ABSTRACT

CONOLEY, JOHN WILLIAM. Impacts of an audience response system on student achievement in high school agriscience courses. (Under the direction of Gary Moore and Barry Croom.)

The purpose of this research was to ascertain the impacts of an audience response system on student achievement. Audience response systems are a group of developing technologies that have been adapted for use in classrooms, as a tool for providing feedback. A group of high school students, enrolled in an agriscience applications course, were examined to discover differences in achievement. Teachers integrated the audience response system into the classroom and students' tests scores were examined comparing the technology-based feedback methods with the verbal and written response-contingent feedback methods. Both student and teacher attitudes were examined to determine perceived impacts of the audience response system.

The results of the study showed a significant increase in student achievement when integrating an audience response system. Some of the impacts of the audience response system, as perceived by students were a more fun classroom environment, an increase in participation, and an enhanced ability to understand the material presented. Impacts of the audience response system, as perceived by the teachers included an improved ability to analyze feedback from students, an increased focus on student learning needs, and spending more time in preparation for each class.

The conclusions drawn from the results of this study show that audience response systems are a promising, developing technology for improving student achievement and positively impacting the classroom environment.

IMPACTS OF AN AUDIENCE RESPONSE SYSTEM ON STUDENT ACHIEVEMENT IN HIGH SCHOOL AGRISCIENCE COURSES

by

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A dissertation submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Degree of
Doctor of Education

DEPARTMENT OF AGRICULTURAL & EXTENSION EDUCATION

Raleigh, NC

2005

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John William Conoley – A Personal Biography

John Conoley was born on October 19, 1978. John was a native of Wendell, North Carolina for twenty years. His parents are Neal and Linda Conoley. John was married in July of 2000 and he and his wife currently reside in Wilson, North Carolina. They have a two-year-old son, John Thomas and a 6-year-old golden retriever named "Lucy".

After graduating from East Wake High School, John pursued a degree in agricultural business management with a concentration in biological sciences at North Carolina State University. He continued his educational endeavors at North Carolina State by receiving a Masters of Extension Education.

John became interested in technology at a young age. As a boy, John spent endless hours growing up learning the intricacies of Nintendo games. The first computer he ever had was an Apple. Fond are the memories of having to constantly switch floppy disks in and out in order to get software to work properly. John has always enjoyed helping people learn to use software or instructing them on the various ways to accomplish tasks with technology. His background and aptitude for technology have led him to become involved with instructional technology.

Professionally, John Conoley joined the East Carolina Biology faculty in August 2004, as a Visiting Assistant Professor specializing in instructional technology. John's duties include teaching in Environmental Biology and making sure technology has a positive impact on students and faculty in the Biology department. John worked previously with the North Carolina Aquariums and with North Carolina State University

as a computer consultant and web site developer. John also owns and operates a website design and computer consulting business, Refresh, LLC in his spare time.

As for John's hobbies, he enjoys outdoor activities, cooking, and spending time with family and friends. He does a lot of fishing, hunting and playing golf. John was an all-conference golfer in high school and has continued to play fairly regularly since then. Offshore fishing continues to be his favorite type of fishing, but he enjoys most any chance he gets to spend time on the water. John's most notable fishing accomplishment occurred during his honeymoon, where he and his wife caught an offshore grand slam, consisting of a blue marlin, white marlin, and a sailfish in one day. During the winter months, John can be found shivering in a duck blind in Hyde County. He has been an avid waterfowl hunter his entire life. John enjoys any chance he gets to spend time outdoors with family and friends.

Some of John's long-term goals include becoming successful in the field of instructional technology and publishing many articles and several books on the subject. He hopes to also become involved in significant research that improves education through the use of technology. John would like to be nationally known for accomplishments in the area of instructional technology.

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CHAPTER 1

Effective teaching can be described as the process of setting instructional goals, conducting a series of processes to accomplish these goals, and assessing how the goals are accomplished. Rosenshine and Furst (1971) identified variables that should be incorporated to insure teaching effectiveness including: variability, enthusiasm, providing students opportunities to learn, incorporating student ideas, amount of criticism (negatively correlated), using structuring comments, questioning, providing feedback to probe student responses, and level of difficulty of instruction. The focus of this research was the effective teaching variables, as described by Rosenshine and Furst (1971), of questioning and providing feedback to probe student responses.

Feedback is the return of information about the result of a process or activity. Feedback is the process in which part of the output of a system is returned to its input in order to regulate its further output (Merriam-Webster, 2004). Feedback is a mechanism of control used to improve a process or activity (Bruning, Schraw, & Ronning, 1999). Feedback, as a component of assessment, is a primary connection between learner and instructor (King & Young, 2002). Cohen (1985) stated that feedback is one of the most powerful and least understood features of instructional design.

According to Kulhavy and Stock (1989), effective feedback provides learners with two types of information: verification and elaboration. Verification distinguishes the differences between correct and incorrect information. An example of verification is explaining the correct way to accomplish a task. Elaboration is information that explains to the learner why the answer is correct. An example of elaboration is explaining why each step is integral to completing a task. Both verification and elaboration are needed

for feedback to positively impact the learner. Kluger and DeNisi (1996) in their meta-analysis of feedback interventions, also describe feedback and feedback methods as fundamental components of the learning process.

Traditionally, there are several proven methods to provide both verification and elaboration resulting in effective feedback in the classroom. Some of these methods include written feedback, verbal feedback, and peer-group discussion feedback (Merrill, 1987). These methods have consistently provided adequate feedback in the past. However, no single feedback method stood out as superior to the others (Merrill, 1987). Providing verification and elaboration to the entire class, in the form of immediate feedback, was not practical in the traditional classroom environment. Instructors in the traditional classroom had very limited options to immediately gauge whether learning was taking place, as a result of providing feedback (Kluger and DeNisi, 1996).

The development of technology and computer-based feedback methods has drastically changed the capabilities of instructional feedback. Techniques and methods that were once impossible for instructors to implement are now becoming reality. Computers allow instructors to collect and analyze large feedback data sets. Database software makes cataloguing feedback responses on different timelines feasible and efficient. Audience response systems allow instructors to instantly assess whether learning is taking place (Chui & Woods, 2002). Technologies, including computers, database software and audience response systems have enhanced feedback delivery methods and feedback capabilities. This study explored the impacts on student achievement and the overall classroom environment of these technology-based techniques for processing feedback.

Audience response systems are a group of emerging technologies that are being incorporated into classrooms and other training venues. Audience response systems have three primary components. Each system is composed of a transmitter, a receiver, and software that collects and process data. There are several manufacturers of audience response systems designed specifically for use in classrooms. The audience response system used in this study was the Classroom Performance System developed by eInstruction. Some other manufacturers of audience response systems include TurningPoint, Reactive Systems, Pearson Classroom Response System, Reply Systems, and many others.

The audience response system used in this research, the classroom performance system or CPS, was comprised of a wireless, infrared transmitter, a Universal Serial Bus (USB) receiver that was connected a laptop computer which was loaded with a database software specifically designed for use with the CPS receivers. The teacher began the data transfer process of this system by projecting a question onto a television or LCD projection screen. Then students keyed in their answer on their wireless transmitter. The receiver processes the answers as correct or incorrect, then displays the correct answer while simultaneously storing the individual students answer in a database for that questioning session. The software allows the teacher flexibility and many questioning, storing, display, and data analysis options, but the overall data transfer process remains the same. For more information on the specific brand of audience response system used in this research visit the manufacturers website at http://www.einstruction.com.

Need for the Study

This study focused on a primary need of determining the impacts of an audience response system on student achievement and the classroom environment. Testing and research should precede technology implementation in the classroom. This study also focused on the need to test audience response systems before implementation in agriscience course occurred. This study also contributes to the wider body of research surrounding audience response systems by analyzing the applications and impacts of audience response systems specific to a high school agriscience classroom environment.

Computer use for educational purposes has greatly increased since the mid 1980's. A publication from the National Center for Education Statistics, *The Condition of Education* (1999), cited that computer use in education had more than doubled between 1984 and 1997. The use of technologies in agricultural programs had also increased dramatically over the last decade (Kotrlik, Redmann, & Douglas, 2003). Studies show that students in agricultural and extension education have embraced new technologies (Miller & Connors, 1996; Raven, Newman, & Day, 1997; Sexton, Raven & Newman, 1998). Researching the impacts of these technologies is a key step that needs to be accomplished before the technologies are widely adopted in high school agriculture classrooms. Before audience response systems are integrated into high school agriscience courses, research should be conducted to explore the possible impacts of this technology.

Audience response systems are being widely implemented in a variety of educational environments. Their use has dramatically increased in both secondary and post-secondary schools. Data from eInstruction (2004) indicates that the Classroom

Performance System (CPS) was being used in all 50 states and in 10 countries worldwide by primary, secondary, post-secondary schools and by other organizations including military and corporate groups. According to eInstruction (2004), there were 74 schools using CPS in North Carolina. As the adoption of audience response system technology becomes more widespread, there should be an effort to determine its effectiveness in a variety of learning environments, including high school agriscience courses.

Statement of the Problem

The main objective of this research was to determine whether using an audience response system improves student achievement. An experiment was conducted with students using an audience responses system in three agriscience applications courses at Southern Nash High School. Comparisons were drawn between traditional question and answer feedback methods and audience response system facilitated question and answer feedback methods.

Three research questions were examined by the study. First, the impacts of using an audience response system on students' achievement were examined. Second, the study investigated the perceived impacts of an audience response system on the classroom environment by examining the attitudes of the students. Third, the study investigated the perceived impacts of an audience response system on the classroom environment by examining the attitudes of the teachers.

Research Questions

1. Do students receiving feedback through an audience response system have higher achievement scores than those who receive feedback through non-technology based methods?
2. What are the students' reactions to using an audience response system?
3. What are the teachers' reactions to using an audience response system?

Statement of Hypothesis

Ho: There is no difference in student achievement between students who received feedback through the audience response system and students who received feedback through non-technology based methods.

Theoretical Basis for Researching Audience Response Systems

Developing a theoretical basis for researching audience response systems use in agriscience classrooms requires the synthesis of theories related to classroom framework and variables, teaching methods, feedback approaches, and technology integration into the classroom environment. A classroom framework developed by Duncan and Biddle (1974) provides an effective model to study student achievement and how introducing a new technological variable in the classroom effects achievement. Duncan and Biddle's classroom learning model describes the interaction of variables within a classroom setting. A detailed description of Duncan and Biddle's classroom learning model can be found in Chapter 2, Figure 1. This model describes the framework and variable interaction occurring in the classroom environment of the three Agriscience applications

courses in an effort to determine whether or not students' achievement was affected by the introduction of an audience response system. It also served as a basis for determining and accurately describing reactions of both students and teachers who used an audience response system.

The second theoretical aspect that must be addressed is the primary teaching methodology applied in the particular classroom framework. An adaptation of the Socratic method of teaching and inquiry-based learning was used as a primary teaching methodology in these three courses. This adaptation is the Method for Academic Progress or MAP. This process was developed and is recommended by eInstruction (2004) as a tested effective methodology for use in conjunction with Classroom Performance System. For comparison purposes, the MAP process was used as the primary teaching methodology in both the treatment and comparison classes as the primary teaching methodology. The MAP process includes a daily prescribed questioning regiment and more details on the specifics of this process can be found in Chapter 2. This adaptation of the Socratic method of teaching provides a tested, effective pedagogical method, justifying the use of both technology-facilitated and traditional question and answer methodologies in the classroom.

A third theoretical component addressed was the application of feedback in the classroom. Feedback Intervention Theory, developed by Kluger and DeNisi (1996), provided justification for studying the effects of using an audience response system technology to provide immediate feedback. Feedback Intervention Theory or FIT was developed through a meta-analysis of psychological research related to feedback interventions. The meta-analysis revealed a trend that certain feedback techniques were

directly correlated to improvement of student achievement and retention of information. (Kluger & DeNisi, 1996) Incorporating FIT into this research established a background for the technology-based use of the question and answer method and provided insight into discovered impacts on student achievement. Additional research provided in Chapter 2 discusses both technology-based and traditional feedback methods used in the classroom.

The fourth major theoretical component is the theory surrounding how teachers perceived the effects of technology on the classroom environment, based on received feedback applications from using an audience response system. To examine this process an analysis of the Information Processing theory was applied. The Information Processing Theory is a theory that relates to human cognition and memory (Miller, 1956). This theory on processing information is applicable to this study because it establishes a framework for assessing attitudes and perceptions of an instructor using feedback to affect learning in a classroom environment and helps delineate technology-based and traditional feedback advantages and disadvantages. It also describes limitations of human information processing capabilities compared to technology-based information processing capabilities.

These four theories comprised the theoretical framework for conducting this research. Further development and description of these theories can be found in Chapter 2 along with additional review of literature and research surrounding the impacts of using audience responses systems in the classroom. Table 1: Comparison of Framework Theories provides a brief summary of the theoretical framework and the role of each theory in this study.

Table 1

Comparison of Framework Theories

Theory	Developed By	Role in this Study
Model for the study of Classroom Teaching	Duncan and Biddle (1974)	Creates a model to describe the interaction of variables, including feedback, in a classroom environment.
Socratic Method / Method for Academic Progress (MAP)	Socrates & Plato Overholser (1999) / Darren Ward, PhD. eInstruction (2004)	Provides a detailed description of the primary teaching methodology applied in the classroom environment.
Feedback Intervention Theory (FIT)	Kluger and DeNisi (1996)	Describes how feedback is integrated into a classroom environment and draws a direct correlation between feedback and improved student achievement.
Information Processing Theory	George Miller (1956)	Documents relevant explanations for comparing students' and instructors' feedback processing capabilities to technology-based feedback capabilities.

Definition of Terms

Agriscience Applications – A course taught in North Carolina High Schools in which students integrate science concepts in agricultural based applications. A course blueprint can be referenced at http://www.ncffa.org/

Audience Response System – a group of technologies designed to collect and analyze feedback from a number of people simultaneously.

Classroom Performance System (CPS) – a brand of wireless audience response system developed by eInstruction, Inc. that is comprised of a receiver, response pads and software for a PC. The system is based on question and answer method of teaching and keeps a log of every class session. For more information on CPS visit http://www.einstruction.com.

Feedback - The return of information about the result of a process or activity; an evaluative response.

Methodology for Academic Progress (MAP) – MAP is a schedule and process of applying questions, discussion and feedback throughout the timeline of a classroom environment.

Assumptions

This study assumed that students and teachers would be receptive and open to using a new technology in the classroom. Without cooperation of the subjects, the experimental data could not be collected. The study also assumed successful technical functionality of the audience response system. If the response system did not function

properly, consistent comparisons could not be drawn between technology-based feedback methods and non-technological feedback methods.

Limitations

One limitation associated with this study is that the two tests used to measure achievement may not be equivalent. This would not have mattered given that the original plan for the methodology was a true switching replications experimental design. In this type of design the equivalency of the two tests would not have mattered because there would have been a treatment and a comparison group measured with each test. However, due to scheduling conflicts of the Agriscience Applications courses, the number of sections taught was reduced from four to only three intact groups. This forced the researcher to modify the design and created an imbalance with the treatment group being assessed with more scores from the instructional unit 1 – history test and the comparison group being assessed with more scores from the instructional unit 2 – leadership group.

This is a minor limitation, however. All of the test items were directly drawn from a classroom assessment test bank that is used by all teachers of Agriscience Applications in North Carolina. All of these items were developed by teachers and testing experts and are directly related to course competencies and are comparable to the secure test bank items used for end-of-course testing. Also, examination of the test item data shows that there were similar numbers of items missed by a high percentage of students. Another factor contributes to this minor problem is that the teachers assisted in the construction of the state classroom test bank for this course were also involved in the

creation of these assessments. Based on their professional judgment, they determined the two tests to be of similar difficulty levels.

After the problems occurred with having to change the experimental design every effort was made to acquire difficulty scores for the items pulled from the classroom test bank. Although the items for the secure test banks for this course have calculated difficulty ratings readily available, the classroom banks do not. This problem is minor to the analysis of the outcomes of the research but should be addressed as a limitation of the study.

Summary

In summary, feedback is an integral component of effective instruction. Audience response systems are an emerging technology for providing and analyzing feedback in the classroom. The needs for this study included testing the audience response system technology before adoption as well as determining reactions of students and teachers who used an audience response system.

The goals of this research were to measure the effects on student achievement of an audience response system that is being widely adopted, and to examine the reactions of students and teachers who used an audience response system.

The synthesis of theories related to classroom framework and variables, teaching methods, feedback approaches, and technology integration described the fundamental principles and constructs set forth in this research. All of the models in this research play a key role in accomplishing the research objectives.

CHAPTER 2
REVIEW OF LITERATURE

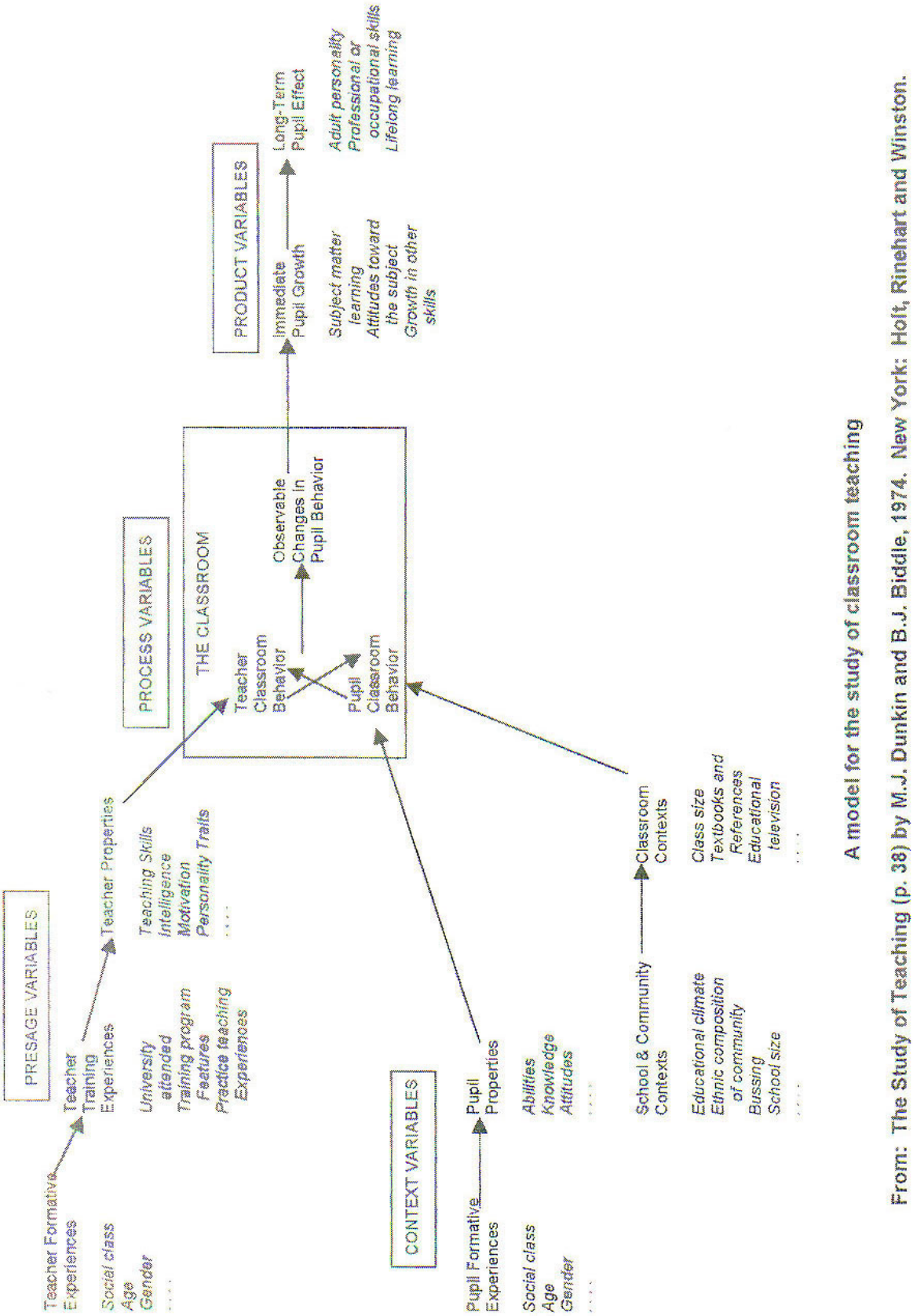
The literary and theoretical basis of this study stems from four theoretical areas, including classroom framework and variables, teaching methods theories, feedback applications for learners and feedback applications for instructors. A synthesis of theories and research in these four areas creates a theoretical reference base for persons researching the impacts of a classroom performance system on high school agriscience courses. Each of these theoretical areas are supported with research that describes the theoretical basis and research that links the theories to the objectives of this research.

Classroom Framework and Variables

Duncan and Biddle's Classroom Learning Model

Cruikshank (1990) stated that in researching interaction of technology in a classroom environment, using a theoretical model such as the one developed and tested by Duncan and Biddle (1974) is very useful. In their model, Duncan and Biddle (1974) suggested that the study of classroom teaching and learning involves four categories of variables: presage, context, process and product (see Figure 1).

Figure 1: Duncan and Biddle's Classroom Teaching Model



A model for the study of classroom teaching

From: The Study of Teaching (p. 38) by M.J. Dunkin and B.J. Biddle, 1974. New York: Holt, Rinehart and Winston.

Presage variables are those variables associated with the teacher. These variables affect the behavior of the teacher in the classroom. Examples of these variables are personality traits, teaching skills, and teaching styles (Duncan & Biddle, 1974). Examples of presage variables in this study are the ability for teachers to use the technology and the willingness or attitudes surrounding the use of the audience response system.

Context variables are those variables not influenced by the teacher. These variables are attributed to the students, the school and the community and are often referred to as learner variables (Duncan & Biddle, 1974). Examples of these variables are prior experiences, prior knowledge and skills, and personality traits of the learner.

Process variables are what Duncan and Biddle (1974) referred to as what takes place in the classroom. These variables are outcomes and interactions of behaviors. Examples of process variables are student-student interactions, student-teacher interactions, teacher behaviors, and student behaviors (Duncan & Biddle, 1974). Examples of the process variable in this study is the method of feedback delivery, either technology-based or non-technology based.

The fourth category of variables is product variables. These describe the outcomes of the learning process. Examples of the product variables are achievement and degree completion. The specific product variable in this research is student achievement on two tests. Long-term outcomes are also integral to the process, but are not addressed by Duncan and Biddle, nor are they addressed by this research.

Duncan and Biddle's classroom teaching model builds a foundation for this research. It provides prescribed classroom variables and a framework to describe traits of the variables and interactions between the variables. This research concentrated on the interactions in the classroom and on the outcomes of the educational process. Duncan and Biddle (1974) would refer to these variables as the process and product variables. This experiment sought to determine if introducing an audience response system as a technology-based process variable into the classroom improved the students' product variable of achievement.

Duncan and Biddle's model also establishes a consistent framework for all of the agriscience applications classrooms. Establishing a consistent framework contributes to this research by helping to control and test the presage and process variables and attribute any discovered significant results to the use of the audience response system technology. Establishing a framework also provides structure for researching integration of technology-based learning tools into the classroom environment. Duncan and Biddle (1974) developed this model to describe interactions between variables in a classroom environment. The model in this research was used as a framework to establish a standardized classroom environment for experimental research. Standardization of a classroom environment allows for a more accurate comparison of traditional feedback methods and technology-based feedback methods.

The decision to use the model for classroom teaching developed by Duncan and Biddle (1974) for a classroom environment model was based on its widespread use in similar applications. Many research studies examining interaction of variables in a classroom environment incorporate Duncan and Biddle's theories. Some examples of

studies that incorporate Duncan and Biddle's model for classroom teaching are Ball, Dyer, & Garton (2001) and Cruikshank (1990). In these studies the classroom model is used as a framework to standardize the classroom environment.

Teaching and Learning Methods

Socratic Method

The original Socratic method began as a question and answer methodology of instruction. This technique originated with Socrates, a Greek philosopher, but was actually recorded by his pupil, Plato (Hooker, 1996). The method addresses three main dialectic elements, including systematic questioning, inductive reasoning, and universal definitions (Overholser, 1992). Dillon (1984) concluded that questioning is second only to lecturing, in popularity among teaching methods. Classroom teachers spend on average anywhere from 35 – 50% of the instructional time conducting question and answer sessions (Dillon, 1984).

The Socratic method in education involves the use of inductive reasoning, systematic questions, and the formulation of general definitions (Overholser, 1992). Students are presented with a scenario and the instructor systematically poses a series of pre-set questions. The questions are designed to force the students' to think critically toward a predetermined goal (Tredway, 1995). Students are required to use their experiences and existing knowledge set to rationalize more complex problems or issues. Inductive reasoning is then applied to help the students expand beyond the details of the given scenario to conceptualize broader implications (Strong, 1998). Once the basic

concepts are understood, the instructor guides the students with questions to help them develop a rationale or universal definition of the concepts (Macmillan & Garrison, 1988).

As a teaching application, the Socratic method has a long history of demonstrated effectiveness. Overholser (1999) stated that the Socratic method (and adaptations of this method) use thought content to change thought processes, thus encouraging active participation and critical and creative thinking. Overholser (1992) also suggested that the three primary components to the Socratic method, inductive reasoning, systematic questioning, and universal definitions can be applied and adapted in today's classrooms to promote active learning.

Another component of the Socratic method that makes it an effective teaching strategy is self-discovery. Overholser (1999) concluded that the Socratic method promoted student self-discovery. Several researchers have shown that student self-discovery, through the Socratic method, produced learning at a deeper level and that the Socratic method was more beneficial than direct instruction (Brown & Palincsar, 1984; Hake, 1991; Perry, 1994; Samuel, 1989; Wilcox, 1987). Robinson (1971) concluded that the Socratic method promoted student self-discovery and learning by allowing students to realize the limits of their knowledge and encouraged them to expand these limits. Although the Socratic method is an ancient technique, adaptations are still employed today as effective classroom strategies (Brown, 1993).

Although there is much research that reinforces the Socratic method as an effective learning methodology, there is some research that questions the efficacy of the Socratic method in the classroom. Canney (2002) stated that the Socratic method is lacking a major element of effective pedagogy. This element is the notion of transference.

Transference as described by Laplanche and Pontalis (1973) was the establishment of a relationship by which the instructor is perceived to have knowledge that is beneficial to the student and as a result of this perception the student perceives that the instructor's presentation of knowledge through statements or questions supersedes the student's knowledge set. Canney (2002) concluded that without first establishing an instructor-student relationship conducive to transference; the strategy of the Socratic method will not be successful.

The traditional method of Socratic learning occurs in a seminar scenario. This scenario is similar to Mortimer Adler's Paideia proposal of the early 1980's. Paideia is composed of three phases including didactic learning, coaching, and exploration and understanding exercises (Adler, 1982). Adler (1982) stated, that in the traditional Paideia seminar method, students provide primary input into the learning process. Feedback from the instructor in this scenario is prohibited (Adler, 1982). One problem with the traditional Socratic seminar method is that it does not facilitate application of theories or concepts learned (Adler, 1983). This creates a problem when applying Socratic teaching methods in an applications-based course such as Agriscience Applications. To integrate some of the effective methods of Socratic teaching into an application course an adapted method of delivery was needed.

Inquiry-Based Learning

Stillings, Ramirez, & Wenk (1999) noted, that the Socratic method of teaching has been adapted in recent years to form another pedagogical strategy known as inquiry-based learning. The difference between inquiry-based learning and the original Socratic method is that inquiry-based learning includes additional methodologies derived from the

scientific method. (Stillings, Ramirez, & Wenk, 1999) This type of learning has been shown to be effective in increasing students' performances, especially in science-based courses (Stillings, Ramirez, & Wenk, 1999).

Referring to Duncan and Biddle's classroom teaching model (Figure 1), the process that reciprocates interaction between teacher classroom behavior and student classroom behavior in this research can be described as an adaptation of inquiry-based learning. There are other learning strategies that can accomplish a reciprocation of interaction between student and teacher, but for the purpose of this research, an adaptation of inquiry-based learning was used to create this interaction.

The standardized method of teaching applied in this research was Method for Academic Progress or MAP. MAP is a direct adaptation of inquiry-base learning, which was derived from the Socratic method. There has been a significant body of research conducted on inquiry-based learning methods (Stillings, Ramirez, & Wenk, 1999). Inquiry-based learning provides three distinct advantages over other teaching and learning methods, when applied in research of an applications course such as Agriscience Applications. These advantages are providing an effective information delivery process, systematically establishing a link between concepts or theories and application, and providing flexible means for observing and assessing student learning (Llewellyn, 2001).

Inquiry-based learning implements delivery process that uses an inquiry cycle that consists of question/theory formation, research design, data gathering, data analysis & interpretation, and question/theory reformulation (Stillings, Ramirez, & Wenk, 1999). This process is effective because each component, questions, discussion/data gathering and feedback, has been demonstrated as an effective teaching technique (Gall, 1984;

Adler, 1982; Kluger & DeNisi, 1996). Questioning has many purposes in the classroom, including developing interest, motivating students to become actively involved, and developing critical thinking skills (Gall, 1984). Discussion promotes active engagement, stimulates additional questions that lead to discovery of information, and applies rationalization and a logical process to find answers to posed questions. This process of student-centered learning has been shown to be effective (Adler, 1982). Feedback provides the learner with an assessment of his or her conclusions and allows the student to re-formulate questions to pursue additional information (Kulhavy & Stock, 1989).

Inquiry-based learning systematically establishes a link between concepts and application (Magnussen, Ishida, & Itano, 2000). Magnussen et al. (2000) also noted that using inquiry-based learning to establish links between concepts and application was effective in improving student achievement and particularly effective in improving low-performing students' achievement.

Inquiry-based learning also provides flexible means for observing and assessing student learning (Llewellyn, 2001). Llewellyn (2001) noted, that there are many effective methods of assessment when incorporating inquiry-based learning techniques. In this research the means for observing and assessing student learning is the primary research variable. A learning method that can still be effective even when integrating drastically different methods of gathering feedback is important for comparison impartiality. The learning method is not being tested in this research rather the method of providing feedback. An adaptation of the inquiry-based teaching method provides this advantage of a single teaching method that can be effective by incorporating both technological and non-technological feedback strategies. This strategy ensures

standardizing the learning methodologies in each class does not compromise student learning.

The inquiry-based learning method provides this research with a standardized, but highly effective teaching method, in which to implement instructional feedback scenarios. The adaptation of the inquiry-based learning method was used in this research first for all of the advantages that it provides to the learner and secondarily for the advantages it provides to the research design.

Methodology for Academic Progress (MAP)

One of the major differences between the original Socratic method of teaching and inquiry-based learning is the mode of delivery. The original Socratic method of learning is delivered through a seminar, while adaptive inquiry-based learning can be offered in a more traditional classroom environment (Edelson, Gordin, & Pea 1999).

An adaptation of the inquiry-based learning method was the primary mode of information delivery implemented, in this study. This adaptation is referred to as Methodology for Academic Progress or MAP (eInstruction, 2004).

The MAP process consists of recommendations for questions and discovery that can be integrated into a traditional lecture-based course. The process outlines recommended daily activities, bi-weekly activities, weekly activities, and bi-monthly activities. The Methodology for Academic Progress or MAP is explicitly described by eInstruction (2004) as shown in Appendix A.

Due to the time restrictions of this study, only the daily and bi-weekly activities were implemented. These parts of the MAP process were used in teaching presentations

in both the technological audience response system classrooms and the non-technological feedback methods classroom.

There are many feedback delivery methods for assessing whether or not students understand the material taught. Most of these feedback delivery methods, whether technology-based or non-technology based, involve asking the students questions. Using a methodology such as MAP that is derived from inquiry-based learning, questioning takes the predominate role in assessing the level of student understanding before, during and after the lesson. Questioning strategies therefore should go beyond short-term recall (Merrill, 1987). The MAP process also integrates levels of both immediate and delayed feedback and is derived from Bloom's taxonomy of Educational Objectives (Bloom, 1956) to provides teacher guidance with a hierarchical structure for questioning at each of the six levels of the cognitive domain: knowledge, comprehension, application, analysis, synthesis, and evaluation. The MAP process was determined to be an effective methodology to use in both technology-based feedback delivery and in the non-technology based feedback deliver for all of the reasons discussed above.

Feedback Applications for Learners

Feedback research is not limited to psychology or education research but extends across almost every discipline because of the many applications of instructional feedback research. Schimmel (1988) conducted a study to determine patterns in students' selection or preference of feedback delivery methods in computer-based instruction. His data showed although individual students exhibited wide differences in selecting feedback information, two general patterns emerged. Most students chose response-contingent

feedback after their incorrect answers and this seemed to have a high correlation with an increase in achievement. The other pattern that emerged was that the students that were more diverse in their selection of feedback information tended to have greater confidence that their answers were correct. The results of the study led to the conclusions that given a choice of feedback methods students preferred the response contingent feedback (Schimmel, 1988).

The effectiveness of the process of feedback is directly dependent on the feedback delivery method (Waldrop, Justen, & Adams, 1986). This study tested the delivery process of feedback and its impacts on learners and teachers. There are essentially two types of feedback delivery methods that were compared in this study: technology based audience response system delivery method and a non-technology based questioning with verbal response-contingent feedback, as described by Kulhavy and Stock (1989).

One reason for comparing the delivery methods is the discrepancy in the overall body of research comparing the effectiveness of technology-based feedback delivery. Several studies have determined that technology based feedback did not influence students' achievement (Merrill, 1987; Mory, 1994; Park & Gittelman, 1992). More research describes technology-based feedback as tools that enhance learning and positively affect student achievement (e.g., Clariana, 1992; Clariana & Lee, 2001; Clariana, Wagner, & Rohrer-Murphy, 2000; Pridemore & Klein, 1991; Morrison, Ross, Gopalakrishnan, & Casey, 1995; Waldrop, Justen, & Adams, 1986; Whyte, Karolick, Neilsen, Elder & Hawley, 1995). The discrepancies in these research findings indicate that particular delivery methods of feedback are most effective in specific learning environments. The goal of this research was to find out whether technology-based

feedback delivery methods or non-technology based delivery methods were more effective in the agriscience, learning environment.

Research has established consensus that feedback is an integral component of the learning process, however the results of a meta-analysis known as the Feedback Intervention Theory, conducted by Kluger and DeNisi (1996), bring into question the efficacy of various feedback techniques.

Feedback Intervention Theory (FIT)

The feedback intervention theory was based on the vast discrepancy in the research findings comparing types of feedback delivery. Although most researchers agree that feedback interventions are useful, Kluger and DeNisi (1996) found while feedback increased performance on average, more than 33% of feedback interventions were not effective or actually decreased learning. These results describing how the same feedback intervention can be effective in one scenario and not effective in another were also reported in studies by Quigley & Nyquist (1992) and Cameron & Cotrell (1970). Quigley & Nyquist (1992) found that using video feedback and teacher evaluation improved student achievement in specific performance arts skills. Cameron & Cotrell (1970) noted that video feedback was no more effective than traditional feedback methods of written and verbal feedback. These findings suggest a discrepancy and provide implications for further research in the area of feedback delivery methods and feedback effectiveness.

Pedagogical strategies for implementing feedback systems and maximizing the effectiveness of these systems are widely varied depending on the classroom environment. (King & Behnke, 1999, King & Young, 2002) This abundance of feedback

systems and application methods makes feedback as a theory difficult to conceptualize. One framework for implementing an effective feedback system was recently conceptualized by Kluger & DeNisi (1996). Feedback Intervention Theory (or FIT) "delimits feedback interventions to actions taken by an external change agent to provide information regarding some aspects of one's task performance." (Kluger & DeNisi, 1996, p. 255)

FIT is based on meta-analysis of the literature that uncovered a trend of feedback efficacy being directly correlated to the nature of the specific learning task. FIT uses feedback as a tool to move students from where they are to where they need to be based on a pre-set performance standard (Kluger & DeNisi, 1996). FIT specifically excludes the concepts of feedback unrelated to performance and naturally occurring feedback. FIT describes two findings regarding feedback efficacy.

First, FIT proposes that feedback interventions related to meta-task processes or those such as treats or praise to self actually inhibit performance, while feedback interventions that are centered on task motivation or the process of learning enhance student achievement. The second proposal of FIT is the level of a particular feedback interventions' efficacy is determined by the nature of the learning task (Kluger & DeNisi, 1996).

FIT concludes that changes in achievement are based on feedback delivery that "changes the locus of attention (Kluger & DeNisi, 1996, p. 259)." FIT also stated that feedback is used to make students aware of a gap between the standard of achievement and the students' current level of achievement. This difference was referred to in FIT as a "feedback standard gap" (Kluger & DeNisi, 1996). Research that lead to the

development of the control theory, (Carver & Scheier, 1981) stated that the student awareness of the gap is usually enough motivation to eliminate the "feedback standard gap". Although the mechanisms of these theories are not fully understood, FIT clearly describes the role of feedback in a classroom environment and is useful when trying to determine if a feedback system is effective.

Use of Non-Technological Feedback Approaches

There are several types of proven effective feedback interventions (Kulhavy & Stock, 1989). Over time, eight commonly used levels of feedback have emerged as a standard for non-technology based feedback interventions. These eight include no-feedback, knowledge-of-response, answer-until-correct, knowledge-of-correct-response, topic-contingent, response-contingent, bug-related, and attribute-isolation (Kulhavy & Stock, 1989 and Merrill, 1987). No-feedback simply states a score based on number of correct answers and gives a level of performance with no reference to individual questions. Knowledge-of-response feedback tells learners whether individual answers are correct or incorrect. This method simply provides verification and does not provide any elaboration into why the errors were made (Merrill, 1987).

Answer-until-correct feedback requires the learner to continue to answer until the correct answer is selected. This level also provides no elaboration. Knowledge-of-correct-response feedback provides item verification and identifies the correct response to each item (Kulhavy & Stock, 1989). Topic-contingent feedback provides item verification and learners are provided additional information that will assist them in finding the correct answer within provided instructional materials. Response-contingent

feedback provides the learner with an explanation of why the incorrect answer was wrong and why the correct answer is correct (Kulhavy & Stock, 1989).

Bug-related feedback provides learners with information on specific errors and references "bug libraries" or collections of corrections to a variety of common student errors. This allows the learners an opportunity for self-correction. Finally attribute-isolation feedback provides learners with item verification and information that focuses the learner on the central concept to improve the general understanding of the error (Kulhavy & Stock, 1989).

The primary non-technology based feedback delivery method used in this study was questioning followed by knowledge of correct response and response-contingent feedback, which provided both verification and elaboration for the learners. Response-contingent feedback has been determined to be a successful method of providing both components of feedback: verification and elaboration, as described by Kulhavy and Stock (1989). A study conducted with mentally handicapped children showed a remarkable increase in the ability to repeat a task when the children learned the task and were provided with a response-contingent feedback delivery system. The study by Hanson and Hanline (1985), found the students who were very unaware of other feedback techniques were very much aware of response-contingent feedback technique and increased the frequency of the task completion based on their heightened level of awareness of the feedback tool.

Non-technological feedback has various modes of implementation and delivery. There are an exponential number of ways to administer this type of feedback in the learning environment. Research has established that each delivery method is most

effective in a certain learning environment. There has been much research conducted on some of the more popular traditional or non-technology based feedback delivery methods.

Some of the more common non-technological modes of providing feedback includes flash cards, games, written feedback, verbal feedback, peer-group discussions and many more (Kluger & DeNisi, 1996). Researchers have discovered that each of the more common non-technology based feedback delivery methods were effective in certain learning environments. Hawkins (1983) and Din & Wienke (2001) both found that using flash cards as a feedback delivery method in elementary mathematics and high school chemistry courses improved student participation, increase student enjoyment of the course, and improved student achievement.

Providing feedback with games has also been found to be an effective non technology and technology based delivery method. Dempsey (1996) and others have found that games are an effective way to improve student achievement and positively impact the classroom environment by making learning more enjoyable. While many researchers have found that games are an effective feedback delivery tool, research in a community college setting conducted by Butler (1983) found that although games were effective in certain scenarios, there were learning environments where games distracted students from learning and created a classroom environment that was not as conducive to learning.

Written and verbal or audio feedback delivery methods are perhaps the most commonly used varieties of feedback delivery (Cohen, 1985; Merrill, 1987; Kluger & DeNisi, 1996). Some researchers, like Wunsch (1982) have found that there are no

differences in written versus verbal feedback delivery methods. Wunsch (1982) tested for differences by providing both written and group oral feedback with students developing business letter writing aptitude and found both to be effective. While other researchers, such as Moore (1977) have found no differences in achievement, but have found that audio feedback had positive effects on the classroom environment. Moore (1977) found in a study of university students that the students who received the audio feedback were more pleased with it than were those who received the written feedback and that there was slightly less time was required to provide audio feedback than written feedback.

Still other research, such as DaRosa, Mazur, and Markus (1982) shows that written feedback was more effective than verbal feedback delivery. DaRosa, Mazur, and Markus (1982) discovered that within the area of non-technology based feedback, a highly structured feedback delivery method was more effective than feedback delivery methods that were less structured. DaRosa, Mazur, and Markus (1982) gave medical students a written feedback assessment of their performance after each patient seen and compared this to simply providing verbal feedback on a non-structured schedule to the students. The students that received the structured written assessment scored significantly higher on the assessment.

Another aspect of both technology-based and non-technological feedback that is often disputed by researchers is a comparison between the effects of immediate feedback and the effects of delayed feedback. Sturges (1978) conducted a study with undergraduates that tested the effects of immediate vs. delayed feedback on retention of

items on a computer-managed test. The results of the study showed a significantly higher rate of retention in the two groups that received the delayed feedback.

Clariana (1999) developed a model for predicting and testing immediate and delayed feedback. Clariana (1999) found that those who received delayed feedback exhibited more retention for items that were easier, while immediate feedback had more impact on those questions that were more difficult. The results also showed that both immediate and delayed feedback had exhibited impact with the more difficult the questions (Clariana, 1999).

Other research such as that of Smith & Wight (1988) found that students favored immediate feedback delivery methods, were more enthusiastic in their assessment of the technique and believed that it helped facilitate learning. Research conducted by DiBattista, Mitterer, & Gosse (2004) also found that student favored immediate feedback when presented with a multiple-choice assessment. The immediate feedback technique used in this study was an answer-until-correct feedback technique. Students believed that the immediate feedback was more enjoyable, contributed to their learning and they indicated a strong desire to have immediate feedback for all of the prescribed multiple-choice tests. DiBattista, Mitterer, & Gosse (2004) concluded that the immediate feedback delivery process had a broad appeal to a variety of students.

Research conducted by King, Young, & Behnke (2000) found that the use of a combination of both immediate and delayed feedback was the most effective approach to learning. Conclusion from the results of this study indicated that immediate feedback intervention was more effective when automatic processing occurred, while delayed

feedback produces greater change with tasks involving deliberative and effortful processing (King, Young, & Behnke, 2000).

Like many of the other comparisons between feedback methods, research surrounding the comparison between immediate and delayed feedback contains many conflicting findings; Thus, leading to the conclusion that there is no one correct approach to feedback and that different methods work better in different classroom environments.

Research discussed above clearly characterized several differences in research surrounding the efficacy of feedback methods. The next section describes some of the research surrounding the use of technology to provide feedback, as well as some similar research discrepancies when comparing different types of technology based feedback methods.

Use of Technology to Provide Feedback

During the past few decades, technology has increasingly been used to implement feedback systems (Garg, 1975; Sturges, 1978; Kulik & Kulik, 1988; Mory, 1992; Zappe, Sonak, Hunter, & Suen, 2002). There are a wide variety of technologies currently being used to implement feedback systems. Some examples of these technologies are web-based feedback systems, video-graphical feedback systems, and handheld wireless feedback systems. All of these feedback systems can be used in a variety of settings, but according to FIT and other feedback research, each of these systems will work best for particular educational settings (Kluger & DeNisi, 1996). This research examined the use of technology-based feedback delivery system compared to a non-technology based feedback delivery system within the context of Feedback Intervention Theory, as developed by Kluger & DeNisi (1996).

There are documented advantages and disadvantages for using technology-based feedback. The ability to provide immediate feedback on all student responses is a primary advantage to using technology-based feedback (Mason & Bruning, 2003). Mason and Bruning, (2003) also state that the most important outcomes of technology-based feedback are identifying errors, becoming aware of misconceptions and motivating further learning. Some other positive aspects of technology-based feedback, as described by Mason and Bruning (2003) are that computers can tirelessly provide feedback that is unbiased, accurate, and nonjudgmental. Technology-based feedback can also be customized for learning styles of individual students, which is a learning goal that is difficult to achieve through traditional feedback implementation vehicles.

A disadvantage of a technology-based feedback system is that the use of these systems has been mainly focused on feedback for discrete responses. Little research has been done that incorporates technology-based feedback systems in providing motivational, process-oriented, and goal-directed feedback.

Audience Response Systems as a Feedback Tool

Audience Response systems and specifically the Classroom Performance System (CPS) are relatively new as a pedagogical feedback tools. The precursors of today's audience response systems have been in use since 1976 with the first of these systems being permanently mounted hard-wired systems. The original development of a wireless audience response system as a pedagogical tool originated from the effective use of precursor hard wired systems and from the success of multimedia use in the classroom. (Abrahamson, 1999)

There are four benchmark studies that have followed the evolution and researched the efficacy of the audience response system such as, the Audience Paced Feedback system, the Q-system, Classtalk, and CPS.

The first benchmark study was the Audience Paced Feedback Study, conducted by a group of researchers from the Netherlands, Germany and the UK (Gilbert, Massen, Poulis, & Robens, 1998). This study began in 1979 and continued until 1996. This study began with a simple audience response system that was a hard-wired system in which the response units had only one button. This meant that a response was an affirmative response and the lack of response indicated a negative response. This study focused on using a student response system in several post-secondary physics courses (Gilbert, et al. 1998). Questions were posed during the course of lectures for a variety of purposes, including exploration, verification, interrogation, and organization. Exploration questions were used to gauge the students' opinions of their own understanding. (Ex: Have you understood my arguments regarding this equation?)

Verification was used to assess the students' comprehension of the material. (Ex: Does this apply to high temperatures?) Interrogation questions were used to test the ability to apply the concepts to a specific situation. (Ex: A multiple choice question that students must solve the correct equation to determine an answer.) Organization questions were also used. (Ex: Are you ready to continue?) All of these types of questions would elicit a response from all of the students using a student response system (Gilbert, et al. 1998). Conclusions based on the results of this study reflected that use of the system improved examination results and student's overall achievement in the course (Gilbert, et

al. 1998). Gilbert, et al. (1998) also found that students' attitudes regarding using the feedback system revealed a positive response to the technology.

The Q-System was introduced in the mid 1980's along with the immediate precursor of CPS, Classtalk. The Q-System, developed by Reactive Systems was a handheld response system, where each of the student response units or keypads was wired to a control system that transmitted information via a serial cable to a computer (Horowitz, 1988). The Q-System was tested in one of the four, benchmark audience response system studies. This study is commonly referred to as the IBM study because Dr. Harold M. Horowitz, Director of Educational Technology for the IBM Corporation, presented this study at the sixth conference of Interactive Instructional Delivery for the Society of Applied Learning Technology (SALT).

The IBM study was conducted with five groups of twenty management-training students in each group (100 total). Three delivery methods were used in the training sessions, including Lecture, discussion, and question and answer (Horowitz 1988). Horowitz (1988) queried the theory that the student response system technology could increase student learning and retention by improving question and answer methods.

Horowitz (1988) also addressed the impacts of an audience response system on teachers' classroom methods. The students in this study answered a variety of types of questions including yes/no or true/false, multiple-choice, and rating scale questions. In the testing this research, instructors increased the number of learning points they could provide in an allotted time by 20 – 30 %. Student test scores improved by 19%, when the facilitator used a prescribed six question and answer sessions during a 90-minute lesson.

The improvement in test scores was 27% when this question and answer method was facilitated by the student response system.

The results of this study led to conclusions that the audience response system improved the learning process and that students attitudes toward using the response system were favorable. The study also noted that further research is needed to determine any retention effects and that some of the effects in this study could have been attributed to a mild Hawthorne-like effect. Further repetitions of the study are needed to eliminate this effect as a contributing factor (Horowitz, 1988).

Horowitz (2002) essentially created a bridge between audience response systems used in business and integration of audience response systems as an effective secondary and post secondary classroom tool for the delivery of feedback. The system Horowitz used in 1988 was the Student Response System developed by Reactive systems. It has been continually updated and is still being used in classrooms today.

Classtalk, another early audience response system was developed by Better Education, Inc. and released in 1985 (Everett & Ranker, 2002). Classtalk was a hard-wired system much like the Q-System. Classtalk software contained a graphical interface that showed images of seats and divided students' information into bins that corresponded with each student's seat number. This was to allow the teacher to efficiently keep track of student responses (Abrahamson, 1998). As the Classtalk system advanced, TI-92 calculators developed by Texas Instruments replaced the simple keypads. The calculators plugged in to the Classtalk network and could be used to transmit graphical and complex equation responses (Abrahamson, 1998).

The third benchmark study, "Classtalk: A Classroom Communication System for Active Learning" was conducted at the University of Massachusetts in physics courses. Classtalk was used in this study in a large lectures physics classroom environment. The audience response system was used to present questions during small group work, to collect student answers, and display histograms showing the class answers. Then a class-wide discussion of the answers was facilitated by the feedback collected with the audience response system. The findings of the research determined that students were more positive and believed they learned more in the audience response facilitated class (Dufresne, Gerace, Leonard, Mestre, & Wenk, 1996). The authors concluded that Classtalk is "an effective classroom management tool, allowing us to create a lively and rich learning environment without losing control of the class" (Dufresne, et al. 1996 p. 24). The study also determined that "students are helping each other learn" and that Classtalk created a "friendlier environment- a place more conducive to learning and more enjoyable for both teachers and students" (Dufresne, et al. 1996 pp. 25). Dufresne, et al. (1996), also stated that Classtalk encouraged student-centered learning and self-discovery in a large lecture course.

Louis Abrahamson, a researcher at Better Education, Inc, conducted the fourth benchmark study. Abrahamson's "An overview of Teaching and Learning: Research with Classroom Communication Systems" (1998) concludes that the Classtalk technology has applications across a wide range of disciplines. The study was conducted in physics, math, economics, and reading comprehension courses with elementary, secondary and post-secondary students. The conclusions of the study were that Classtalk improves students overall achievement in all of these courses (Abrahamson, 1998).

Abrahamson (1998) noted, that the results were sufficient enough to show full correlation with theory.

There has been some research conducted using the Classroom Performance System (CPS). There have been some preliminary studies conducted examining the effects of CPS. One preliminary study, designed by Chui and Woods (2002), is currently underway at the University of Texas at Austin. Chui & Woods (2002) are using a wireless CPS system in undergraduate biology and physics courses and trying to ascertain whether or not this system affects student achievement.

East Tennessee State University experimented with using the Classroom Performance System. This Classroom Response Study, conducted by Everett & Ranker (2002), examined the effects of CPS on students enrolled in introductory economics courses concluded that pre-post test results favored the CPS group, the student endorsement of CPS was strong and the faculty data was mixed but too few to allow for generalization (Everett & Ranker, 2002). The findings of these studies are positive and the justification for additional research on the Classroom Performance System is apparent.

Feedback Applications for Instructors

Information Processing Theory

Madeline Hunter researcher credited for popularizing the direct method of teaching, classifies instructional feedback as simply checking for understanding (Hunter, 1982). Hunter (1982) describes the process as determination of whether students have "got it" before proceeding. Hunter (1982) also notes that the teacher must know that

students understand before proceeding to practice. This is the process of collecting feedback, analyzing the feedback, and making an assessment of whether or not learning has occurred.

The instructor's role in feedback intervention is to intentionally adjust and improve student behavior through instructional communications (King & Young, 2002). Effective communication between student and instructor must begin with the instructor. The instructor must first collect, store, analyze and evaluate student responses and behaviors. The ability for instructors to process feedback information is limited by the boundaries of human cognition. George Miller, a noted cognitive psychologist, developed a theory, known as the Information Processing Theory, which describes the limits of human information processing (Miller, 1956).

George A. Miller (1956) developed two theoretical ideas establishing the information processing theory. The first concept known as "chunking" develops a limit or capacity to what can be held in short-term memory. Miller (1956) theorized and researched the idea that short-term memory could only hold 5-9 chunks of information. A chunk could refer to any information that is meaningful. An example of information divided into chunks is a telephone number such as 555-555-5555. This concept of chunking and its explanation of the limited capacity of short-term memory became a basic element of information processing theory and other theories related to memory and human information storage.

The second concept Miller (1956) established was information processing. Processing involves gathering and representing information, storing information, and getting at the information when needed. Miller (1956) categorizes these steps as

encoding, retention, and retrieval. Instructors are able to encode, retain, and retrieve information and are able to effectively provide feedback intervention in an instructional environment (Miller, 1956; King & Young, 2002). However, with the advent of new computer-based technologies, information processing has radically changed (Chandler, 1995).

In a presentation at the Australian Computers in Education Conference, Paul Chandler (1995) compares Miller's Information Processing theory and human information processing in general, to computer and technology based processing. Chandler (1995) also states that technology-based information processing is exponentially greater than that of the human capacity to process information. Chandler and Sweller (1996) developed a theory that is known as cognitive load theory, which is used to develop computer-training programs. This theory simply states that learning happens best under conditions that are aligned with human cognitive architecture.

Miller's (1956) information processing theory and Chandler and Sweller's (1996) cognitive load theory supports the limitations of human cognition. Chandler (1995) demonstrates the exponential difference between limited human information processing and expandable technology-based information processing. These theories suggest the need for researching the level of information processing attainable by combining human cognition and abilities with expandable technology-based processing capabilities. This directive leads to the research goals of this study, which are to determine if the technology-based feedback system is more effective than traditional verbal and written feedback interventions.

The theories of Miller (1956) and Chandler and Sweller (1996) provide insight into affecting change in the classroom based on processed and evaluative feedback. Instructors cannot affect change in classroom methodologies, based on feedback, if they are unable to adequately and effectively encode, retain, and retrieve feedback information. These theories of cognition (Miller, 1956; Chandler & Sweller, 1996) that establish that human capacity is for information processing is far less than technology-based processing methods, lead to a logical conclusion that feedback could be more efficiently and effectively processed by technology-based methods, such as audience response systems. The theories also provide a framework for studying impacts on the classroom environment based on a theorized enhanced capability for instructors to effectively process and make a change in teaching methodology based on processed feedback.

Technology-based Adaptation of Classroom Methodologies Based on Student Feedback

There are many ways that have been explored to adjust teaching methodologies based on feedback that students provide. Madeline Hunter stated, a teacher must structure a learning situation so that students can learn (Hunter, 1982). Knowing how different students learn is a prerequisite for instructions. David Kolb developed a learning style inventory that describes how students learn by relating how individuals deal with ideas and day-to-day situations in life (Kolb, 1984). This inventory and several others like it are a good tool for teachers to use to determine the learning styles present in a particular learning environment so that they may adapted their teaching

methods accordingly. Adapting teaching methodologies based on individualized student feedback is an integral part of the learning process.

Many schools collect student feedback data after the course is over in the form of a summative student evaluation. Administrators also employ tactics such as in class teacher observations and peer groups. All of these types of summative assessments serve a purpose. Summative evaluations are an effective resource for gauging student behavior in a classroom environment (Mustian, 1988). However, instructors who can use formative evaluation tools to immediately collect and assess student feedback can make more timely adjustments to possibly benefit student who are currently enrolled in the course (Chui & Woods, 2002).

Development of database interfaced technologies, such as those associated with audience response systems, have made storing and analyzing student feedback much more feasible and efficient (Gilbert, et. al. 1998). Teachers can implement this type of technology through audience responses systems to collect and analyze student feedback. Audience response systems technologies also allow instructors to immediately respond to feedback and adjust teaching methodologies accordingly. This study explored the effects on the classroom environment of providing teachers with access to an audience response system, for their use as a formative evaluation tool.

Summary

In summary, researching four theoretical areas, including classroom framework and variables, teaching methods theories, learner feedback applications and instructor feedback applications, established the theoretical basis of this study. A synthesis of theories and research in these four areas provides adequate information to justify any

discovered impacts of an audience response system in high school Agriscience courses. Establishing contextual and research-based links between theory and practical application of audience response systems was the primary objective of this chapter.

CHAPTER 3
METHODOLOGY

The purpose of the study was to first determine if using an audience response system effects student achievement. Secondly, the study determined the reactions of students who used an audience response system. Third, the study investigated teachers' reactions to using an audience response system. The dependent variables in this study were student achievement, students' attitudes, and teachers' attitudes. The independent variable in the study was the feedback delivery method, using either an audience response system or verbal and written response-contingent feedback methods.

This study used mixed method design, employing both quantitative and qualitative phases of research. To test the study hypothesis, a post-test only, quasi-experimental design was implemented. The quantitative phase addressed the differences in student achievement for those students using the audience response system compared to those students using more traditional feedback delivery methods, such as verbal and written response-contingent feedback. The second section included a qualitative, descriptive design that used a focus group approach and discovered reactions of students who used an audience response system. A third component was a focus group approach that documented reactions of teachers who used an audience response system.

Research Design

A mixed methodology design as described by Tashakkori and Teddlie (1998) was implemented in this study. Greene, Caracelli, & Graham (1989) highlight five major advantages of a mixed method design as triangulation, complementarity, development,

initiation, and expansion. Triangulation tests the consistency of findings obtained through different instruments. In this research, triangulation will increase chances to control, or at least assess, some of the multiple causes influencing the results. Complementarity clarifies and illustrates results from one method with the use of another method. In this research, focus group observation will add information about the learning process and will qualify the achievement scores and statistics. Development results from one method shaping subsequent methods or steps in the research process. In this research process, development would occur with further repetitions of the study. Initiation stimulates new research questions or challenges results obtained through one method. In this research, focus groups conducted with teachers and students provide insights on how the audience response system impacted the overall classroom environment, as well as establishing the perceived value of the system to the agriscience classroom. Expansion provides richness and detail to the study by exploring specific features of each method. Expansion occurs when a single method design is expanded to include multiple methods and provides description in greater detail.

Quantitative Phase

The design implements a quantitative phase to test research question one: Do students receiving feedback through an audience response system have higher achievement scores than those who receive feedback through non-technology based methods?

This phase of the design included testing a total of three sections of Agriscience Applications, taught by three different teachers at Southern Nash High School.

Achievement data was collected in all three sections, from two instructional units in each section. Two classes served as the treatment groups and the other class served as a comparison group, for the first instructional unit. Then during the second instructional unit, the group roles were switched. This resulted in a modified switching replications design. The classes were purposefully assigned which classes would receive the treatment for each lesson to balance the groups for comparison. A true switching replications design was going to be implemented. This design require four intact groups and due to the combination of two of the sections of the course before the semester, creating only three intact groups, this design was not feasible.

Preliminary steps during this part of the design included training the three teachers in the use of the audience response system technology. Two days of three hour per day periods of training, facilitated by the researcher, took place. Also the two instructional unit tested were developed based on standard competencies and were tested for both validity and reliability. For specific details, see the instrumentation section that follows.

Each instructional unit was completed, implementing the MAP process as the primary teaching methods in all three of the classes, as well as the prescribe feedback delivery method. Then each student took the first unit achievement test and an achievement score was collected. This process was repeated for the second instructional unit, with the only difference being the feedback delivery method implemented. After the second instructional unit test, the data collected had to be standardized on the same scale before analysis. Since the two tests had a different number of total questions, the students' scores on each of the instructional unit tests were standardized based on a one

hundred-point scale. An example of the standardization process would be if a student's score was fifteen points out of twenty possible points, then the standardized score would be 75 out of 100 possible points.

The research design was adapted from Trochim (2000) and reflects a modified switching replication experimental design. This post-test only, comparison group quasi-experimental design was chosen based on two constructs. First, research concludes that this design is an effective method allowing a determination of a cause and effect relationship when a true experimental design is not feasible. (Heppner, Kivlighan, & Wampold, 1992; Huck & Cormier, 1996) This design is summarized below in Table 2.

Table 2

Experimental Design

Agriscience Applications Class Number	Instructional Unit 1: FFA History	Instructional Unit 2: Leadership Development
Class 1: Daniele	Traditional Instruction	CPS Treatment
Class 2: Joan	CPS Treatment	Traditional Instruction
Class 3: Mike	CPS Treatment	Traditional Instruction

There are inherent limitations due to the structure of research with intact groups in classrooms, which forces researchers trying to determine causation, to use a quasi-experimental design. Intact groups or classes are already formed and treatment cannot be withheld from groups. Therefore using this type of design, that provides the treatment to

all students, provides the most accurate data to address the research hypothesis set forth by this study.

The quasi-experimental research design controls for all but three of the threats to internal validity (Cook & Campbell, 1979). The first threat was instrumentation (Cook & Campbell, 1979). Using a standardized instrument or test for each unit that was developed by the instructors of the classes and was tested for both validity and reliability controlled this threat.

Second is the threat of differential statistical regression or regression toward the mean (Cook & Campbell, 1979). This threat is not applicable in a post-test only scenario and is not a factor in this research. Third is the threat of interaction between selection and history (Cook & Campbell, 1979). Conducting the experiment with the comparison group and the treatment group taking the course at the same time will control this threat. Also any historical effects will be offset, because the effects will apply to all of the groups.

Population and Sample

The population of this study was all students participating in agriscience applications courses at Southern Nash High School. Those students registering for the selected courses during the Fall 2004 semester were automatically placed into the class group for which they registered. Three sections of Agriscience Applications were tested over a period of two instructional units. The intact groups were purposively assigned either a treatment or comparison group for instructional unit one and then the assignments were switched for instructional unit two. Sample sizes were determined by how many students enrolled each section. Class one had an enrollment of 23 students.

Class two had an enrollment of 20 students. Class three had an enrollment of 18 students. The total sample size therefore was 61 students.

Each of the students experienced a lesson with both the audience response system feedback and the non-technology based feedback. Therefore, prior to the data analysis two groups were constructed with 61 students' achievement scores in each of the two groups. Group one was the treatment group or the student achievement scores from when the students participated in the audience response system feedback. Group two was the comparison group or when students participated in verbal and written response-contingent feedback.

Instrumentation

The instruments in the quantitative phase of the study were instructional unit tests for each of the two instructional units. These tests can be found in Appendix C: Unit Tests. These tests were created by a collaborative effort of the three instructors. The tests were examined for both validity and reliability. Content validity was verified by a panel of experts. The two unit tests were emailed to experts in subject matter, curriculum and test design. The panel of experts consisted of a vocational regional coordinator, two current agriscience applications teachers, a university professor/teacher educator, and retired agriscience application teacher. After careful reviews the test were determine to be valid measures of achievement in those specific units of Agriscience Applications.

The units were tested for reliability, as well. The test for reliability that was used was Kuder-Richardson, as a measure of internal consistency for dichotomous or correct/ incorrect testing, as described in Green & Salkind (2004). The Kuder-Richardson coefficient was determined to be 0.798 for instructional unit test one and 0.760 for

instructional unit test two. These two coefficients confirm that the tests are reliable measures of achievement and would measure achievement consistently with additional replications.

These unit tests were also created based on North Carolina State standard course competencies for Agriscience Applications, which can be found in Table 3 on the next page.

One of the limitations of this study that could not be controlled and was previously addressed was the equivalency of the difficulty levels of the two achievement tests. As addressed in the limitations section of chapter 1, every effort was made to control this limitation. The items were drawn from a statewide test bank and the teachers assisted in the construction of the state classroom test bank for this course were also involved in the creation of these assessments. Based on their professional judgment, they determined the two tests to be of similar difficulty levels.

This process ensured student achievement was measured based on standardized, competency-based instructional units and that both of the achievement tests were similar and determined to be valid and reliable measures of achievement in the particular units tested. Also, this design insured that the instrument was not intrusive and did not change the normal classroom setting, since it was developed by the three teachers and would have been implemented regardless of this study.

Table 3

North Carolina Competencies for Agriscience Applications

Competency #	Competency Description
003.00	Examine the history of organizations that have made a significant contribution to agriculture.
003.01	Summarize at least ten historical events that have shaped the establishment of Agricultural Education.
003.02	Investigate three professional agricultural organizations that seek to improve the agricultural industry.
004.00	Explore leadership development opportunities related to pursuing a career in agriculture.
004.01	Interpret the significance and meaning of the mission, goals, ceremonies and traditions in organizations such as the National FFA Organization.
004.02	Investigate youth development activities that prepare students for advancement in an agricultural career pathway.
004.03	Explain the significant contributions that the FFA organization has made to the development of leadership for the agricultural industry.

Notes: This table displays competencies 3 and 4 for Agriscience Applications as described by the Department of Public Instruction in North Carolina. All of these competencies for this unit are core competencies and vary between cognitive levels of 2 and 3 on Blooms Taxonomy scale as described in Bloom (1956):

Data Collection

Data collection for this research occurred after the completion of instructional units one and two. The experimental process began with the teaching of instructional units one and two. In the traditional instruction classroom, the inquiry-based learning and activities of the MAP process were implemented on a daily basis. This process

included providing response-contingent verbal and written feedback using the same questions that were being presented in the treatment group. The feedback was provided to as many students, as the teacher determined feasible within the time constraints, usually only providing feedback to one or two students per question. Achievement scores from each student were collected for units one and two. Then the scores were combined to form the treatment group (group 1) and the comparison group (group 2).

In the classroom using the audience response system the same inquiry-based learning and activities of the MAP process were implemented with the aid of the audience response system. Feedback was provided to all students, immediately with the aid of the audience response system. The results of daily questioning activities were not documented in the traditional feedback delivery classroom but were cataloged by the audience response system software. Teachers were allowed to use this data at their discretion.

Analysis of Data

The SPSS 13.0 software platform was used to calculate and compare achievement scores from each student. One achievement or test score was recorded from each student, in each of the two units. Achievement scores were collected based on the ratio of correct to incorrect answers. Then these ratios were converted into a 100-point scale to standardize aggregate scores for comparison. Descriptive statistics such as mean, mode, and median on this data were calculated. The instructional unit scores were combined into two groups, the treatment group and the comparison group and an independent samples t-test process, as described by Green & Salkind (2004), was used to analyze any

significant differences present between the two groups. Descriptive statistical data was also calculated and reported.

Qualitative Phase

A focus group approach, as documented by Holsti (1969), Krippendorf (1980), Neuendorf (2002), and Bader & Rossi (2002), was used to examine attitudes of students and teachers in this phase of the research design. The focus group process described the students' and teachers' reactions and was used to discover common themes in their reactions regarding using an audience response system.

Every student participated in the treatment group for either instructional unit one or instructional unit two. Seven students from each class were selected to participate in the focus group sessions. Neuendorf (2002), in the recommendation of the content analysis process, suggests choosing a manageable group size of between 5 and 10 participants. One focus group was held during each class for scheduling purposes. Seven students from each class were randomly selected by the teachers to participate in each of the three focus group sessions. This resulted in holding three focus groups, one for each class with a total sample size of twenty-one students.

The student focus groups were conducted by questions being asked by the researcher and students' answers were recorded. Additional question development and discussion occurred during the focus group process resulting

A focus group format was also used to discover teacher reactions to using an audience response system. Since the sample of teachers was very small (only 3), data collected serves as a baseline and provides direction for future research on impacts of audience response systems.

The justification for using focus groups can be drawn from studies that have determined that this method is effective. Survey and experimental methodologies remove the subject from real-life context; Focus group analysis "investigates a contemporary phenomenon within its real-life context;" (Yin, 1989, p. 23) Yin (1989) also states that single and multiple person interview applications were becoming an increasingly more popular paradigm among researchers. Educational research and more specifically attitudes regarding the introduction of technology into classrooms can be best be qualitatively described by these methods (Yin, 1989). Finch and Lasonen (1995) also concluded that focus group methods had a history of success in applied research and evaluation especially where an analysis or evaluation of qualitative data was needed.

The instrumentation for the focus groups was developed by the researcher and was adapted to better suit high school students from a previous instrument used in Chui and Woods (2002). The focus groups instruments can be found in Appendix B: Focus Group Questions.

A focus group process was developed and implemented based on computer-coded content analysis procedures of Neuendorf (2002) with additional references from Holsti (1969) and Krippendorf (1980). Computer coding was used and a "per utterance" content scheme was applied to the data. Word frequencies were calculated to determine themes in the content of the focus groups. A separate instrument was developed for both the student and teacher focus groups. A core set of six questions were posed and discussed by the members of the focus group. The focus groups instruments can be found in Appendix B: Focus Group Questions. The approximate time frame of these focus groups

varied depending on responses and discussion times and the development of new themes but ranged from 45 minutes to an hour and a half per group discussion.

Data Collection

The data collection was based on the Neuendorf (2002) content analysis protocol. The researcher facilitated the four focus group discussions with a set of six questions to begin or engage the discussion on each topic. There were different questions for the student focus groups and the teacher focus group. These questions can be found in Appendix B: Focus Group Questions. The researcher posed a question and then discussion was lead or conducted on that question until the researcher determined that no new themes were emerging. Then the researcher moved on to the next questions. This process was repeated until all six questions had been discussed and responses had been gathered including at least one response per question from each student or teacher.

All four of the focus group sessions (3 student groups, 1 teacher group) were documented in the form of audio recording for further study and analysis. A laptop computer and software were used to record the sessions. All student and teacher recorded material was kept confidential. Actual recorded material was compressed and archived after transcription of the material into Microsoft word documents. The data collection occurred approximately two weeks after the completion of the second instructional unit. Approximately, three hours of recorded material was collected in the focus group process. These data were then transcribed into text documents for analysis.

Analysis of Data

These data were analyzed using content analysis, as described by Neuendorf (2002). For a graphical depiction of this process, see Figure 2: Content Analysis Process below.

The audio recordings were recorded on a laptop PC with mp3 recorder and Annotape Software was used to index and separate the focus group session audio files by student name. The content was then transcribed into text files by the researcher and analyzed by TextSTAT 2.0 a freeware program designed to analyze word frequencies. The raw data recorded by TextSTAT 2.0 can be found in Appendix D: Focus Group Data. A coding scheme based on a per utterance word frequency relationship to the classroom environment, as well as concordance of words related to the classroom environment was developed by the researcher. This coding scheme, concordance and the content analysis freeware were used to determine consistent themes in all of the focus groups by documenting word frequencies of those words relative to the classroom environment and comparing them to the related concordance.

The traditional content analysis procedures of Holsti (1969) and Krippendorf (1980) were followed with adaptations from the work of Neuendorf (2002). This includes the recommendation of Neuendorf (2002) to use computer coding and simple text analysis software to determine recurring themes in a data set. The process used to analyze the teachers' focus group transcript was a computer coding content analysis as described by Neuendorf (2002).

Figure 2: Content Analysis Procedure (Neuendorf 2002)

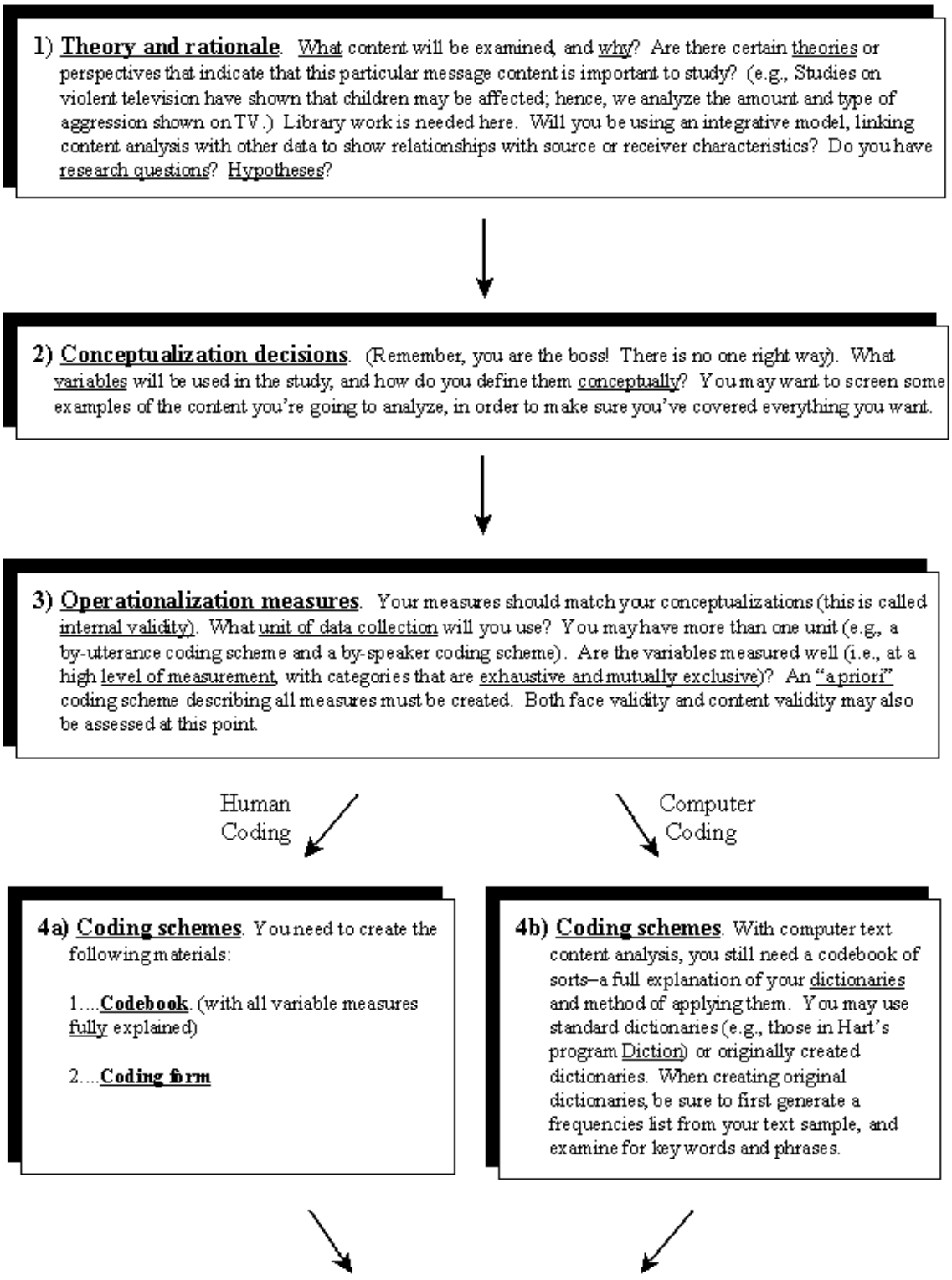
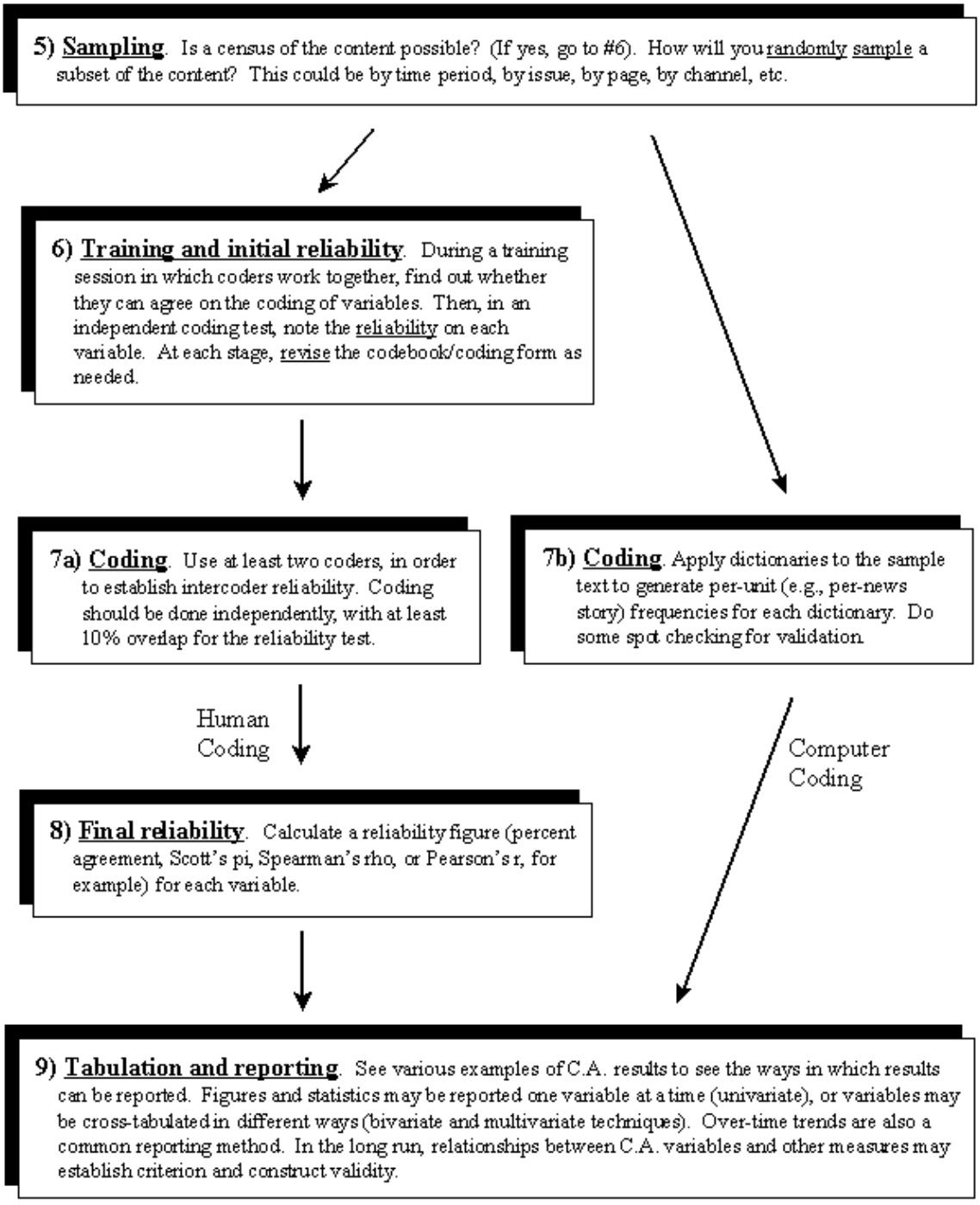


Figure 2: Content Analysis Procedure (Neuendorf 2002)



The audio recordings were transcribed into a text document. Then the TextSTAT 2.0 was used to determine words frequencies. The word frequencies were analyzed and

compared back to the context of the discussion and a determination was made on the statements that related to reactions to using an audience response system.

The students' and teachers' responses were analyzed, based on their comments and discussion in their respective focus groups, and common themes in their reactions were noted. Word frequencies were documented and analyzed to determine the attitudes of both students and teachers and to document specific contextual responses addressing research questions two and three. Also specific quotes were pulled from the focus group discussions that most accurately reflected the common reactions of both students and teachers with regard to the impacts of using an audience response system.

Summary

In summary, the study investigated and compared the effects of two feedback delivery methods on student achievement. Secondly, the study determined student reactions to using an audience response system. Third, the study documented teacher to using an audience response system. This study used a mixed methodology design, applying both quantitative and qualitative research approaches to measure each of the three research objectives and to provide a comprehensive approach to studying impacts of an audience response system.

CHAPTER 4
FINDINGS

This chapter presents the findings of the study, including student achievement data, student attitudes data, and teacher attitudes data. There were no missing data in this research, as all students registered for the courses were present for both unit tests or completed the test as a make-up in a timely manner and all students selected for the focus groups participated.

Quantitative Phase Findings

The results presented in this phase address the research question one:
Do students receiving feedback through an audience response system have higher achievement scores than those who receive feedback through non-technology based methods? The null hypothesis for research question one states that
Ho: There is no difference in student achievement between students who received feedback through the audience response system and students who received feedback through non-technology based methods.

Table 4: Achievement Scores by group, below, represents the descriptive data collected from combining achievement scores calculated on a one hundred-point scale, into a comparison group and a treatment group. Group one in the table represents the treatment group and group two represents the comparison group. The treatment group or group one had a sample size of 61, a mean score of 89.98 on a 100 point maximum scale, with a standard deviation (SD) of 8.817 and a standard error of the mean (SEM) of 1.116. The comparison group or Group two had a sample size of 61, a mean score of 84.41 on a

100 point maximum scale, with a standard deviation (SD) 12.618 and a standard error of the mean (SEM) of 1.616.

Table 4

Achievement Scores by Group

	Group	N	Mean	Std. Deviation	Std. Error Mean
Treatment	1	61	89.98	8.717	1.116
Comparison	2	61	84.41	12.618	1.616

An independent samples T-test was conducted to test the null hypothesis for research question one. This test was conducted to compare group one, the treatment group and group two the comparison group and to discover any significant differences that existed between the group achievement scores. As a preliminary requirement for conducting independent samples T-test, it is best to examine the variances of each group to determine if equal variances exist. The statistical test for homogeneity used in this research was Levene's Test for equality of variances.

Table 5: Test of Homogeneity for the variable of achievement represents the results from the Levene's Test for equality of variance. Levene's Test for equality of variances determined that the data had an $F = 7.335$ and a significance of $p = 0.008$. This demonstrates that there is a significant difference in the variances of the two groups at the $\alpha = 0.05$ level. As a result of these preliminary analyses, variances cannot be assumed to be equal when conducting the independent samples T-test calculation.

Table 5

Test of Homogeneity for the variable of achievement

Levene Statistic	df1	df2	Sig.
7.335	1	120	.008

Table 6, below represents the results of the independent samples T-test calculations, which compare the combined achievement scores from group one the treatment group and group two the comparison group. The results of the analysis of the variable of achievement were analyzed at the $\alpha = 0.05$ level and due to the preliminary analysis of Levene's Test for equality of variance, the variances can not be assumed to be equal.

The findings of the independent samples T-test are that the variable of achievement has a score of $t = 2.835$, with degrees of freedom of 107. The calculations also produced data resulting in a two tailed significance of $p = 0.005$, a mean difference of $\bar{x}_1 - \bar{x}_2 = 5.567$ with a standard error of proportion (SEP) of 1.964, and a 95% Confidence Interval of the difference of $1.674 \leq \bar{x}_1 - \bar{x}_2 \leq 9.460$.

TABLE 6

Comparison of Achievement Mean Scores

Achievement	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Equal variances assumed	2.835	120	.005	5.567	1.964	1.679	9.455
Equal variances not assumed	2.835	107	.005	5.567	1.964	1.674	9.460

Qualitative Phase Findings

The findings presented in this section describe the impacts discovered research questions 2 and 3: Research question 2: What are the students' reactions to using an audience response system?

Research question 3: What are the teachers' reactions to using an audience response system?

To address research question two, transcripts were created from audio recording of three focus groups sessions. A random sample of seven students from each class participated in three separate focus group session. This data was analyzed using content analysis process, as described by Neuendorf (2002). For a graphical depiction of this process see Chapter 3, Fig. 2: Content Analysis Procedure. Word frequency tables were generated for each of the three focus group sections using TextSTAT 2.0. The researcher developed both a coding scheme based on a "per utterance" word frequency

and concordances of words related to the classroom environment for comparing relevant word frequencies. The coding scheme, a word relevancy concordance and the content analysis freeware were used to determine consistent themes in each of the focus groups by documenting word frequencies of those words related to student and teacher reactions to using an audience response system. Also relevant quotes were documented to contextually represent each of the discovered common reactions.

Student Reactions to Using an Audience Response System

For the full focus group data broken down by focus group session and placed in a 40 character left and 40 character right context, see Appendix D: Focus Group Data. A summary of the TextSTAT 2.0 relevant word frequencies of the transcribed data related to research question 2 on students' reactions to using an audience response system is presented below in Table Seven: Student Focus Group Word Frequency Totals.

Table 7

Student Focus Group Word Frequency Totals

Relevant Word or Word String	Frequency on a Per Utterance Basis
Helped	65 instances
Easy	51 instances
Participate	38 instances
Fun	38 instances
Learn	25 instances
Pay Attention	17 instances
Understand	10 instances

As described in the table above, the most uttered relevant words in the student focus groups were helped, easy, and participate, followed by fun, learn, pay attention, and understand. The word utterance totals give a documented general idea of the attitudes of students regarding using an audience response system.

The general consensus among the students who used the audience response system was a favorable response toward the use of the audience response system. There were four prominent, student-perceived, positive impacts discovered. First, the students perceived that the audience response system was a helpful tool that increased learning and understanding. Student comments that were representative of this perceived impact are listed below:

> "It (the audience response system) helped us learn the material because he would do it over and over and we got to see which ones we did wrong and what the right answer was. When we do it on paper we couldn't see everyone's answer and what the right and wrong answers were."
>
> "The CPS reviews let her talk more about the answers and helped me understand why to choose the correct answer."
>
> "It (the audience response system) helped me a little like to pass the test and stuff because it gave us a review of all the stuff we talked about that was going to be on the test. It helped me understand the material."
>
> "It (the audience response system) helped me learn the material, because I really don't like to study and the technology helped me study better."

> " It (the audience response system) helped me learn the class material because if you ever got a question wrong you could go back over the question with the computer and see what you did wrong."

Secondly, the students perceived that the audience response system technology was easy to use. Students had little difficulty learning to use the technology or implementing it regularly in the classroom environment. There were some difficulties, notably not having enough time or not being able to get the receiver to record the answer in a timely manner. These comments taken from the focus groups transcripts and displayed below reflect these perceived impacts.

> "I liked that it (the audience response system) was easy to use and it was easier to go by instead of writing down notes or reading out of the book. It was an easier way to prepare for the test and it was fun."
>
> "It (the audience response system) was easy to use. You just hit the button of the answer and just wait for the class to finish. Then you see all the answers and percentages and stuff and you can see if you are right or wrong. I participated more because it was easier than just writing."
>
> "It (the audience response system) was pretty easy to use if it got better reception sometimes. It don't get the answer all the time, but it's a whole lot better than reading."
>
> "It (the audience response system) was easy and fun to use to me, because all it is, is pushing a button and you think about the question and press your answer and if you don't like your answer you can press another and change it right away."

"It (the audience response system) was easy to use. Plain and simple, point, click and done."

Third, the students perceived an increase in class participation and awareness, when using the audience response system. The students' reactions showed that using the audience response system increased overall class participation and helped students become more active and exhibit an increase level of awareness in class. The quotes below reflect these student perceptions.

"It (the audience response system) helped us participate more, because everybody use them and if you didn't use them you could see it on the screen. He would call you out and make you participate and when you're doing it on paper you can't really tell whether or not everybody is participating."

"It (the audience response system) helped me participate and others in class who aren't vocal sometimes. It got the class working together on questions."

"It (the audience response system) made us watch what was going on and pay attention to the materials."

"We listened more than usual and we focused more on the question and all the answers. When you usually do work, you usually don't think of the answers, you just go find the answer in the book after you look up the question and you usually don't think about it or talk about the other possible answers. It makes you pay attention to get the answers quickly, too."

"Umm, most like slackers got involved in it and we didn't have to be slowed down by people not wanting to do it because everyone had to do it. It was fun but it made everyone pay attention, too."

Fourth, the student perceived that using the audience response system was enjoyable and made the overall class experience more fun. Observations from the researcher also confirm that students seemed to have more fun in class and exhibited behaviors reflective of this perceived impact. Quotations from the focus groups as displayed below summarize this perceived impact.

"It made the class fun and we looked forward to it."

"I got a better test grade when using CPS. It also made the class more fun."

"I think that was one of the things that our whole class liked to do. It was one of the things we looked forward to when she said that we got to do it. It was fun."

"It was fun. I enjoyed using it. It made the class fun."

"We had fun while we was learning. It was a good activity for us."

Although most of the students had a positive reaction to using an audience response system, some student comments indicate that there were negative impacts of using the audience response system. Some of the documented negative impacts were difficulties experience with the technology or the implementation of the technology and distractions created by the use of the audience response system. Specifically, students did not like the timer function of the audience response system software. Students' attitudes also reflected a perceived problem with the receiver not recording their response

to a question. Another student perceived negative impact of using the audience response system was distractions created as a result of using the system. The quotations below describe these perceived negative impacts.

> "Sometimes he put the time too short and I didn't have time to answer it and sometimes the remotes didn't work perfect and it wouldn't pick up my answer."
>
> "Sometimes the clicker wouldn't respond to the thing sitting on top of the TV that it had to go to."
>
> "Its good for students who use it but it just, ummm, sometimes they goof off with it and think of it as a toy, but its not, its something to study about."
>
> "Sometimes you ran out of time and didn't have enough time to answer."
>
> "Sometimes you don't get your time to do what you've got to do with it."

Teacher Reactions to Using an Audience Response System

For the full teacher focus group data broken down by focus group session and placed in a 40 character left and 40 character right context, see Appendix D: Focus Group Data. A summary of the TextSTAT 2.0 relevant word frequencies of the transcribed data related to research question 3 on teacher reactions to using an audience response system is presented below in Table 8: Teacher Focus Group Word Frequency Totals.

Table 8

Teacher Focus Group Word Frequency Totals

Relevant Word or Word String	Frequency on a Per Utterance Basis
Help	19 instances
Review	12 instances
Learn	12 instances
Change	10 instances
Focus	6 instances

As described in the table above, the most uttered relevant words in the teacher focus groups were help, review, learn, change, and focus. The word utterance totals display an overall summary of the teachers' attitudes. The most frequently uttered relevant words show that the teachers' attitudes reflected a positive response to using the audience response system. Three consistent themes developed from the analysis of teacher reactions to using an audience response system. These themes indicated a favorable response from the teachers on using an audience response system. However, there were some disadvantages of using the system that were noted.

The first theme was the teachers perceived that the audience response system increased overall student participation. The teachers noticed that some of the students who never participated in verbal discussion always participated in using the audience response system. Another theme that developed from analysis was that the teachers

perceived that using the audience response system forced changes in their teaching methodologies. The third theme that was discovered was that teachers perceived that the use of an audience response system helped them focus on student learning needs. Quotes listed below reflect the above summary of findings. In these quotations CPS refers to the Classroom Performance System, which was the brand name of the audience response system used in this study.

> "I really think this technology changed how I approach presentation of my material, as well. I focus more on the student needs and the techniques that help them learn the best instead of just blanketing them with content."
>
> "It was amazing. I saw students who hadn't ever said two words in an entire class participating, answering questions and enjoying using CPS. It really helped some of them come out of their shell."
>
> "The biggest change that CPS forced me to make in my teaching methods was that before I never really went back over content. If they didn't pick it up the first time it was up to the student to communicate that to me and they rarely did. Now with the feedback from CPS I can review during the next class period specifically the things that the class had the most trouble learning."
>
> "My methods definitely changed when I used CPS. I normally would just present the lesson and then do an activity and that would be it. The process of integrating CPS helped to better structure my lessons."

Although the overall representation of teachers' attitudes was positive toward using an audience response system, some disadvantages or problems were noted. The most significant perceived disadvantage noted was the amount of time it took to prepare the questions for each lesson. Also some intermittent problems with transmitter and receiver functionality were discussed. The quotes below from the focus group transcripts depict the perceived impacts discussed above.

> "One of the disadvantages for me was the amount of prep time this thing took. It really takes a commitment to use it daily."
>
> "Sometimes the students would get frustrated when the receiver wouldn't pick up their answer immediately and they would have to lean over or stand up and point to get it to work. Sometimes it (the audience response system) would just be stubborn."

Summary

This chapter presented the findings from this study. The study was comprised of two phases, a quantitative phase and a qualitative phase. The quantitative phase tested research question one:

1. Do students receiving feedback through an audience response system have higher achievement scores than those who receive feedback through non-technology based methods?

The qualitative phase tested research questions two and three:

2. What are the students' reactions to using an audience response system?
3. What are the teachers' reactions to using an audience response system?

The sample sizes for the study were 61 students for the quantitative phase and 21 students and 3 instructors for the quantitative phase. The descriptive data showed groups with differing means. Group one represents the treatment group and group two represents the comparison group. The treatment group or group one had a sample size of 61, a mean score of 89.98 on a 100 point maximum scale, with a standard deviation (SD) of 8.817 and a standard error of the mean (SEM) of 1.116. The comparison group or group two had a sample size of 61, a mean score of 84.41 on a 100 point maximum scale, with a standard deviation (SD) of 12.618 and a standard error of the mean (SEM) of 1.616.

Preliminary testing showed the two test groups had unequal variances with a Levene's Test statistic of $F = 7.335$ and a significance of $p = 0.008$. This demonstrates that there is a significant difference in the variances of the two groups at the alpha equals 0.05 level and thus equal variances cannot be assumed when conducting a T-test. The T-test results showed a significant difference in the groups with the variable of achievement having a score of $t = 2.835$, with degrees of freedom of 107. The calculations also produced data resulting in a two tailed significance of $p = 0.005$, a mean difference of 5.567 with a standard error of proportion (SEP) of 1.964, and a 95% confidence interval of the difference of $1.674 \leq \bar{x}_1 - \bar{x}_2 \leq 9.460$. This test revealed a statistically significant; higher mean score in the treatment group than in the comparison group.

The qualitative findings studied both student and teacher attitudes regarding the integration of an audience response system. The relevant word frequency data showed that the most uttered relevant words in the student focus groups were helped, easy, and

participate, followed by fun, learn, pay attention, and understand. The attitudes of students showed a favorable response to using an audience response system.

An examination of student reactions to using an audience response system developed common themes. The theme was that the audience response system was a helpful tool that increased learning and understanding. Second, students thought that the audience response system technology was easy to uses. Third, the students perceived an increase in class participation and awareness, when using the audience response system. Fourth, the students enjoyed using the audience response system and thought that it made the classroom environment more fun. There were some noted negatively perceived impacts as well. These included a dislike of the timer function in the audience response system software and problems with the technology communicating between transmitter and receiver.

Teachers seemed to exhibit a favorable response to using the audience response system as well. Word frequency data showed that the most uttered relevant words in the teacher focus groups were help, review, learn, change, and focus. Three themes emerged as teacher reactions to using an audience response system were studied. The first impact teacher group perceived was an increase in student participation and awareness during class. Another theme that developed from analysis was that the teachers perceived that using the audience response system forced changes in their teaching methodologies. The third theme that was discovered was that teachers perceived that the use of an audience response system helped them focus on student learning needs. The teachers also noted some disadvantages including a lengthened preparation time and transmitter to receiver communication problems similar to those impacts perceived by students.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

Conclusions

There were three purposes of this study. First, this study sought to determine if differences in student achievement existed between groups of agriscience applications students that used an audience response system and those that used more traditional written and verbal response-contingent feedback methods. The second purpose was to determine student reactions to using an audience response system. The third purpose was to discover any common themes in teacher reactions to using an audience response system. Presented in this chapter are the conclusions drawn from the research findings, the recommendations based on the findings of this study, as well as recommendations for further studies. Based on the findings of this study, three conclusions were identified and are presented below with supporting data.

Conclusion 1 - Addressing research question one:

1. Do students receiving feedback through an audience response system have higher achievement scores than those who receive feedback through non-technology based methods?

Based upon the findings of this research we reject the null hypothesis that stated,

Ho: There is no difference in student achievement between students who received feedback through the audience response system and students who received feedback through non-technology based methods.

Results of the data analysis reveal that the implementation of an audience response system in the agriscience classroom environment resulted in statistically significant positive difference in student achievement, when compared to students receiving the more traditional written and verbal response contingent feedback methods. This is reflected in a statistically significant difference, at the $\alpha = 0.05$ level, of 5.567 between the mean of the treatment group with a mean score of 89.98 and the comparison group with a mean score of 84.41. Although equal variances were not assumed, the t-test results showed this difference to be significant with the variable of achievement having a t-score of $t = 2.835$, with degrees of freedom of 107. The calculations also produced data resulting in a two tailed significance of $p = 0.005$.

These results led to the conclusion that students improved achievement when using an audience response system as a primary feedback method. This conclusion was reached based on the findings that students scored significantly higher on instructional unit tests, when using an audience response system.

Conclusion 2 - Addressing research question two:

2. What are the students' reactions to using an audience response system?

The students' reactions showed several common themes. The most consistently perceived impacts found were an increased level of understanding and learning, a perception that the technology was easy to use, an increased level of student participation and awareness, and a more enjoyable classroom environment. From these perceived impacts, a conclusion can be drawn that the student perceived the audience response system to be a beneficial tool and to have positively influenced learning in the agriscience classroom environment.

Another conclusion that was postulated from the student perceived negative impacts of using an audience response system is that use of technology such as an audience response system can sometimes cause frustration and can potentially disrupt the learning process.

Conclusion 3 - Addressing research question three:

3. What are the teachers' reactions to using an audience response system?

The teachers' reactions to using an audience response system reflected three consistent themes. These themes were that using an audience response system increased student participation and awareness, using an audience response system forced the teachers to change teaching methodologies, and using an audience response system helped the teachers to focus on student learning needs. From these perceived impacts, a conclusion can be drawn that the teachers perceived the audience response system to be a useful feedback delivery method and to have had a positive influence on both teaching and learning in the agriscience classroom environment.

Another conclusion that was drawn from the teachers' reactions to using an audience response system is that use of an audience response system takes more preparation time on the part of the teacher and that technology frustrates the learning process when the technology does not function properly.

The findings and conclusions of this research contribute to the overall body of research surrounding the implementation of audience response system technology into a classroom environment, specifically an agriscience classroom environment.

The conclusions of this study are similar to the conclusions of studies conducted by Abrahamson (1998), Dufresne et al. (1996), Gilbert et al. (1998), Horowitz (1988),

and Everett & Ranker (2002). All of these researchers found an increase in student achievement, when using an audience response system feedback method. The perceived impacts of this study are also reflected in studies conducted by Abrahamson (1998) and Everett & Ranker (2002). Both of these studies found similar positive attitudes from students and teachers related to the use of an audience response system. Similar negative, teacher perceived impacts were discovered by Everett & Ranker (2002) including the perception that using an audience response system was more time consuming than providing written and verbal feedback.

This study helped to bridge a gap in the knowledge base surrounding this type of research by comparing an audience response system method of feedback delivery to a verbal and written response-contingent method of feedback delivery in an applications-based course. This research helped to further clarify discrepancies in the efficacy of feedback delivery methods. The research also provided insight into user perceived impacts surrounding the implementation of an audience response system that can be studied further with additional research.

Recommendations

General Recommendations

Two general recommendations have been derived from the findings of this study. First, using an audience response system was found to have a student and teacher perceived positive affect on learning. Thus, this research recommends that the Classroom Performance System or a similar audience response system could be integrated into agriscience applications classrooms with some degree of confidence of success. Two

considerations, however, before implementation occurs must be availability of funding and time considerations, including training time, preparation time, and implementation time.

The second recommendation based on the findings of this study is that generalization of this study should not be made to all areas of curriculum. This study was conducted with a relatively small sample and under a particular set of circumstances. Wide generalizations regarding the efficacy of audience response systems in the classroom requires further substantiation through additional research and replications in a variety of classroom environments.

Recommendations for Further Research

The recommendations of this study were to continue researching and testing the use of audience response systems, in particular the Classroom Performance System, in applications based classrooms, such as agriscience applications. Replications and further study of this technology should substantiate the findings of this research that using an audience response system improves student achievement and that the technology has a user perceived positive impact on the classroom environment.

Additional recommendations of this study were that testing and additional research should be done with new technologies as they emerge. Development of new technologies could potentially solve some of the perceived problems found in this study. Students and teachers in this study perceived that one of the negative impacts of the audience response system was the functionality of the transmitter communicating with the receiver. The system that was used in this study uses an infrared or IR transmission system. As a result there must be a “line of sight” between the transmitter and receiver.

An emerging technology that could remedy the transmission problem is audience response systems that operate on a radio frequency or RF transmission protocol. By continually researching new technologies as they emerge, educators can potentially eliminate the technology frustration of the learning experience that was perceived by teachers and students in this study.

Also additional research should be conducted to compare audience response systems. Instead of focusing on one system, a study that compares several systems, produced by different manufacturers would be beneficial and add to the knowledge base. Information gathered in this type of study would also help agencies make informed decisions about adopting an audience response system for their classrooms.

Summary

In summary, the purpose of this research was to ascertain the impacts of an audience response system on student achievement and to determine user-perceived impacts of using an audience response system on the classroom environment. The conclusions drawn from the results of this study show that audience response systems are a promising, developing technology for improving student achievement and positively impacting the classroom environment. Recommendations included the continued use of an audience response system in agriscience applications classrooms as well as establishing the need for further research surrounding the use of audience response systems.

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APPENDICES

Appendix A

Method for Academic Progress (MAP)

"Research on the learning benefits of questions has shown that the learning environment can be improved by as much as 150% by the application of various questioning approaches. The use of appropriate questions have proved to (1) engage the learner (2) focus the learner on specific objectives (3) help the learner practice retrieval and application of information to answer questions (4) provide opportunities for feedback allowing students to understand why they missed specific questions (5) provide opportunities for repetition within the learning process. The eInstruction MAP program is designed to maximize the classroom learning environment. It consists of the following four fundamental components.

1. Daily Instructional Activity

We recommend, as a general guideline, that 8-12 appropriate objective questions be integrated into every one hour learning activity. The break down of the questions, assuming the maximum of 12 questions is as follows:

- Prequestions (4)
  - 2 review questions over previous materials to provide retrieval and repetition practice
  - 2 prequestions to direct attention to the session's learning objectives
- Inserted questions (5)
  - Questions for retrieval and repetition purposes
- Postquestions (3)

- Questions for retrieval and repetition practice (spacing occurs which improves learning benefits)

2. Bi-weekly Instruction Activity

On a bi-weekly basis, it is recommended you incorporate a fun team activity into the learning environment. eInstruction has developed a CPS team activity called "There It Is!" to support a simple and fun retrieval/repetition activity. Basically, each team has a set of objective questions in hard copy format numbered from 1 to some reasonable number, let's say 30. Each question has a set value and a bonus value. Prior to the game, the teacher will input a key for the game providing the correct answer for each question.

The teacher initiates each round of the game. CPS will randomly select a question number from the 30 questions and assign that question to a team. Each team will immediately identify that numbered question from their hardcopy of the questions, process that question and respond with their answer. When all the teams have provided an answer, the teacher will end the round and the scores will be shown.

Of course, teams that missed the question will not receive any points. The teams that get the correct answer will receive the point value for correct answers. The first team to get the correct answer to their question, on their first attempt, will receive the bonus points.

The game proceeds on that basis until a predetermined number of rounds have been completed. If there is a tie, then a sudden death can proceed to determine a winning team.

This activity integrates fun, competition, teamwork, repetition, retrieval, spacing and delayed feedback into the learning environment. The questions would be focused on the learning points of the previous 2-3 days. Additionally, delayed feedback can be accomplished by revisiting questions, if any, which were missed by any team.

3. Weekly Instructional Activity

On a weekly basis, the MAP identifies a self-paced classroom activity with immediate feedback. This is diagnostic in nature with practice on retrieval, repetition and spacing. Again, CPS supports this by coordinating a teacher-entered key to a set of objective questions in hardcopy format. It is recommended that a relatively small number of questions be used and coordinated to the key learning points of the week. Approximately 10 – 15 questions are reasonable to support this activity.

Each student proceeds to answer the questions. As an answer to a question is entered the student is provided feedback in the following manner. If the answer to the question the student is attempting is correct, CPS will blink the student's response pad number and then move immediately to the next question. The feedback is positive – the answer entered was the correct answer.

On the other hand, if the answer provided is incorrect, CPS will blink the student's response pad number, but remain on the question. The feedback indicated that the answer entered was incorrect and another answer must be entered until the correct answer is provided. At that time, the student is positioned on the next question and ready to enter an answer for that question.

Although the feedback is very minimal, correct or incorrect, the student can eventually attempt every question and identify the correct answer to every question. This can provide the basis for additional work for the student to understand the basis for the correctness of a question.

4. Bi-Monthly Instructional Activity

Twice a month, we suggest a more formal 30-50-question test. This test can be constructed in the same manner as the Bi-weekly activity with a hardcopy for the student and a CPS teacher-constructed key. The key benefits of spacing, repetition, retrieval and delayed feedback are applicable with this activity. Notice the delayed feedback approach recommended here. As the student undertakes the questions, no feedback is provided other than the fact that CPS has received the student's answer. Since the results are electronically captured there should be no reason why the feedback for the activity cannot be provided within a day or two of the activity.

Many times activities like these require so much teacher work that the results of the activity are not available for several days or perhaps a week. Research shows that delayed feedback beyond a "reasonable" time of a day or so provides no learning benefit." (eInstruction 2004)

Appendix B

Focus Group Questions

Student Focus Group Questions

1. What do you feel were the advantages of CPS?
2. What do you feel were the disadvantages of CPS?
3. How do you feel that using CPS during class affected how you learned the material?
4. What effects, if any, did using CPS have on your participation in class?
5. How would you describe the ease of use of CPS?
6. How would you describe the impacts of using CPS on your overall class experience?

Instructor Focus Questions

1. What do you feel were the advantages of using CPS?
2. What do you feel were the disadvantages of using CPS?
3. To what extent did using CPS affect your level of awareness of student comprehension in the class?
4. Did you change your teaching methods while using CPS and if so, how?
5. How would you describe the ease of use of CPS?
6. How would you describe the impacts of using CPS on your overall class experience?

Appendix C

Instructional Unit Tests

Competency Test for Instructional Unit 1

1. Which state was the first to have a Future Farmers club for boys?
   A. New Jersey.
   B. North Carolina.
   C. Virginia.
   D. California.

2. Which Professional Agricultural Organization is open to any adult who wishes to support agricultural education programs?
   A. Farm Bureau.
   B. FFA Alumni.
   C. Corn Growers Association.
   D. North Carolina Pork Producers Council.

3. The NFA was formed in what year?
   A. 1928.
   B. 1935.
   C. 1965.
   D. 1969.

4. The FFA became established as a national organization in what year?
   A. 1910.
   B. 1917.
   C. 1920.
   D. 1928.

5. FFA was granted a Federal Charter from Congress in what year?
   A. 1928.
   B. 1935.
   C. 1950.
   D. 1969.

6. Professional Agricultural organizations allow members the opportunity to:
   A. Travel, speak, and learn.
   B. Network, learn, and communicate.
   C. Read, talk, and fly.
   D. Write, network, and finance.

7. Trade shows and journals update members on:
   A. New methods, products, and technology.
   B. Old farming techniques.
   C. Jokes, news, and want ads.
   D. Sports, travel, and products.

8. What are used to finance commodity advertisements, trade journals, and educational programs for members of professional agricultural organizations?
   A. Dues.
   B. Taxes.
   C. Donations.
   D. Dividends.

9. Which of the following is an example of a commodity related professional agricultural organization?
   A. Grange.
   B. Farm Bureau.
   C. North Carolina Landscape Association.
   D. FFA Alumni.

10. What is the purpose of the Cooperative Extension Service?
   A. Provide travel advice.
   B. Provide information to those working in agriculture.
   C. Provide funding for agribusinesses.
   D. Provide supplies and services to establish aquaculture systems.

11. What did the letters “NFA” stand for?
   A. New Fighters of America.
   B. Negro Farmers of America.
   C. New Farmers of America.
   D. Future Farmers of America.

12. Females were allowed into the FFA for the first time in what year?
   A. 1928.
   B. 1935.
   C. 1965.
   D. 1969.

13. What Act established funding for vocational agriculture in high schools?
   A. Brown-Wynne.
   B. Jones-Smith.
   C. Hughes-Carter.
   D. Smith-Hughes.

14. What year was a Federal act passed to establish funding for vocational agriculture in high schools?
    A. 1910.
    B. 1917.
    C. 1920.
    D. 1928.

15. FFA and NFA merged in what year?
    A. 1935.
    B. 1950.
    C. 1965.
    D. 1969.

16. The North Carolina Pork Producers Council relates to which commodity?
    A. Corn.
    B. Hogs.
    C. Cows.
    D. Chickens.

17. Mary would join the North Carolina Landscape Contractors Association if her business related to:
    A. Installing electrical system in barns.
    B. Installing irrigation systems in field crops.
    C. Installing ornamental plants.
    D. Installing roofs and walls in barns.

18. The NFA was established for
    A. Students living in town.
    B. African-American boys.
    C. White boys.
    D. Girls.

19. Future Farmers clubs were first established in the:
    A. 1910's.
    B. 1920's.
    C. 1930's.
    D. 1960's.

Competency test for Instructional Unit 2

1. The FFA Creed was adopted in which year?
    a. 1930
    b. 1917
    c. 1928
    d. 1935

2. The FFA Creed has how many paragraphs?
    a. One
    b. Three
    c. Five
    d. Seven

3. Each paragraph of the FFA Creed begins with what words?
    a. I understand"
    b. "I believe in agriculture"
    c. " "We the people"
    d. "I believe"

4. The FFA Creed was written by:
    a. T. S. Elliot
    b. E. M. Tiffany
    c. S. N. Smith
    d. W.R. Hughes

5. The FFA Creed was adopted at which National FFA Convention?
    a. First
    b. Second
    c. Third
    d. Fourth

6. The FFA Creed expresses belief in what?
    a. Work ethic, patriotism, and tradition
    b. School, learning, and agriculture
    c. Farming, Agriscience, and making profits
    d. Farming, animals, and plants

7. The first degree in FFA is:
    a. Greenhand
    b. Chapter
    c. State
    d. American

8. CDE are used to develop:
   a. Winning attitudes
   b. Technical Skills and Leadership
   c. Losing attitudes
   d. Chapter Officers

9. Which of the following CDEs help members conduct better meetings?
   a. Dairy
   b. Creed
   c. Parliamentary Procedure
   d. Floriculture

10. Which of the following is a purpose of the FFA?
   a. Premier Leadership
   b. Computer skills
   c. Working alone
   d. Improve driving abilities

11. Which symbol on the FFA emblem stands for the National scope of the FFA?
   a. Owl
   b. Plow
   c. Rising Sun
   d. Eagle

12. Which symbol on the FFA emblem stands for knowledge and wisdom?
   a. Owl
   b. Corn
   c. Rising Sun
   d. Eagle

13. Which symbol on the FFA emblem stands for the progressive nature of Agriscience and the need for cooperation?
   a. Owl
   b. Corn
   c. Rising Sun
   d. Eagle

14. Which FFA officer is responsible for keeping the public informed about FFA activities?
   a. President
   b. Reporter
   c. Sentinel
   d. Secretary

15. Which FFA officer is responsible for presiding over the meetings?
    a. Secretary
    b. Vice President
    c. President
    d. Treasurer

16. Which CDE requires members to write and present a speech in 30 minutes?
    a. Prepared
    b. Extemporaneous
    c. Parliamentary Procedure
    d. Creed

17. Writing speeches help develop members':
    a. Confidence
    b. Dress
    c. Writing abilities
    d. Grades

18. The FFA Creed was revised in which years?
    a. 1928 and 1930
    b. 1950 and 1990
    c. 1930 and 1990
    d. 1950 and 1965

19. Which FFA officer is responsible for maintaining financial records for the group?
    a. President
    b. Advisor
    c. Secretary
    d. Treasurer

20. Which of the following are the National FFA Colors?
    a. Blue and yellow
    b. Corn gold and National Blue
    c. Indigo and red
    d. Corn yellow and American Blue

21. Which symbol on the FFA emblem stands for labor and tillage of the soil?
    a. Eagle
    b. Owl
    c. Corn
    d. Plow

22. “CDE” stands for:
    a. Careers, Division, Exports
    b. Compare, Deer, Elk
    c. Career, Development, Events
    d. Competition, Division, Entertainment

23. What is the fist line of the FFA motto?
    a. Living to Serve
    b. Learning to Do
    c. Earning to Live
    d. Doing to Learn

24. Which CDE grades and evaluated cattle?
    a. Floriculture
    b. Creed
    c. Forestry
    d. Dairy

25. Which CDE grades and evaluates chickens and chicken products?
    a. Poultry
    b. Livestock
    c. Extemporaneous Speaking
    d. Parliamentary Procedure

Appendix D

Focus Group Data

Below are the word frequency tables for the Class 1 – Daniele focus group.

This table contains the relevant utterance words or strings in a 40 character left and 40 character right context of the focus group transcripts. The five most frequently uttered relevant words or strings were Helps/Helped with 21 utterances, Easy/Easier with 21 utterances, Fun with 14 utterances, Learn/Learned/Learning with 12 utterances, and Pay/Paid/Paying Attention with 10 utterances. The table places each utterance into context for validation that the utterance was relevant.

Class 1 - Word Frequencies in Context

Helps/Helped – 21 Instances
way to study for tests and stuff. It HELPS with like seeing the percentages and st
a class discussion and like I say it HELPS by giving you the percentages and stuff
the questions using the clickers. It HELPS me on the test because I remember what
we did with the system. Daniel: It HELPS me like learn new information because i
you the percentages and stuff and it HELPS it stick in your brain. Brooke: Yeah, i
like how it works, I like how it is. It HELPS with learning and makes it easier in cl
have us take notes and stuff but this HELPS you learn about each topic she is talki

it was a lot easier too. I thought it HELPED me study, too and it made the class mor
the class more interesting. Daniel: It HELPED me learn how to like memorize the infor
to like memorize the information and HELPED me learn. It was better than doing stuf
fun. Robert: The little blue things HELPED us to review, you get to play with the
why the other answers weren't right. It HELPED me pay attention cause I was looking at
disadvantages that I could see. Brad: It HELPED me learn the material because it's a cl
stick in your brain. Brooke: Yeah, it HELPED us because it covered a lot of stuff an
because it was more fun. Greyson: It HELPED by being able to read it and understand
for test with it in class. Reker: It HELPED me learn the material, uhmm, like the l
stuff she was talking about. Robert: It HELPED me a little like to pass the test and s
that was going to be on the test. It HELPED me understand the material. Brad: It br
Brad: Well with class participation it HELPED. It made paying attention more easier.
I think everybody enjoyed it and it HELPED everybody learn. We listened more than
to study about, but its easy to use and HELPED me have fun and study a bunch. Reker:
Easy/Easier – 21 Instances
It made Greyson: I liked that it was EASY and it was easier to go by instead of w
like it is on the test, so it makes it EASY to use. Brooke: It was easy to use and

its something to study about, but its EASY to use and helped me have fun and study
I learn more like that. Robert: It was EASY. Plain and simple, point, click and don
point and click. Quinton: I mean it was EASY to use because all you have was A, B, C
all that stuff down. Greyson: It was EASY most definitely. It was easy because al
it saved a lot of time. Daniel: It was EASY to use. You just look at it on the scre
it makes it easy to use. Brooke: It was EASY to use and it saved a lot of time. Dani
It was easy most definitely. It was EASY because all you had to do was read the
less that two seconds. Reker: It was EASY, easier than what we usually do in clas
participated more. I think it was fun and EASY because instead of doing work we could
the questions in class. Brad: It was EASY to use as a study guide because you don
than writing out notes and it was a lot EASIER too. I thought it helped me study, too
I liked that it was easy and it was EASIER to go by instead of writing down notes
or reading out of the book. It was an EASIER way to prepare for the test and it was
It helps with learning and makes it EASIER in class, you know. Reker: It's a bette
and that was real fun. Quinton: It was EASIER to use the clicker because like it show
shouldn't pick the wrong ones. It was EASIER too cause we could study for test with

that two seconds. Reker: It was easy, EASIER than what we usually do in class. We us
helped. It made paying attention more EASIER. Using CPS is easier than doing regular
attention more easier. Using CPS is EASIER than doing regular study guides. Brooke
Fun – 14 Instances
way to prepare for the test and it was FUN. Quinton: Well, it gives you a better c
remote controllers because it was more FUN. Greyson: It helped by being able to re
ink you talk more because you be having FUN with the remote controls. I think you t
t was a different experience and it was FUN. Greyson: I think that was one of the t
ve fun and study a bunch. Reker: We had FUN while we was learning. It was a good ac
. I enjoyed using it. It made the class FUN.
a good activity for us. Robert: It was FUN. I enjoyed using it. It made the class.
but its easy to use and helped me have FUN and study a bunch. Reker: We had fun wh
It made me participate a lot but it was FUN. It was like we were playing a game sho
swering the questions and that was real FUN. Quinton: It was easier to use the click
ge of the question and it's a much more FUN way to study for tests and stuff. It he
ff from the board. It makes things more FUN. Robert: The little blue things helped
n she said that we got to do it. It was FUN. Quinton: I think CPS is nice. Its good

ow. I participated more. I think it was FUN and easy because instead of doing work
Learn/Learned/Learning – 12 Instances
you know. Reker: It's a better way to LEARN. Like, she usually have us take notes a
take notes and stuff but this helps you LEARN about each topic she is talking about i
more interesting. Daniel: It helped me LEARN how to like memorize the information an
with it in class. Reker: It helped me LEARN the material, uhmm, like the little que
body enjoyed it and it helped everybody LEARN. We listened more than usual and we
the system. Daniel: It helps me like LEARN new information because if I look over
that I could see. Brad: It helped me LEARN the material because it's a class discu
out, but that (CPS) is much better. I LEARN more like that. Robert: It was easy. Pl
memorize the information and helped me LEARN. It was better than doing stuff on paper
and some people got the information and LEARNED it. You had to pay attention to what
works, I like how it is. It helps with LEARNING and makes it easier in class, you know.
a bunch. Reker: We had fun while we was LEARNING. It was a good activity for us.
Pay/Paid/Paying Attention – 10 instances
it a lot. Brooke: Some people PAY ATTENTION because the teacher wasn't constantly
class, cause you had to. She makes you PAY ATTENTION. Robert: I don't know. I participated

information and learned it. You had to PAY ATTENTION to what was happening, too. It was a
the other possible answers. It makes you PAY ATTENTION to get the answers quickly,
game show or something. It also made you PAY ATTENTION. Quinton: I think you talk
her answers weren't right. It helped me PAY ATTENTION cause I was looking at the questions
it covered a lot of stuff and everybody PAID ATTENTION more than usual. When you write it down
it increased how much I participated. I PAID ATTENTION more, too. Brooke: I think it had a lot
I was more involved in class and I PAID ATTENTION to what we were doing. Greyson:
class participation it helped. It made PAYING ATTENTION more easier. Using CPS is easier

Below are the word frequency tables for the Class 2 – Joan focus group.

The relevant utterance words or strings in a 40 character left and 40 character right context for the class 2 focus group. The five most frequently uttered relevant words or strings were Helped with 19 utterances, Participate/Participated/Participation with 15 utterances, Easy/Easier with 12, Fun with 10 utterances, and Understand with 6 utterances. The table places each utterance into context for validation that the utterance was relevant.

Class 2 - Word Frequencies in Context

Helped – 19 Instances
tests and everything. Daryl: I think it HELPED improve my overall class experience bec
It made the class more fun. Nickie: It HELPED me with my tests because when we stop
d everyone else participate more and it HELPED everyone who don't do as well to do bet

and participate more. Taylor: To me it HELPED everyone else participate more and it h
my overall class experience because it HELPED my grades go up and it was easy and fun
ss. Brittney: It was easy to use and it HELPED us understand more of the information
tspoken person, so the same. Taylor: It HELPED me participate more in class. Brittney:
d the same as always. Linda: I think it HELPED me participate more in class. Nickie: W
e a lot to participate more. Jordan: It HELPED me participate and others in class who
I participated more in class because it HELPED a whole lot of people and it gave us so
reviews were done in class. Taylor: It HELPED me more because it showed more like pic
helped to review the stuff. Nickie: It HELPED me learn the class material, because to
elped me learn the stuff, in general it HELPED to review the stuff. Nickie: It helped
answer by yourself. Linda: I, umm, it HELPED me learn the stuff, in general it
g fun and new and different. Jordan: It HELPED me learn the class material because
it wrong. That helped a lot. Daryl: It HELPED you learn the material because it was s
got it right and who got it wrong. That HELPED a lot. Daryl: It helped you learn the m
iews let her talk about the answers and HELPED me understand why to chose the correct
I can't think of any disadvantages. It HELPED to use the clickers. Josh: Sometimes th
Participate/Participated/Participation – 15 Instances
who don't normally participate a lot to PARTICIPATE more. Jordan: It helped me
as always. Linda: I think it helped me PARTICIPATE more in class. Nickie: Well, the
Taylor: To me it helped everyone else PARTICIPATE more and it helped everyone who
ther people in class who don't normally PARTICIPATE a lot to participate more. Jordan:
participate more. Jordan: It helped me PARTICIPATE and others in class who aren't
rson, so the same. Taylor: It helped me PARTICIPATE more in class. Brittney: It was

ly speak in class would be involved and PARTICIPATE more. Taylor: To me it helped
but mostly just using it in general. I PARTICIPATED in class more when we used it.
working together on questions. Josh: I PARTICIPATED the same as always. Linda: I thi
grades and on my grades. A lot of people PARTICIPATED more and paid attention more
the answers easily. Brittney: I think I PARTICIPATED more in class because it helped a
you can see if you are right or wrong. I PARTICIPATED more cause it was easier than
about it. Brittney: I think everybody PARTICIPATED more and everybody did better
think it was very good because everybody PARTICIPATED equally. It was fun. Linda: It
to look forward to. Daryl: I think my PARTICIPATION stayed about the same, but it
Easy/Easier – 12 Instances
icipate more in class. Brittney: It was EASY to use and it helped us understand more
easier than just writing. Josh: It was EASY. I'm used to computers and stuff, so I
I thought it was easy. Nickie: It was EASY to use because all you had to do was re
se it helped my grades go up and it was EASY and fun to use in class. Jordan: It, um
was real easy. Linda: I thought it was EASY. Nickie: It was easy to use because all
ers and stuff, so I thought it was real EASY. Linda: I thought it was easy. Nickie:
mash the button. Taylor: It was pretty EASY to me. There was nothing really hard ab
of the information. Daryl: It was very EASY to use because all you had to do was pr
could see your answer. Jordan: It was EASY. You just hit the button of the answer
wrong. I participated more cause it was EASIER than just writing. Josh: It was easy. I
We had fun with it, too. Linda: It was EASIER using the CPS system. It made the class
review over the question and it's a lot EASIER than just doing it on paper. Its sort o

Fun – 10 Instances
you were more in control. It was a more FUN way of reviewing for a test than just u
on and it was to your advantage. We had FUN with it, too. Linda: It was easier usin
han just doing it on paper. Its sort of FUN and it's a break from regular class wor
y. It was fun. Linda: It made the class FUN and we looked forward to it. Nickie: Yo
n class. Jordan: It, um, made something FUN to do, something different than book wo
ecause of the paper reviews were not as FUN. Taylor: Its pretty good. I like it dif
not just taking notes it was something FUN and new and different. Jordan: It helpe
everybody participated equally. It was FUN. Linda: It made the class fun and we lo
ped my grades go up and it was easy and FUN to use in class. Jordan: It, um, made s
the CPS system. It made the class more FUN. Nickie: It helped me with my tests bec
Understand – 6 Instances
yourself. Linda: I, umm, it helped me UNDERSTAND the stuff, in general it helped to
break from regular class work. I could UNDERSTAND things better, too with it. Josh:
ight and who got it wrong. It helped me UNDERSTAND the material. Daryl: It helped
talk about the answers and helped me UNDERSTAND why to chose the correct answer.
've been using it. I think people could UNDERSTAND what she was talking about better
It was easy to use and it helped us UNDERSTAND more of the information. Daryl: It

Below are the word frequencies in context for the Class 3 – Mike focus group. This table contains the relevant utterance words or strings in a 40 character left and 40 character right context of the focus group transcripts. The five most frequently uttered

relevant words or strings were Help/Helps/Helped/Helping with 25 utterances, Easy/Easier with 18 utterances, Participate/Participating/Participated/Participation with 15 utterances, Fun with 14 utterances, and Learn/Learning with 10 utterances. The table places each utterance into context for validation that the utterance was relevant.

Class 3 - Word Frequencies in Context

Help/Helps/Helped/Helpful – 25 Instances
y think of any disadvantages. Aaron: It HELP me better learn the test material. I do
Aaron: CPS HELPS you focus and you've got more opportuni
me is that I do better on tests and it HELPS me remember things more easily. Jake:
sheet of paper. Chase: I mean it really HELPED you study better. Instead of just looki
it. Kristin: I enjoyed using it and it HELPED me a lot. Lauren: Umm, most like slacke
eally got it stuck in my head and so it HELPED me a lot. I mean, I really liked it. Kr
t into the class. Jake: To me it really HELPED me improve my test scores. I mean I'm u
pressing a button. Aaron: Well, uh, it HELPED me concentrate better on test, because
n, I guess, than doing regular work. It HELPED me participate more than usual. Aaron:
y helping each other study. Kristin: It HELPED me participate more because it was inte
o remember it and study by. Christy: It HELPED us participate more, because everybody
s on the TV and easy to read. Aaron: It HELPED me participate more because it was
ing over stuff. Lauren: Umm. I think it HELPED because, uh, you didn't have to worry a
hat the question is saying. Kristin: It HELPED me because it was easier than just goin
easier than doing it on paper. Jake: It HELPED me learn the material because like we d
ivity that we had to do in class, so it HELPED me remember the things we did in class

nology and stuff like that. Christy: It HELPED us learn the material because he would
don’t like to study and the technology HELPED me study better. I really like technolo
it like everybody else does. Chase: It HELPED me learn the material, because I really
fore the test really helped. Carrie: It HELPED because you go over the material and yo
e material a lot before the test really HELPED. Carrie: It helped because you go over
better than doing written work. Bob: It HELPED me learn the material from repetition.
wrong with it at all. I mean it really HELPED me with my test scores because after we
e in class because it made us alert and HELPED us pay attention more in class. Elizabe
multiple choice. To some it was really HELPFUL and to some it wasn’t because you just
Easy/Easier – 18 Instances
written wrong and it was on the TV and EASY to read. Aaron: It helped me participat
better than reading. Bob: It was pretty EASY to use. All you had to do was hit one b
like press the button. Christy: It was EASY to use, once you found out the part, or
ress A, B, C, or D really. Jake: It was EASY to use to me, because all it is, is a b
was press a button. Chase: It was real EASY. The only thing you had to do was like
o do was hit one button. Carrie: It was EASY to use. All you had to do was press a b
to click the answer. Elizabeth: It was EASY because all you had to do was press A,
d change it right away. Kristin: It was EASY and kind of hard. Pressing numbers and
because it was fun to do it and it was EASY. I probably participate more using CPS
e more than usual. Aaron: It was pretty EASY to use if it got better reception somet
time runs out. Kristin: I feel like its EASIER than going over just regular questions.
the answer and question before, it was EASIER to get it right on test because I just
ust regular questions. It’s a whole lot EASIER because you have to remember stuff and

m. It was a lot faster and it was a lot EASIER to understand it. The fact that it was
ngs we did in class more better. Is was EASIER than doing it on paper. Jake: It helped
g. Kristin: It helped me because it was EASIER than just going over stuff. Lauren: Umm
the answers and it made it a whole lot EASIER to remember it and study by. Christy: I
nd of aggravating. Lauren: It was a lot EASIER because you could answer the questions
Participate/Participated/Participation/Participating – 15 Instances
it and study by. Christy: It helped us PARTICIPATE more, because everybody use them
and easy to read. Aaron: It helped me PARTICIPATE more because it was something
seen. He would call you out and make you PARTICIPATE and when you're doing it on
each other study. Kristin: It helped me PARTICIPATE more because it was interesting.
than doing regular work. It helped me PARTICIPATE more than usual. Aaron: It was
paper. It made a lot of more people PARTICIPATE and the overall class grades were
to do it and it was easy. I probably PARTICIPATE more using CPS because of the fun
Bob: It kept me awake in class. I PARTICIPATED more in class and looked forwad
press the buttons and stuff. Chase: I PARTICIPATED better because I really didn't like
Carrie: Uhm. I don't know. I think I PARTICIPATED more than normal because you had
grade because I probably wouldn't have PARTICIPATED if it hadn't, umm, had the
Elizabeth: Every time we used it, I PARTICIPATED every single time because it was fun
participated if it hadn't, umm, had the PARTICIPATION, I mean not participation, but
ted more in class and looked forward to PARTICIPATING in class. Carrie: Uhm. I don't
really tell whether or not everybody is PARTICIPATING. Elizabeth: Every time we used
Fun – 14 Instances
using CPS. It also made the class more FUN. Carrie: Uhm. You got to go over the ma

en we get to do something like that its FUN, it's a whole lot better. I like it bet
rticipate more using CPS because of the FUN activity involved in it. Jake: It really
every single time because it was FUN to do it and it was easy. I probably pa
because everyone had to do it. It was FUN but it made everyone pay attention, too.
helped me a lot. I mean, I really had FUN using it. Kristin: I enjoyed using it a
in there is boring and that was the only FUN thing we had to do. Christy: I got bett
to write it down and I thought it was a FUN way to do classwork. Chase: It made cla
to the materials. Bob: It was more FUN, this class is already my favorite, but
B, C, or D really. Jake: It was easy and FUN to use to me, because all it is, is a b
Hit one button. Carrie: It was easy and FUN to use. All you had to do was press a b
interesting and fun. Lauren: It was more FUN to get involved in, I guess, than doing
more because it was interesting and FUN. Lauren: It was more fun to get involve
body helping each other study and we had FUN learning stuff. Kristin: It helped me p
Learn/Learning – 10 Instances
disadvantages. Aaron: It help me better LEARN the test material. I don't like work, s
stuff like that. Christy: It helped us LEARN the material because he would do it ove
paper. I think it helped me study and LEARN the material better. It made a lot of m
wasn't generic and they really helped me LEARN all of the stuff we talked about. Carri
doing it on paper. Jake: It helped me LEARN the material because like we did it eve
doing written work. Bob: It helped me LEARN the material from repetition. Doing it
everybody else does. Chase: It helped me LEARN the material, because I really don't li
we got to use different experiences on LEARNING how to do things. Elizabeth: I like it
something your used to doing so you're LEARNING what the question is saying.

helping each other study and we had fun LEARNING stuff. Kristin: It helped me parti

Below is the Instructor Focus Group Utterances in Context.

Instructor Focus Group Utterances in Context

Help/Helped/Helps/Helpful – 19 Instances
and paid attention. I think this method HELPS students focus and have fun learning.
f my students. Having the feedback grid HELPED me to separate responses into an easy
ta that is collected. This data is very HELPFUL but it tends to be more time consume
e student needs and the techniques that HELP them learn the best instead of just bla
mally would do in class so I think that HELPED them comprehend better because they w
ach class was over. I found this really HELPFUL. Also the customizable review sheets
be able to print out and definitely HELPED them study for the test. CPS helped m
d be it. The process of integrating CPS HELPED to better structure my lesson. When u
or the next class. This system was very HELPFUL and without the technology I don't
as easy to pickup and use and it really HELPED structure my class. It made class (re
ook forward to when coming to class and HELPED them to drastically increase their pa
clickers. They really enjoyed it and it HELPED me too because it added a dimension t
ons together and gave us a great way to HELP the students study effectively for the
heir participation. I thought it really HELPED the overall mood of the class. Studen
he class that I had not used before. It HELPED me to have a process to follow that c
ion quiz of the new material that would HELP me create a review for the next class.
that the students missed before really HELPED them learn the objectives they were w
ely helped them study for the test. CPS HELPED me gauge what was happening in each

iencies. The feedback from the students HELPED me to analyze my presentation of the
Review/Reviews/Reviewing – 12 Instances
a fun, interactive way for students to REVIEW. It has a lot of advantages including t
time consuming if using this method of REVIEW. It takes more prepare lessons when inc
s really helpful. Also the customizable REVIEW sheets for each student were great to b
o use the study guides and have all the REVIEW questions already prepared and tailored
we did change how we conducted our test REVIEWS Some units, instead of making a
s Some units, instead of making a paper REVIEW for a test, we used CPS instead. It was
y prepared and I think having a focused REVIEW with the questions highlighted that the
d. Now with the feedback from CPS I can REVIEW during the next class period specific
n using the technology I started with a REVIEW from the last class, then presented the
ew material that would help me create a REVIEW for the next class. This system was ver
lped structure my class. It made class (REVIEWing) less boring and more exciting for
ecause they were looking forward to the REVIEW at the end of class and were trying to
Learn/Learned/Learning – 12 Instances
e. The students seemed to be engaged in LEARNING. The students really seemed to
fun learning. It also changes how they LEARN in class and it changes the way that we
udents missed before really helped them LEARN the objectives they were weakest in bef
needs and the techniques that help them LEARN the best instead of just blanketing the
tudents seemed to be more interested in LEARNING and participated throughout the clas
glad too because it takes me forever to LEARN to use new software but this was easy t
ppening in each class. I could tell who LEARNED each objective and who needed more
y user friendly and it was real easy to LEARN. The best thing about it was the easy t

allowed me to look at how the students LEARNED the material after each class was ove
ngs that the class had the most trouble LEARNING. I really think this technology chan
learning. The students really seemed to LEARN a lot with this method. One of the bigg
ethod helps students focus and have fun LEARNING. It also changes how they learn in c
Change/Changed – 10 Instances
ts focus and have fun learning. It also CHANGES how they learn in class and it changes
changes how they learn in class and it CHANGES the way that we teach them. Typing in
easy to read document and allowed me to CHANGE and adapt the lesson based on stude
tailored to each student. It was also a CHANGE from what they normally would do in cla
they were more focused. I'm not sure I CHANGED methods but we did change how we
m not sure I changed methods but we did CHANGE how we conducted our test reviews
y saw it again on the test. The biggest CHANGE that CPS forced me to make in my teach
earning. I really think this technology CHANGED how I approach presentation of my
hem with content. My methods definitely CHANGED when I used CPS. I normally woul
e technology I don't think I would have CHANGED anything with my teaching methods.
Focus/Focused – 6 Instances
n increased dramatically. Students were FOCUSED on answering the questions posed in
comprehend better because they were more FOCUSED. I'm not sure I changed methods
presentation of my material, as well. I FOCUS more on the student needs and the techn
s already prepared and I think having a FOCUSED review with the questions highlighted
ion. I think this method helps students FOCUS and have fun learning. It also changes
own after the questions and get them to FOCUS on the lesson. The only disadvantage w