common problem seen in this session and warned that similar carburetor problems are a typical easily fixed problem. As the other projects came together quickly there was a similar attitude that the project was complete as soon as it made noise. A1 performed very rough work, but was the exception in expecting maximum performance from his project, and was willing to give the time and effort to achieve it. A1 held a social position on the edge of the group.

The observations and comments brought out in this illustration lead to the results that are discussed in the next section on Observed Performance Evaluation. The group as a whole failed to transfer concepts from illustrations and demonstrations. With the exception of A6, the students had limited mechanical background or experience with technical drawings to build on. A6 was regularly intimidated by the strong group dynamics and generally failed to assert his thoughts on the group, and lacked confidence to express his understanding individually.

Module Two of Case One dealt with ignition systems. The experience with Module Two was similar to that described for carburetors and Module One with the additional complication of attendance for the traditional classroom group. Module Two occurred late in the semester and end of semester interruptions negatively affected class attendance. Electrical concepts are abstract and were not understood, although the students perceived they had good comprehension. The lack of understanding became evident when troubleshooting scenarios were presented. The online group failed to print instructions or illustrations, but when these were available the installation of mechanical components and the adjustments required for ignitions systems were performed well by both groups.

Observed Performance Evaluation

The outcomes for each of these modules can be identified in Table 1 which identifies matrix scores for each module. Observed Performance Evaluations apply to skills performance for specific modules scored in the matrix and do not reflect; student performance or skills in any other areas, or student grades.

Students in the traditional class groups who had displayed even limited mechanical experience were able to perform the laboratory tasks to some level when they were reminded of the materials handed out and discussed during class. The students involved with the asynchronous groups were unable to perform in the

Table 1

Observed Performance Evaluations for Case One Students

Task	Competency Level*				
	5	4	3	2	1
Carburetors	-	-	A6, B2,	A1, A7, B3, B5, B6	A2, A4, A5, A8, B4, B7,
Ignitions	-	-	A6	A1, A5, A7, B2	A2, A4, A7, A8, B3, B4, B5, B6, B7

**Note.* Competency Levels

5 MASTERED AND CONFIDENT – Works independently with no supervision

4 COMPLETED AND HESITANT – Can complete with limited supervision

3 REQUIRED SUPERVISION – Required instruction and close supervision

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1 NO UNDERSTANDING

laboratory. Once this group was again furnished with the materials from the instruction modules, those students with even limited mechanical experience were able to quickly catch on to basic requirements and perform tasks to some level. Students in the traditional class sessions participated well, but were unable to take the very answers they had given in the classroom and apply them in the laboratory setting. Both groups relied on quickly summarizing materials related to exact equipment specimens and applying concepts to installation.

Case One students were divided in two groups designated A and B. Group A students performed module 1 – carburetors – in the asynchronous setting and module 2 – ignitions – in traditional classroom. Group B students performed module 2 – ignitions – in the asynchronous setting and module 1 – carburetors – in traditional classroom.

The observed performance evaluations presented in Table 1 reflect a skill level at a given time and not the potential of any student. The skill levels obtained closely corresponded with the performance expectations of the students involved in the study.

Questionnaire and Interview

The data from the questionnaire, the interview notes, and the voice recorder are compiled and discussed under the categories of performance, technology, self evaluation, value, and interview comments.

Performance. To establish success in the performance of the asynchronous module, confirmation of technical operation of the course management tools was needed first, followed by information on the completion of exercises.

Ten students (A1, A2, A5, A6, B2, B3, B4, B5, B6, B7) had computers at their residence, but only five students (A2, A5, B2, B4, B5) utilized a connection which was adequate for multimedia operations. Only five students (A5, A6, A7, B5, B7) tried to access the course more than once. B2 was the only student who had no trouble with the operation of the asynchronous module of instruction. Responses explaining failure of technical operations included; (a) didn't know what to do (A1, A5, B5, B7), (b) "it" didn't work (A2, A4, B4), (c) no sound (A6, A8), (d) needed discipline to learn how (A7).

During the interview process several of the students were responding with similar vague answers and a nonchalant shrug. During extended questioning, one of these students revealed that four of them (A2, A4, A5, A8) had given up as a group and had his girlfriend do the work for them. The joint effort was attempted at the girlfriend's house with a slow dial-up connection, which would explain some of the issues with video quality for group A. The joint activity of these four students and the intervention of an outsider nullify their responses in this area. Lincoln and Guba (1984) warn of the introduction of such distortions (p. 302). The responses of these four students will continue to be recognized in all areas except performance.

During class lectures and during the interview process, efforts were made to form associations with past experiences of Case One students. Very few examples were found with which students could identify. Case One students lacked life experiences to connect with new applications. Much more time was needed to provide basic concepts as a foundation.

The traditional class group and the asynchronous group were both reminded of the necessity of securing instructions and illustrations for use with their projects. The asynchronous activities began with an introduction and instructions to print material necessary for the completion of the on-line project, and future reference. Four of the asynchronous group (A8, B2, B4, B5) responded as having printed the materials. Those who tried to work at home had no printer or were out of ink, and knew it, but failed to take advantage of other opportunities to print the material. Of the four who claimed to have printed the material, none brought the material to class the following weeks. Within the traditional groups only two students (A7, B2) maintained notebooks where they kept the handouts dependably.

Some of the questions concerning difficulties focused on possible improvements or specific needs. The overwhelming response was for more video, even though the majority weren't able to view what was given. Only A6 thought that students should have to furnish tools, even though several regularly furnished their own tools by choice. Six (A1, A7, A8, B3, B5, B7) agreed that if students furnished their own projects they would be more interested. Seven responses (A1, A2, A4, A5, A8, B3, B4) specifically stated that all equipment should be standardized since they could not recognize the components of the different models of equipment provided.

Technology. Technology for asynchronous studies primarily involves computer hardware, software, and related devices; and Internet capability. When presented with a forced choice Likert scale – no mid point - for self evaluation of computer skills, eight (A1, A5, A6, A7, A8, B2, B5, B6) placed themselves above average as computer users.

In response to questions following this statement only one (B6) understood browser plug-ins, and installation of programs, and two (A5, B6) were familiar with manually loading a URL in a browser or media player. Four responses (A4, B4, B6, B7) were familiar with more than one media player. One student (A2) claimed to spend zero hours per week on the Internet, six students (A1, A4, A6, A8, B5, B7) claimed to average 2 hours or less per week on the Internet and the remainder spread from 5 to 10 hours per week on the Internet. Most agreed that these times represented the majority of the time they spent on the computer. The responses for technology skills tie in with the self evaluation comments and students perceptions of skills and activities.

Self Evaluation. Students were asked about their skill in acquiring new concepts, principles, and designs. Nine (A2, A5, A6, A8, B2, B4, B5, B6, B7) indicated they were skilled at reading and understanding designs and concepts. Ten (A1, A2, A5, A6, A8, B2, B4, B5, B6, B7) considered themselves competent with drawings, plans, and illustrations. Eight (A2, A4, A5, A6, B4, B5, B6, B7) perceived themselves as capable of transferring concepts from one model to another. From the performance category recall, seven responses (A1, A2, A4, A5, A8, B3, B4) specifically stated that all equipment should be standardized. Further inquiry during the interview revealed that they wanted all examples, lab equipment and illustrations to match exactly. Some of the carburetors had additional fittings and different bases for the air cleaners. These differences caused great confusion.

Value. Three respondents (A5, B6, B7) declared that they had taken this course because they wanted to, while the remainder had participated because it was a required course. Six students (A2, A4, A7, A8, B3, B6) agreed that they would have taken an alternate course if it had been offered. Four students (A6, A7, B2, B6) did not have plans to teach.

Even with the stated performance and values, 11 (A1, A2, A6, A7, A8, B2, B3, B4, B5, B6, B7) considered this course as necessary in an agricultural education curriculum. Nine (A1, A5, A6, A7, B2, B4, B5, B6, B7) agreed that they would be using or needing the information from this class in the future. Seven of those who responded (A7, A8, B2, B3, B4, B6, B7) stated that they would utilize asynchronous studies again.

Case One Summary

The two modules of training involved in this case were the two most advanced and represented the ultimate achievements for the class involved. Neither group in either module exhibited many instances of success. The traditional class group in both modules held a slight performance advantage, but that advantage was not until both groups had been reminded of their initial instructions.

Definitely the key factor to the success of any class, either traditional or asynchronous is the value of the educational experience to the student. Earlier interviews might have produced more favorable answers, but the modules involved were taught at the end of the semester, and with the complexity of the projects, value was at its lowest.

Another very important factor to the asynchronous learner is advanced technical skill. This means different things to different generations. Self perceptions and knowledge assumed from the perspective of rank or position will adversely affect both the instructor and student. Joint exercises, equipment requirements, and practice will be necessary to confirm a uniform skill level. Pretest should be considered.

The biggest factor affecting the success of the two groups in this case was “autonomy” as described by Moore (2003). Moore’s continued observation led to the idea of independence in how one learned, even in a group setting. While there are strengths in group settings and the dynamics can be used to the advantage of all, the individual is responsible for their learning. Asynchronous study requires the maturity to asynchronously study.

In order to build knowledge a student must have a base of experience to draw from. Even if unrelated, knowledge and personal experience can be transferred to new settings. Case One students had few previous experiences which related to the modules taught or mechanics in general. Background principles were needed as a foundation for continued learning.

Case Two

In a not uncommon setting for a technical program, a 1950’s military base served as the default home for electrical trades classes and the site for Case Two. Electrical classes made-up 80% of a larger Industrial Maintenance program. The campus for Case Two was located 12 miles out of town in an inconvenient location with very few amenities. The environment was one of work, and the students were workers. Not only did the students come to work in class, but the morning class left in a rush to get to a job, and the night students came in dirty and tired from a job.

Case Two students represented the primary wage earners for their household. All were male and worked at least part time. With a mean age of 34 and only one student with post-secondary formal training outside of the technical program, many had attended short-courses or seminars. Of the 18 students discussed in this study four were on unemployment and were participating in a Texas Workforce Commission retraining program, following the closure of a local plant. Six Case Two students were studying to improve themselves for their own business. Four Case Two students were working on advancement with their current employer and four were looking for a better job. For most trades, all technicians must know some electrical skills, and good technicians have good electrical skills. Thus electrical skills are considered both the rudimentary and the pinnacle of technician skill. Reading electrical diagrams, designing circuits, installing electrical controls, and troubleshooting are considered formidable tasks in the trades, and the course studied in Case Two is normally approached with apprehension.

All of the students had taken preliminary electrical classes in preparation for this course. With the given demographics of the students in the program very few students took a full load or finished within any common time frame. Each student may have followed a different schedule and different pattern of classes. These factors suggest that although the students had been enrolled for several semesters, and had taken the same preliminary courses, students were seldom in the same class setting or had the same instructor. Thus while they were acquainted, and may have worked together there were very few alliances. Case Two students worked well in any team assignment and took possession of whatever project they were exposed to. Occasionally there were language or comprehension problems which were quickly resolved by someone in close proximity.

Group Observations

Technical Skills. At the start of the semester the classes for Case Two were taken to the computer lab to download and print their syllabus, schedule and tool list. During the initial session, the diversity and teamwork was again apparent. One of the students had taken numerous computer hardware and software classes, and had worked on computers for the public; one student worked with graphic arts; one student spent all his time and money overclocking computers and gaming. Two of the Case Two students had worked more than 20 years each in machining and machine tools trades, and were adept at computer numeric control programming and computer aided drafting and design applications. The majority of the students in Case Two used computers and related technology in the work place to receive work orders by email, maintain inventories, access service manuals, and to record images and service information. At the other end of the technology skill continuum, several of the students were observed helping one another, including demonstrating the use of the mouse. Several students left the first class uttering apologies for not knowing anything about a computer.

Case Two utilized WebCT as the management tool for the asynchronous modules of instruction. Even with the considerable technical experience represented, WebCT was not considered intuitive, but everyone quickly took the challenge and mastered the parts relevant to their need.

Mechanical Skills. In the traditional class setting electrical controls are taught using a visual system of communication which is prescribed by the American National Standards Institute. Using the prescribed standards, and a process which builds on previous steps, electrical controls evolve in patterns. Each class period of electrical controls was scheduled for four hours with approximately one half of the time devoted to lecture, examples and illustrations, and the other half devoted to laboratory practice. The times are not normally split into two units, but may alternate between the classroom and laboratory three or four times per session. The classroom time is spent developing the principle and laying out industry and code standards. The students then proceed to the laboratory where each lesson is applied to a variety of electrical control equipment. The laboratory sessions in Case Two were typical where each student from beginner to advanced was busy concentrating on the transfer from principle and drawing to the physical equipment.

All students face the same challenge, and the distinction between students with experience and those new to the field is seen in the time that is required to accomplish a project or the number of repetitions before a practice is spontaneous. Time is allowed for reflection and repetition, and one of the factors which separate individuals in these classes are their willingness to take advantage of these times. Another major factor which sets students apart in this setting is class attendance. From the description of Case Two students it is understood that they had obligations at home and at work which often had to supercede school commitments. Student's employers often placed last minute unplanned obligations on students which interfered with school plans and caused students to miss steps in the building process. Students who worked to catch up continued at the group pace, others fell so far behind that they dropped the course or stopped attending. Since it is rare that someone signs up for electrical controls without experience or basic electrical exposure, such classes commonly experience a uniform level of participation and interest. Case Two students came to class each week with the goal of completing the next step quickly, but were willing to dedicate extra time as needed. Within the first three weeks of the semester mechanical skills became very uniform. Each week Case Two students were eager for more practice and the next level of applications. This attitude persisted through the last week when they unanimously wanted more laboratory time and one more practice. Interest, participation, and interaction were particularly high when projects involved multiple interconnects with everyone's project connected electrically to all other projects in the laboratory. Laboratory exercises were performed in pairs, and individuals had the opportunity to observe and interacted continuously. Skill, personal application or relevance, attention, and motivation to acquire all possible knowledge were group norms. Several of the asynchronous students bought components to replace parts they had broken or perceived to be faulty. All of the home laboratory project components were returned.

Performance in the asynchronous group paralleled performance in the traditional laboratory setting. Those who performed well in the traditional class were also the ones who performed well in the asynchronous setting. Observation selections will be based on asynchronous performance with reference to traditional needs. Nine of the 18 students considered in Case Two were observed to master the materials presented to an employable level. These nine will be discussed within two rankings which score them according to overall skill obtained in electrical controls and class performance, both traditional and asynchronous. The first group contained C4, D4, D10, D13, D14, and D16. The second group contained C5, C7, and D7.

The first and most successful group represented the senior members of Case Two and those with the most years of experience, with the exception of one who was younger but still had tenure in electrical experience. This entire group had outstanding experience with computer hardware, software, and related devices; and D4 and D10 excelled in this area. D4, D10, D13, D14, and D16 were employed in positions which required them to work independently at times, as well as maintain supervision of other employees. During the weeks that led up to the modules of instruction involved with this study, the members of this group were the most interactive and involved with laboratory activities. Following their module of asynchronous instruction group 1 was also the most involved in comparing notes and exchanging experiences.

Superior technical skills solved the computer issues. Years of experience gave a solid background to build on. Class participation had prepared this group for the final modules. Outgoing and sharing attitudes helped them work through doubts and misunderstandings. Independence in life and work had instilled habits and practices which lead to success. C4, D4, D13, and D16 still came in early with their projects in hand looking for feedback, reassurance and answers. D10 had no issues, D13 had completed his project and it worked properly but he did not have enough confidence to plug it in. D4 had worked for three days trying to change something that was working as per design. He understood the wiring, and he understood the mechanical components but was expecting a different reaction. D4’s project was correct and he did not realize it. D14 with all his experience had not seen the circuit before but understood the principle immediately, brought in his controls and was able to reproduce it and help others later.

The second and also successful group included C5, C7, and D7. The second group was very similar to the first group except for lower technical skill levels and fewer positive employment experiences. The members of the second group were all extremely articulate, dedicated, and diligent students. This group was younger and advancing in employment status rapidly. All the members of this group felt challenged by the older, experienced members.

All of the successes in Case Two had strong life experience and background knowledge to build on. These students were alert to opportunities to recall and transfer previous training and observations.

Observed Performance Evaluation

Students in the traditional class group performed Module One, which worked with three-wire controls utilizing start-stop stations, very satisfactorily. The asynchronous group performed this exercise satisfactorily as a whole. Module Two, which worked with the concept of lock-out relays, was a little more abstract and gave both groups more problems but was also performed satisfactorily. Table 2 contains compiled matrix scores for each module. Observed Performance Evaluations apply to skills performance for specific modules scored in the matrix and do not reflect student performance or skills in any other areas, or student grades. Case Two students were

Table 2

Observed Performance Evaluations for Case Two Students

Task	Competency Level*				
	5	4	3	2	1
Start-Stop Station	C4, D4, D10, D13, D14, D16	C5, C7, D7	C3, C8, D12	D1, D2, C9, C15, D18	C6
Lock-out Relay	D10, D14, D16	C5, C7, D4, D7, D12, D13	C3, C4, C9, C15	C8, D1, D2, D18	C6

**Note.* Competency Levels

5 MASTERED AND CONFIDENT – Works independently with no supervision

4 COMPLETED AND HESITANT – Can complete with limited supervision

3 REQUIRED SUPERVISION – Required instruction and close supervision

2 NOT MASTERED – Requires assistance and complete oversight

1 NO UNDERSTANDING

divided in two groups designated C and D. Group C students performed module 1 – start-stop stations – in the asynchronous setting and module 2 – lockout relays – in traditional classroom. Group D students performed module 2 – lockout relays – in the asynchronous setting and module 1 – start-stop stations – in traditional classroom.

The observed performance evaluations presented in Table 2 reflect a skill level at a given time and not the potential of any student. The skill levels obtained closely corresponded with the performance expectations of the students.

In Case Two there was a slightly lower performance for Module 2 than Module 1. Module 1 was a developed pattern from previous training modules and part of a sequence. Module 2 was a new application of several established concepts and more of a challenge. There was a slightly lower success rate with the asynchronous groups than the traditional class groups. Factors which effected success were recognition of results, confidence from prior experience, and transfer of previous experience to recognize equipment changes.

Questionnaire and Interview

The data from the questionnaire, the interview notes, and the voice recorder are discussed under the categories of; performance, technology, self evaluation, value, and interview comments.

Performance. The performance of the technical skills was aided by having a computer lab readily available and time to resolve problems. There were administrative resets and other major server problems just as the modules under study began. Students called, drove out to the campus to catch an instructor, and came to class early, in a panic, until all issues were resolved and they were able to access the modules through WebCT.

Of those who had any difficulty performing the asynchronous module C5 recommended more examples and instruction, C15 suggested pictures, and D2 wanted more material of any kind. C6 was the only one that did not print the instructions. The universal comment was requesting more time in the laboratory and a variety of equipment.

The most common cause of failure to completely perform the asynchronous module was the inability to recognize the mechanical components on alternate brands of equipment. Students struggled with any design change or change of location of components. Home lab kits for the asynchronous modules utilized a variety of spare parts, which caused considerable bewilderment. Any single wire that was out of place set off an effort to rebuild the equipment or develop a work around. The transfer of knowledge to a new application was a problem for all except the most experienced (D4, D10, D14). When asked if they would consider on-line laboratory instruction again, or using such sources for makeup work, all of the groups observed as successful (C4, D4, D10, D13, D14, D16, C5, C7, D7) eagerly agreed, with the stipulation that they needed more feedback.

Technology. C9 was the only student that encountered hardware or connection problems. C9 was one of the youngest students and constantly talked about computers and computer activities. He averaged six hours per week on the Internet, yet he was unable to logon to the server. He attributed his problems to sorry server software, poor instructional material and site design, not enough time to find free computer usage, and he indicated the school should furnish him a computer. C6 was outside smoking when instructions were given. C15 lacked confidence to explore WebCT. C3, D1, and D2 had difficulty including shaky video, and trouble understanding instructions. C4, C5, C7, C8, D7, D12, and D16 had no problems with the WebCT course management system or the laboratory project. D4, D10, D13, D14, and D18 used the terms "perfect" and "no problem what so ever."

Self Evaluation. Case Two students with the exception of C6 consistently gave themselves lower scores than the instructor in all areas except the transfer of knowledge and concepts to new settings. This misperception reinforces the need for continual feedback.

When questioned about their personal habits and practices there appeared a great disparity between student's time spent on Internet – computer activities and reading. Table 3 lists the students declared time in each of these activities. Recognize that the students were asked bluntly to answer these questions and had not kept a log. It was later discovered that some of these students understood the questions to relate to entertainment activities. This misunderstanding caused some error, and it is known from their employment position that more activity was required, than listed. Since computer – Internet activities are often reading, these activities could be combined for our consideration. In Table 3 we will consider the list to be in the order of success and the top nine as a combination of the two successful groups.

Table 3

Students Declared Hours Per Week Spent in Computer – Internet Activities and Reading

Student Alias	Activity		Combined Activities
	Computer	Reading	
D10	20+	10-15	30+
D4	10	10	20
D13	4	5	9
D14	-	-	-
C4	15	8	23
D16	2	4	6
C5	0	10 min	10 min
C7	5	1	6
D7	2	5	7
D12	-	1	1
C3	4	8	12
D18	15	4	19
C8	1	4	5
D1	1	4	5
D2	1	4	5
C9	4	4	8
C15	5 min	1	1
C6	2	2	4

If we consider other factors involved in individual successes, we can better see a relationship. Throughout the entire course C9 wanted to write a paper on the poor design of a switch instead of hooking up the wires and turning it on. C9 struggled to follow directions and stay on task. C6 did not print the instructions, did not purchase a text book, and regularly left class early. C6 continually performed poorly and demonstrated low interest.

C3 and D18 were the least likely to succeed in Case Two. C3 and D18 both had language problems and had negligible experience or background. Neither C3 nor D18 had plans for needing electrical controls on a daily basis. With this low potential and incentive, yet far above average reading and computer practice both C3 and D18 were able to achieve some success.

The remaining students with extensive time commitments in the areas of computer – Internet, and reading are near the top of the success scale. Considering the most successful and those least likely to succeed, it appears that success in an asynchronous study utilizing computers, reading instructions, following illustrations, and applying demonstrated practice requires practice in reading and computer usage.

When asked about reading instructions, understanding written concepts, following printed diagrams, and transferring concepts C3, C4, C5, C6, C7, C8, C9, C15, D1, D2, D4, D7, D10, D12, D13, D16, and D18 consistently perceived themselves as good at these activities. This perception was generally an overstatement.

Value. Every student participating in Case Two was employed as a technician or seeking a job in the field. C3, C8, C9, D1, D2, and D16 stated that electrical controls was a required course, but C3, C15, and D18 were the only ones who planned not to use electrical controls daily on the job. Comments were made which indicated that C6 was trying to maintain living assistance by means of a student status, and C9 had a probationary time limit to complete training and gain employment. With the exception of C6, students brought projects and wiring diagrams from home or work, and continually had personal applications of class subjects. Group interaction and interest were high and students were eager for the next level of training.

Case Two Summary

The outcome of Case Two was positive in both the traditional classroom and the asynchronous activities. Success rates for both settings were high with those who excelled in the traditional classroom also leading in the asynchronous environment. Value for class content was high, and most students were using the laboratory practices daily, in their field of employment. Technical problems were minimal as a result of the extensive experience of many students and access to computers which were properly setup, controlled and utilized for online training on a regular basis. The older generation had technical skills which allowed them to independently troubleshoot problems and change setups if necessary. This pattern was followed by those with less experience.

The diversity and independence of Case Two students established patterns of behavior prior to the final modules which were studied. While Case Two students were autonomous they were interested in every project in the laboratory, but took possession of their own projects. The group dynamics represented mature adult education, but age and maturity set the pace.

Technological means of instruction are primarily based on reading instructions, and assimilating knowledge from illustrations, written descriptions, and video. Case Two students had very little comment on the video. Indications are that to perform well in the asynchronous environment one must have the established habits of reading and following instructions, and practice in developing cognition from text, illustration, and demonstration. Most mentioned that they understood the video, but suggestions for improvement requested more detailed instructions, larger graphic illustrations, and feedback. All but the most experienced (D10, D14), came back after the asynchronous module eager for confirmation, reassurance, or to ask questions.

An unrecognized act in the traditional laboratory is instant feedback. Several of the students seemed to miss this greatly in the asynchronous environment and mentioned this regularly. Even those who didn’t bring it up brought back results with uncertainty, and very low confidence levels. D1 and D4 expressed that they had problems at one time and thought they had it figured out, but could not reconstruct the situation for the group. The desperate emails and phone calls exhibited the need for immediate feedback, and not waiting for the next class period.

Electrical controls was taught in a very incremental stepwise method, thus Case Two studies prepared students for the next module of instruction. Asynchronous modules were simply one more small step, not a major concept. Very small increments were used, and it was almost predictable what was next. The modules were not the introduction of new concepts. This was probably a factor in the successes.

Successes in Case Two had experience in the field and had some familiarity with tools and components. Students in Case Two had taken preliminary courses in preparation for electrical controls. The background experience and familiarity with terminology gave a foundation on which to build electrical controls knowledge.

Case Two successes seem to identify a list of factors which helped them to comprehend a series of solution steps.

Cross-Case Analysis

In the cross-case analysis we want to consider in what areas the two cases suggest the same points, where they differ, and where the two cases conflict. To recap the findings from each group and allow for comparison, outcomes are profiled and explained as follows:

1. Group dependence, lack of autonomy (Moore, 2003), or lack of self-directedness (Grow, 1991), created by; maturity levels, leadership structure, situations and personalities prevented self expression or self assertion in the Case One setting. Self-directedness was a trait of success in Case Two. Grow (1991) suggests that self-directedness is a trait which can be learned and aids in successful adult learning.

2. Generational or cultural view of laboratory as superfluous. Case One enjoyed the activity and camaraderie of the laboratory but considered the detail of the activities intense. Case Two came to “work in the lab” and take advantage of laboratory time. The word culture is used as it agrees with Merriam’s (1998, p. 13) explanation of when a belief or attitude structures the behavior pattern of a group of people.

3. Case One students considered that the content of their curriculum was needed and pertinent to Agricultural Education, but they would personally never utilize the information. Case Two students valued the content of their course of study and relied on it daily. The need, and thus value of knowing something for work or life is one of the first tenets of Knowles (Knowles, Holton, & Swanson, 1998, p. 40) theory of Andragogy.

4. The perception of technical skills relating to computers and Internet applications for Case One students was the ability to get by or find a shortcut. They considered that they were fairly competent based on the fact that they had made it this far in their education. Case One students relied on automatic preset functions. Case Two students treated the computer as another machine and ran it as a technician would run a machine. When Case Two students ran into a problem they learned how to solve it. In addition Case Two had a well maintained computer lab, regularly used for online sources, where pre-module training could work out issues.

5. A mechanical background with an inventory of experiences that can be built on is a required foundation. Familiarity with tools and their usage, experience interpreting drawings, recognizing different models of the same equipment, and transferring knowledge from one application to another are learned skills gained through experience. These foundations must be built prior to advanced subjects. Case One students had very little mechanical experience and struggled to comprehend concepts and their application. Case One students did not understand basic mechanical terminology and did not try to learn it. Some Case Two students had experience in a

single industry and were not familiar with a wide range of equipment designs. These students struggled with understanding the instructions even though they understood the concept. Most Case Two students were able to recall and apply prior experience to instructions. These results are in agreement with Vygotsky's concept of instructional scaffolding as redefined by McLoughlin (1999, p. 3) for technology supported environments.

6. Resource material was considered optional and not utilized until reminders were given to Case One students. Case Two students printed and followed instructions and resource material. Case Two students had experienced and embraced the need and value of resource material.

7. Skills performance in Case Two closely corresponded with the amount of time spent reading and working on the computer. Case One students admitted to low performance in these areas and it corresponded to their success rate. Grow (1991) stressed the importance of an individual understanding how they learn, what their weaknesses are, and working to strengthen all learning tactics.

8. Successful students in Case Two who had a problem or a doubt eagerly sought feedback. Case One students waited untill the next class period and came in complaining, but failed to seek help or guidance.

9. It was not planned, but was realized that Case One involved the introduction and completion of the theory and maintenance of a complete engine component. Case Two was taught in small incremental steps. Each step was an addition to the previous steps.

The comparison of the two cases brought no conflict, but found that the two cases complement each other, and additional observations arose. The nine paired outcomes will be used to address the original questions proposed to guide discovery.

Research Questions and Findings

Research Question 1 - Findings

What characteristics describe learners who are more successful when experiencing asynchronous studies than students who are challenged by this instructional strategy?

Successful students in the asynchronous laboratory were autonomous learners, with a large inventory of background experience, advanced technical skills, high reading comprehension skills, and who placed a high value on the content of the laboratory curriculum. These students perceived the laboratory as an opportunity and challenge, and saw the computer as a machine or tool to be maintained and utilized. Successful students in the asynchronous laboratory had sufficient experience to predict and recognize correct outcomes for an exercise.

Research Question 2 – Findings

What characteristics describe learners who are more successful when experiencing traditional face-to-face synchronous studies than students who are challenged by this instructional strategy?

Individuals who seek a group setting for comfort, confidence, and feedback, and who lack related technical experience or reading comprehension skills are more successful in a traditional face-to-face setting. Students who had not learned to collect, maintain, and utilize information sources were continually reminded to retrieve their classroom material and laboratory handouts in the face to face setting. Students who sought and were more successful in the face-to-face synchronous studies continually stated that they were visual learners as though that relieved them of responsibility in other settings. These characteristics collectively indicate immaturity and the traditional synchronous setting allowed for them to be coddled.

Research Question 3 - Findings

What key factors aid the success of asynchronous laboratory studies?

A system of feedback or confirmation of results is of major importance in the asynchronous setting. Curriculum content which allows for small incremental instructional steps which build on each other is a positive factor in the success of asynchronous study. Each step requires evaluation and affirmative feedback to maintain interest and prevent the development of misunderstandings.

Research Question 4 - Findings

What key factors impede the success of asynchronous laboratory studies?

Subject content which involves the introduction of independent complex concepts greatly limits the chance of success in the asynchronous laboratory. The time required to test every component in the home lab kit, maintain support and feedback, develop and test the laboratory project, and grade independently generated laboratory reports will greatly limit the performance of an instructor. The lack of compatibility among computer operating systems, media players, and other software inhibits the asynchronous student. Technical and reading skills are assumed at certain student levels and may limit success. In the asynchronous environment any component failure or breakage, measurement error, or failure to understand the directions, may bring an unavoidable complete failure to that exercise since there is one opportunity for success until feedback is received, equipment replaced, supplies are replenished, and the exercise is repeated. Student performance and comprehension, equipment operation, and expected results must be confirmed at each individual step. Lack of success for any factor will render the student behind any reasonable schedule.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Contemporary social and educational trends demand flexibility on behalf of the students schedule and location. Typically this demand is being fulfilled with asynchronous activities through some form of distance education. Science, engineering, and technology programs are being left behind in this trend because of the laboratory components found in their curriculum. Asynchronous laboratories are considered major obstacles to offering science, engineering, and technical education independently (Holmberg, Liston, & Carter, 1998, p. 166). Distance education has been around for over 100 years and the earliest uses were for vocational education (Moore 2003). Many forms of delivery have been used and most continue to be used. Currently the major method of providing content for distance education is through the Internet and computers. This medium offers great potential for demonstration, illustration, and simulation. Adding to this issue are two additional pressures; (a) laboratories require large amounts of school resources (Graham, 1982); (b) laboratories are no longer sacred in education and alternatives are being sought (Hofstein & Lunetta, 1982).

Distance education literature reveals many studies exposing opportunity and success as with any immature research field and many studies in support of the *no significant difference doctrine* (Verduin & Clark, 1991). Laboratory studies are concerned with “practical hands-on experience using apparatus” in a “suitable equipped environment” (Lemckert & Florance, 2002). The questions posed in this investigation consider the characteristics of successful learners, in both the asynchronous and teacher directed synchronous laboratory; and factors which aid or impede asynchronous laboratory studies.

Methodology

This study was a particularistic case study using qualitative research methods or naturalistic inquiry. Particularistic means that the study focused on a particular situation or program, and case study indicates that the study involved a bounded unit or specimen (Merriam, 1998). This study involved two case studies and a cross-case analysis. The individual cases each involved a post secondary education class with large laboratory components. Case One involved small engines in a Mechanical Systems Managements course taught through a university agricultural education department. Case Two covered an Electric Motor Controls course taught through a college-based technical program.

Qualitative methods were chosen to uncover and understand a subject about which little is known, and to identify what variables might need to be tested (Strauss & Corbin, 1990; Hoepfl, 1997).

The goal of the researcher was to work as the primary instrument, collect data, perform analysis, and elicit understanding and meaning, with as little disruption to the natural setting as possible (Merriam, 1998). Convenience sampling was used, and the total enrollment of each class was solicited to participate. Steps were planned to assure trustworthiness. Data were collected in the form of a journal containing observations, discoveries, and assessments; an observed performance score; and a final interview and questionnaire. Data were analyzed to identify trends, categories, and common threads using the constant comparative method. The raw data were used to develop principles which eventually led to the writing of a theory.

This study sought to find out if laboratory content could be taught using distance education techniques, and if so who were likely student candidates and what are some basic factors that should be considered. The initial questions asked to guide the study were:

What characteristics describe learners who are more successful when experiencing asynchronous studies than students who are challenged by this instructional strategy?

What characteristics describe learners who are more successful when experiencing traditional face-to face synchronous studies than students who are challenged by this instructional strategy?

What key factors aid in the success of asynchronous laboratory studies?

What key factors impede the success of asynchronous laboratory studies?

Findings

Case One Findings. Case One results yielded low success rates in the synchronous groups and even lower results in the asynchronous groups. Factors which influenced these results were as follow.

Both the asynchronous laboratory sessions and the synchronous sessions were affected by the low value of the course to the participants. Students agreed to the value of the course content to agricultural education, but felt that they would not use the information. Case One students expressed the opinion that the type of material presented in their course was for someone else. Value is a requisite for Andragogy (Knowles, Holton, & Swanson, 1998, p. 40).

Both the asynchronous laboratory sessions and the synchronous laboratory sessions were also effected by the lack of background mechanical experience. Students had nothing to build on or relate to. A foundation for scaffolding was needed. Lemckert and Florance (2002) suggested that this would be a limitation to the application of asynchronous laboratories.

The asynchronous laboratory sessions suffered from the students marginal technical skills. The assumption that students at the level of training involved possessed such skills was a misconception, as were the students self perceptions of efficacy.

Case One possessed a strong group culture (Merriam, 1998, p. 13). They lacked self-directedness (Grow, 1991) or autonomy (Moore, 2003). Through many common classes and much time spent together a leadership hierarchy had developed and few were willing to upset the group status with independent performance. These low successes agree with the model developed by Grow (1991).

Both the asynchronous laboratory sessions and the synchronous laboratory sessions suffered from the lack of value or experience utilizing resource materials. Many students did not print resource items as instructed, or failed to keep them or refer to them as needed.

Case Two Findings. Case Two results yielded success in both groups; high in the asynchronous groups and higher in the synchronous groups. Factors which influenced success were as follow.

Students were using materials from the course in their work daily, and had high value and need for the knowledge. The “need to know” factor is supported by Knowles (Knowles, Holton, & Swanson, 1998, p. 64).

Technical skills among successes in Case Two were unusually high. Students proved to be technicians and were able to troubleshoot problems with the delivery system just as any piece of machinery. There were no indications of distraction by computer hardware, software, and related devices; or instructional delivery equipment.

Successes were mature students, independent in learning and behavior, placed in a highly interactive environment. Students met the model of self-directed learners (Grow, 1991).

Case Two students possessed large and varied inventories of background experience. Students quickly related to previous experiences, as predicted by Lemckert and Florance (2002).

Case Two successful students were discovered to spend much more time than average both reading and working on the computer and Internet. These individuals regularly practiced reading and interpretation skills involving technical instructions and illustrations.

A need for relevant feedback was discovered with Case Two. Even the successes sought approval and assurance. Some students completed the project properly but did not understand the results. Others assembled their project incorrectly, but because they received a reaction where something happened or moved, they were convinced of achieving perfection, when they had actually achieved the opposite of the desired reaction.

Cross-Case Analysis. Through the cross-case analysis no conflict was found, and the data from the two cases were found to complement each other. The comparison brought out nine paired outcomes which included additional observations not seen individually. The paired outcomes each contained a factor which resulted in failure for one case and success for the alternate case. The factors included (a) self-directedness or autonomy, (b) belief or attitude toward laboratory, (c) value of laboratory curriculum content, (d) technical skills relating to computer and Internet applications, (e) inventory of background experiences, (f) value and utilization of resource materials, (g) reading, comprehension, and computer skills, (h) feedback, and (i) curriculum design based on small additive steps.

Related Discoveries. Revelations were also found in the literature which indicates a neglect of current research on laboratory instruction. It is hard to focus on asynchronous laboratory instruction when teacher directed synchronous laboratories have not been defined. Contemporary research that can be found does not focused on student performance development.

There are almost 18 years of the *Journal of Agricultural Education* archives currently available online. A search of these editions yielded only 166 articles which contained reference to laboratories or shops. The majority of these articles addressed subjects such as; teacher attitude, first year teaching experience, management skills, sound levels, and perceptions of in-service needs. While all these were good and proper studies, very few articles mention the student or laboratory objectives.

Conclusions

The combined results indicate limited applications of asynchronous laboratories for select prepared individuals with a critically designed curriculum.

Conclusions: Research Question 1

What characteristics describe learners who are more successful when experiencing asynchronous studies than students who are challenged by this instructional strategy?

For an individual to be successful in asynchronous studies, that person must be mature enough to control their learning techniques and recognize their abilities. Only then can they learn independently and individually seek and apply knowledge. Independence will have to be at a level which requires minimal feedback.

The asynchronous learner of today must demonstrate technical skill. Currently that will typically involve computer hardware, software and related devices. The modern era is swept up in conveying information via the computer and related equipment. As technologies develop, there are more and more devices, software, updates, compatibility issues, conflicts, and the list is endless. Technical skills include staying current and possessing a knack for adaptation. Asynchronous learners must meet a standard which is universally spoken of, yet dynamic.

Other than the use of a college entrance exam, postsecondary education and training in the United States often assumes reading skills of an adequate level. For asynchronous laboratory studies an individual must have the ability to follow written instruction, read and understand principles and phenomenon, develop mental images, and be able to identify applicable settings. These skills are gained and lost with practice. The ability to read relevant material should be established by testing.

Asynchronous laboratory studies will require the student to be familiar with tools and equipment of the trade and their operation. The ability to tune, troubleshoot, maintain, and operate equipment are prerequisite for practice oriented disciplines (ABET, 2003). Having worked in the field, developed a feel for equipment, and knowing what response to expect is the only way an asynchronous student will have any idea of correct results within a laboratory exercise.

Conclusions: Research Question 2

What characteristics describe learners who are more successful when experiencing traditional face-to-face synchronous studies than students who are challenged by this instructional strategy?

Students who are less independent or unwilling to work independently are more likely to succeed in a traditional face-to-face synchronous setting. Maturity, social needs, values, and confidence level will have a part in this assessment and will cause it to change.

Laboratory participants who do not possess a minimum level of technical skill should stay in the traditional face-to-face classroom. Everyone thinks they are a computer expert and can figure it out as they go. One cannot be expected to learn the technology and the class material at the same time.

Students who have not developed their reading comprehension and concentration levels adequately, and are not willing to do this prior to beginning study should choose a traditional face-to-face study.

Most students enroll in a laboratory study to develop background in a field. Lacking experiences to build on, not recognizing applications or dangers, and having no idea of what results to expect are the reasons traditional face-to-face laboratories were developed.

Conclusions: Research Question 3

What key factors aid the success of asynchronous laboratory studies?

For asynchronous laboratories to succeed the delivery technology must be current, standard, tested, and secured. This is not a one-time process, but should be completed prior to the start of every new enrollment. Not only should every experiment be tested and proven to completion, but also every component of every laboratory kit. There is no second chance on an asynchronous project. Projects must be tested to be fail-safe, and protective measures designed to prevent the destruction of tools and equipment. Class material must be presented in small predictable modules which build upon one another. This is necessary to catch any misconceptions from a prior module. Students will have to be prepared to be patient and faculty will have to develop habits of predictable response in order to satisfy some form of corrected feedback.

As an additional note, consider what was not found. The asynchronous modules used video, animated audio, moderated images, and illustrations with written instructions. No difference or preference was stated by any of the successes. Of those who were less successful; the students unable to operate the video, requested more video; the students who chose not to print the instructions wanted more instructions; and the students who chose not to print and finish the illustrations, wanted more illustrations and photographs. Increased technology and material increased the escape opportunity for those less prepared to succeed. Those prepared and driven to succeed did so with sources that were available. This is in agreement with Clark's conduit theory (1983).

Conclusions: Research Question 4

What key factors impede the success of asynchronous laboratory studies?

Any concept that asynchronous laboratory studies are faster, easier, or cheaper will guarantee failure. The thought that someone less prepared for traditional studies should try asynchronous studies is a myth. With the many versions of software, hardware, course management tools, file formats, and computer settings, it is imperative that everything possible be done on the production and supply side of the independent studies setting to eliminate distracting issues. The smallest conflicts in technology will sidetrack the learning environment. Many asynchronous studies have very high student – teacher ratios. Laboratory applications will need to be limited in order to maintain proper oversight of student progress. Students can proceed through several assignments building misconceptions or failing to receive complete results.

Recommendations

Application

Students likely to succeed in the asynchronous laboratory environment, and factors which will aid in their success are:

1. Students must be mature, self-directed, autonomous learners. These characteristics are not a constant and may change, with situation, subject, and time.

2. Content and outcome must have value for the learner. All content and every session must have “worth” to participants. Little tolerance is expected for support material which does not possess immediate value.

3. Students must have a large background experience inventory. Examples must fit the learner’s inventory of experience. Results must fit a pattern consistent with experience. The ability to transfer experience to another setting must be learned and practiced. McLoughlin (1999) and Bruner (1960) would call this scaffolding, where a foundation is set and added to. Bruner (1960) hold the instructor responsible for whatever background is needed for a foundation. In a traditional face-to-face setting the instructor can keep backing up to simpler more basic settings until the learner is able to understand. Feedback to the instructor is immediate and recognizable. In the asynchronous laboratory it has to be assumed that the learner has base experience to work with. This is especially true in anticipation of an outcome. The learner may not recognize the outcome or effect of the exercise. Lemckert and Florance (2002) suggest that asynchronous laboratories are a possibility for the mature student who has significant experience with mechanical devices. We are still assuming a given level of experience and the ability to transfer knowledge and skills to new applications.

4. Students must have advanced technical skills. There seems to be a generational difference in the meaning of these terms. The current trend to deliver content via

computer and Internet, dictates that the independent learner must be adept at maintaining their own hardware, software, and related devices; more than just a "computer user."

5. Students must have advanced reading, comprehension, and interpretation skills. There seems to be a generational difference in standards for this area. Comprehending and following written communication is a learned and practiced skill.

6. Curriculum development must adjust to independent time frames, feedback mechanism, and progression of content in small modules. Small predictable increments of instructional modules allow for the feedback to be returned and corrections made prior to the next step. Introduction of major concepts will require establishing foundational background first.

The list of student criteria appears very selective and the fulfillment of all these characteristics would limit most potential students until new techniques are developed. Asynchronous delivery has never been for everyone and the application of such techniques to laboratories is more restrictive. The curriculum, feedback, and equipment issues will greatly increase the workload of the instructor and the time required to complete a course of instruction.

Asynchronous laboratories are not currently a viable alternative for most institutions unless students are (a) mature, self-directed, autonomous learners, (b) with a need for the content, (c) possess an inventory of experiences in the field, (d) develop advanced technical skills, (e) can demonstrate reading comprehension and interpretation skill, and (f) the institution commits to curriculum adjustments, technology maintenance, resource development, and revised faculty loads.

Given the current level of technology, research, and resources a comprehensive asynchronous laboratory is not practical. It is recommended that asynchronous sessions be utilized to perform pre-laboratory orientations and post-laboratory reporting, as research continues.

Research

Laboratory instruction has been taken for granted and has lost its respect and expectations. The name laboratory has been assigned to every out of classroom activity. Science – especially Agricultural Science – engineering, and technology education have neglected the research of laboratory instruction. Education is lacking vocabulary to explain the efforts and intentions of laboratory instruction. Agricultural education must take back the laboratory or close the shop. Specific laboratory goals must be established and other activities conducted in an environment which cost less in time, money, and space. Once laboratory goals are established, research must be conducted based on specific goals. Suggested outcome goals could begin with general laboratory concepts as described by Graham (1982) and Lemckert and Florance (2002); (a) experimental procedures, (b) types of equipment, (c) methods of data analysis, (d) report writing, (e) practical hands-on experience using apparatus, and (f) sources of error. From a simplistic view, education is about the acquisition, retention, transfer, and application of knowledge; how does the laboratory achieve this and more specifically what are the long range outcomes? John Dewey (1938, 1963) worked until the 1950's to establish principles which led to education reform and the system which supported strong laboratory educational experiences. Fifty years later experience, experiment, discovery and purposeful learning are considered optional in most institutions. But time and money is still allocated for laboratories which are filled with nebulous and indefinite activities. Science, engineering, and technology needs to again define laboratory activities and study techniques.

Present day education must address and reflect the needs of a widening age span and there appear to be distinct generational trends. Some of the characteristics of these generations are intensified in a homogenous group setting and may disperse in a diverse group arrangement.

Value of content has come to mean “I like it” or “I enjoy it.” New meaning must be given to value and value must be given to knowledge. Research must explore value systems as they apply to long range outcomes as a replacement for immediate gratification.

Lessons were learned concerning the investigation process. During the design it was hoped to find modules of instruction which were as closely matched as possible in difficulty, time, and significance. While this may have been achieved the modules chosen were some of the most difficult in the course, and it could not be assumed that there would be a high success rate in any environment. Also by choosing the particular modules that were studied, the investigation took place late in the semester. Erlandson, Harris, Skipper, and Allen (1993, p. 133) state “Distortions may be caused by the events that occur within a particular time span. The month before the closing of public school at the end of a spring semester is a very atypical one.” Further investigations should be performed on basic elementary exercises in which a high percent of the students could reasonably be expected to readily accomplish. Such investigations would properly fall during a typical schedule setting with out last minute distractions.

Research and collaboration must develop recognized efficient laboratory goals. Education can no longer afford to place everything in the laboratory category that cannot be classified otherwise.

Research must continue to explore experiential education and the value of the laboratory that have come to be taken for granted. Research should immediately address the acquisition, retention, transfer, and application of knowledge in the laboratory. This research must set high expectations and look for long-term goals in different generations and cultures. Agriculture represented a single culture at one time, but today we have many cultures in Agriculture, and many have few experiences to build on. Research must reach beyond the no significant difference concept. There are differences and these differences must be studied. Advancements normally come in small increments. Education must not continue to justify any means that performs to the lowest standard.

Research may then concentrate on asynchronous laboratories. The results of this study indicate that the principle factor involved in success is the background and preparation of the individual. Research must explore means of preparing less prepared generations. The limitations are not hardware or software, but "humanware." The answer is something other than more broadband video capability.

Research must explore solutions to equipment, and equipment operating experience requirements in both the traditional and independent laboratory. Education is not able to maintain the latest model of anything, given the current industry rate of change. And the latest gadget is seldom what laboratories strive to teach.

Research must address systems of feedback and reinforcement. A student cannot be allowed to continue in error or uncertainty and reinforce faulty concepts until someone answers an email.

Research must address the different reading and comprehension styles of the generations. This could probably be expanded to note taking and organization of information and resource material.

In today's post-secondary learning environment, asynchronous laboratory study offer challenges and opportunities for the student, instructor and the course.

This research supports the work of others in that students are more likely to be successful when they (a) hold intrinsic value for the educational experience (Knowles, Holton, & Swanson, 1998); (b) internalize meaning for the content, have a prerequisite knowledge framework, and have approximation skills that lead them toward appropriate solutions (Lemckert & Florance, 2002); (c) have prerequisite technical skills in the use of computer hardware and software, peripherals and media, and the Internet; (d) seek and use instructional resources to guide the activity and correct problems (Shih & Gamon, 2002) ; and (e) seek immediate corrected feedback from experts (Bloom, 1976; Earley, 2003; Riccomini, 2002).

Instructors are more likely to be successful when they (a) have access to the literacy, education and related experience of the learner; (b) deploy best practices in instructional design and delivery for adults (Knowles, Holton, & Swanson, 1998); (c) use contextual applications to tailor learning content for the student (Knowles, Holton, & Swanson, 1998); (d) pilot-test and field-test asynchronous laboratory activities prior to wide-scale use; and (e) manage timely student feedback to correct and reinforce sequential learning (Bloom, 1976; Earley, 2003; Riccomini, 2002).

Courses with asynchronous laboratory study are more likely to be successful when they (a) are systematic in knowledge development (Bloom, 1976); (b) build knowledge from a whole-part-whole design (Knowles, Holton, & Swanson, 1998); (c) provide appropriate teacher-learner ratios that lead to active learning engagement; (d) promote sequential self-directedness with the learner (Rogers, 1983); (e) enroll a more homogeneous group of learners and foster a community of learners (Lave & Wenger, 1991); and (f) introduce asynchronous laboratory study as small, step-wise experiences prior to immersion into a completely asynchronous laboratory environment.

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APPENDIX A

RANDOMIZER SOURCE FOR STUDENT GROUP SELECTION

esults - Research Randomizerhttp://www.randomizer.org/form.htmPage 1 of 1

RESEARCH RANDOMIZER

Close
For best results, close this window after each use.

Print

Download in Excel

Research Randomizer Results

1 Set of 8 Unique Numbers Per Set.
Range: From 1 to 16. -- Unsorted.

Job Status: **Finished.**

Set #1:

14, 11, 13, 10, 6, 3, 2, 8

Print Download in Excel Close

esults - Research Randomizerhttp://www.randomizer.org/form.htmPage 1 of 1

RESEARCH RANDOMIZER

Close
For best results, close this window after each use.

Print

Download in Excel

Research Randomizer Results

2 Sets of 8 Unique Numbers Per Set.
Range: From 1 to 17. -- Unsorted.

Job Status: **Finished.**

Set #1:

5, 4, 3, 6, 16, 8, 15, 7

Set #2:

4, 6, 13, 10, 1, 12, 3, 7

Print Download in Excel Close

APPENDIX B

INFORMED CONSENT FORM

Independent Asynchronous Laboratory Studies Utilizing Simulation and

Demonstration / Practice

Consent Form

I understand that I am being asked to participate in a research study on Independent Asynchronous Laboratory Studies. This study is being conducted by Kim T. Hays and will be the subject of his record of study / dissertation as a part of the Joint EdD in Agricultural Education with Texas A&M University and Texas Tech University. I understand that interviews will be tape recorded, transcribed verbatim, and analyzed. I understand that the class will be taught the same and evaluation techniques will be the same for participants and non-participants. I understand that this study will last for the full spring semester 2004 and that results will be available in August 2004.

I understand that potentially everyone enrolled in Motor Controls at Amarillo College and everyone enrolled in Mechanical systems management at West Texas A&M University will be involved in this study. I understand that the possible number of total participants is 45. I understand that I may withdraw from the study at any time. I understand that withdrawal from the study does not require withdrawal from the course, and that withdrawal from the study will not change the requirements for observation and interviews. I understand that withdrawal from the course will cause withdrawal from the study. I understand that participation is voluntary and Kim T. Hays will not be able to determine if I participate in this study until final grades are reported.

I understand the purpose of this study is to better understand what techniques are effective in asynchronous independent studies. These findings will aid students in this and other technical and science fields.

I understand that I may refuse to participate in this study without any consequences.

I understand that all records will be held confidentially and that my identity will remain anonymous. No one but Kim T. Hays will have access to the tape recordings and only Kim and the five members of his graduate committee will have access to the transcripts made from them. In Kim's working documents, in his dissertation / record of study, and in any subsequent publication of the study, my real name will not be used. I understand that confidentiality is a top priority. Anything I say during interview may be reproduced word for word. I understand that Kim may securely store and keep tapes and documents indefinitely.

I understand that if I have questions about this study I may contact Kim or the chairperson of his committee, Dr. Glen Shinn, whose contact information is listed below.

I understand that this research study has been reviewed and approved by the Institutional Review Board – Human Subjects in Research, Texas A&M University. For research – related problems or questions regarding subjects' rights, I can contact the Institutional Review Board through Dr. Michael W. Buckley, Director of Research Compliance, Office of Vice President for Research at (979) 845-8585 (mwbuckley@tamu.edu).

I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in the study. I understand that there are no risks involved in this study. I understand that there are no personal benefits from this study.

I have been given a copy of this consent form.

____

Signature of Participant Date

____

Signature of Principle Investigator Date

Principal Investigator:
Kim T. Hays
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Kress, TX 79052
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APPENDIX C

SCORING MATRIX FOR STUDENT TASK PERFORMANCE

Competency Matrix Case #1

5 MASTERED AND CONFIDENT – Can work independently with no supervision
4 COMPLETED AND HESITANT – Can work job completely with limited Supervision
3 REQUIRED SUPERVISION – Required instruction and close supervision
2 NOT MASTERED – Requires assistance and complete oversight
1 NO UNDERSTANDING
N NO EXPOSURE
INS Instructor initials

5	4	3	2	1	N	Ins	TASK
							Carburetors
							Ignitions
							Micrometers

Competency Matrix Case #2

5 MASTERED AND CONFIDENT – Can work independently with no supervision
4 COMPLETED AND HESITANT – Can work job completely with limited Supervision
3 REQUIRED SUPERVISION – Required instruction and close supervision
2 NOT MASTERED – Requires assistance and complete oversight
1 NO UNDERSTANDING
N NO EXPOSURE
INS Instructor initials

5	4	3	2	1	N	Ins	TASK
							Three wire control
							Lock our relay
							Ladder diagrams

APPENDIX D

INTERVIEW QUESTIONNAIRE

Name (optional) ____________________ Group #______________

AGRI 304 Mechanical Systems Management in Agriculture

Survey of demographics, practices, and opinions – does not affect grade

Print and bring to final class.
Please circle responses when choices are given, and give frank, honest answers for others. Extra comments appreciated. Use the back if needed for answers or comments. Thanks you.

1. How would you rate yourself as a computer user?
Best 4 3 2 1 Worst

2. Do you know what a plug-in is for a browser?

3. Do you know how to check for a plug-in?

4. Do you know how to find and load a plug-in?

5. How many media players are you familiar with?

6. Do you know how to manually load a URL in a player?

7. How much time a week do you spend on the Internet?

8. Why did you take this course?

9. How much time a week do you spend reading for pleasure of information?

10. What was the greatest difficulty with the on-line training?

11. Did the exercise work for you?

12. If not, would different material have helped?

13. If not, would more material have helped?

14. If yes, did you remember how to make it work in the lab the following week?

15. Whether it worked or not, did you understand the principle?

16. Do you grasp new concepts or instructions through independent reading?

17. Do you grasp new concepts from drawings, plans, or prints?

18. Can you transfer concepts from one design type to another?

19. How much mechanical experience do you have?
None 1 2 3 4 Experienced

20. Do you plan on teaching mechanics in an Agricultural Science program?

21. Would you have taken a different class if there were an alternative?

22. Do you see any need for this type of class in the future of Agricultural Education?

23. What grade do you feel you should receive?

24. Would it improve the class to standardize the equipment and assign every individual an item?

25. Would it improve the class to require every individual to furnish a certain piece of equipment?

26. Should students be required to furnish their own tools?

27. How well do you understand carburetors?
Proficient 4 3 2 1 None

28. How well do you understand ignition systems?
None 1 2 3 4 Proficient

29. Do you plan on using this again, or ever needing to know these subjects?

30. What weight should Ag Mechanics have compared to Animal Science in a modern Agricultural Education curriculum?
All Ag Mechanics 5 4 Equal 2 1 All Animal Science

31. What other subjects should be weighed against Ag Mechanics?

32. Would other subjects be more practical in Ag Mechanics than small engines?

33. If so what?

34. Did you understand the video?

35. Did you understand the class discussion on the alternate subject?

36. Was your connection good enough to be smooth?

37. Were the video and audio of adequate quality?

38. Did you print out the instructions?

39. Would you take necessary laboratory instruction on–line in the future?

40. If so, with what requirements? (ex. – more video, better video, more print outs, actual equipment, …)

41. Could on-line training work for you, for make-up or supplemental material?

42. Do you have a computer at your residence?

43. At what times did you access or try to access your lessons?

44. Make a comment about this survey?

Name (optional) ____________________ Group #______________

IEIR 1310 Motor Controls

Survey of demographics, practices, and opinions – does not affect grade

Print and bring to final class.
Please circle responses when choices are given, and give frank, honest answers for others. Extra comments appreciated. Use the back if needed for answers or comments. Thanks you.

1. How would you rate yourself as a computer user?
Best 4 3 2 1 Worst

2. Do you know what a plug-in is for a browser?

3. Do you know how to check for a plug-in?

4. Do you know how to find and load a plug-in?

5. How many media players are you familiar with?

6. Do you know how to manually load a URL in a player?

7. How much time a week do you spend on the Internet?

8. Why did you take this course?

9. How much time a week do you spend reading for pleasure of information?

10. What was the greatest difficulty with the on-line training?

11. Did the exercise work for you?

12. If not, would different material have helped?

13. If not, would more material have helped?

14. If yes, did you remember how to make it work in the lab the following week?

15. Whether it worked or not, did you understand the principle?

16. Do you grasp new concepts or instructions through independent reading?

17. Do you grasp new concepts from drawings, plans, or prints?

18. Can you transfer concepts from one design type to another?

19. How much electrical experience do you have?
None 1 2 3 4 Experienced

20. Do you plan on working with electrical control systems?

21. Did you take this class by choice or as a requirement?

22. Do you see the need for more electrical control training in your future?

23. What grade do you feel you should receive?

24. What would improve the class?

25. How well do you understand HOA switches?
None 1 2 3 4 Proficient

26. Should students be required to furnish their own tools?

27. How well do you understand start / stop stations?
Proficient 4 3 2 1 None

28. How well do you understand lockout relay systems?
None 1 2 3 4 Proficient

29. Do you plan on using this again, or ever needing to know these subjects?

30. What weight should electrical controls have compared to refrigeration in a modern maintenance curriculum?
All electrical controls 5 4 Equal 2 1 All Refrig.

31. What other subjects should be weighed against electrical controls?

32. Would other subjects be more practical in motor controls?

33. If so what?

34. Did you understand the video?

35. Did you understand the class discussion on the alternate subject?

36. Was your connection good enough to be smooth?

37. Were the video and audio of adequate quality?

38. Did you print out the instructions?

39. Would you take necessary laboratory instruction on–line in the future?

40. If so, with what requirements? (ex. – more video, better video, more print outs, actual equipment, …)

41. Could on-line training work for you, for make-up or supplemental material?

42. Do you have a computer at your residence?

43. At what times did you access or try to access your lessons?

44. Make a comment about this survey?

VITA

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2006	Doctor of Education: Major: Agricultural Education Texas A&M University and Texas Tech University
1996	Master of Science: Major: Engineering Technology West Texas A&M University, Canyon, Texas
1973	Bachelor of Science: Major: Agriculture / Ag Business & Economics West Texas State University, Canyon, Texas

Professional Experience:

1991 – Present	Teaching: Industrial Maintenance Technology Amarillo College; Tenure, Professor
Fall 2004 - Present	Department Chair; Manufacturing Technologies Industrial Maintenance Program Welding Program Non-Destructive Testing Program
Fall 2002 – Spr 2004	Teaching: Agricultural Education West Texas A&M University Welding and Metalwork, Mechanical Systems Management, and Agricultural Buildings and Environmental Control