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USING ELECTRONIC AUDIENCE RESPONSE SYSTEMS IN HIGH SCHOOL AGRISCIENCE COURSES

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Abstract

The purpose of this research was to determine whether using an audience response system improves student achievement. Audience response systems are computer-based tools for use in classrooms for the purpose of providing feedback to students on questions asked during instruction. This study used a quasi-experimental design to determine if students receiving feedback through an audience response system had higher achievement scores than those who receive feedback through non-technology based methods. The experiment included students from three high school agriscience classes. 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. The results of the study showed a significant increase in student achievement when integrating an audience response system. The study concludes that audience response systems are a promising, developing technology for improving student achievement and positively impacting the classroom environment.

Introduction

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. Feedback is an important part of the assessment phase because it provides students with information on their performance and suggestions for improvement. Feedback significantly improves student learning and provides a useful connection between the teacher and the learner (Bruning, Schraw, & Ronning, 1999; Cohen, 1985; King & Young, 2002).

Effective feedback provides learners with two types of information: verification and elaboration. Verification tells the learner if their answer to a question or problem was correct. Elaboration explains to the learner why their answer is correct or incorrect (Kulhavy & Stock, 1989). There are several methods to provide both verification and elaboration resulting in effective feedback in the classroom, including written feedback, verbal feedback, and peer-group discussion feedback (Merrill, 1987). The development of technology and computer-based methods has changed the capabilities of instructional feedback. 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 learning outcomes (Chiu & Woods, 2002).

Audience response systems are a group of emerging technologies that are being incorporated into classrooms and other training venues. Audience response systems typically include a wireless, infrared transmitter, a receiver connected to a laptop computer loaded with a software package specifically designed for use with the receiver. The teacher projects 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 answers 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.

This study focused on a primary need of determining the impacts of an audience response system on student achievement and the classroom environment, and the need to test audience response systems prior to implementation in agriscience courses. This research project 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.

Purpose

The purpose of this research was to determine whether using an audience response system improves student achievement. Specifically, the research question was: 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 was:

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.

Review of Literature

Duncan and Biddle (1974) suggested that the study of classroom teaching and learning involves four categories of variables: presage, context, process and product. Presage variables are those variables associated with the teacher, and are typically identified as personality traits, teaching skills, and teaching styles (Duncan & Biddle). 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. Process variables refer to the teaching and learning processes occurring in the classroom. The fourth category, product variables, describe the outcomes of the learning process such as achievement and degree completion (Duncan & Biddle).

Duncan and Biddle's (1974) model also established a consistent framework for all of the agriscience applications classes. 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. Standardization of a classroom environment allows for a more accurate comparison of traditional feedback methods and technology-based feedback methods. Two research studies that examined the interaction of variables in a classroom environment incorporated Duncan and Biddle's theories were Ball, Dyer, and Garton (2001) and Cruikshank (1990). In these studies the classroom model is used as a framework to standardize the classroom environment.

Madeline Hunter classified instructional feedback as simply checking for understanding (Hunter, 1982). Hunter described the process as determination of whether students understand the material before proceeding. Hunter also noted 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 begins 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. The

teacher's ability to remember and make sense of the data being received through interaction with students can be explained by Miller's information processing theory. Miller (1956) theorized that short-term memory could only hold five to nine 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 123-456-7890. The concept of chunking became a basic element of information processing theory. Miller also found that processing new information involved gathering, storing and representing information. Miller categorizes these elements 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; King & Young, 2002). Unless instructors can adequately and effectively encode, retain, and retrieve feedback information, they cannot significantly influence the learning process (Chandler & Sweller, 1996; Miller).

Eight commonly used levels of feedback have emerged as a standard for non-technology based feedback interventions: no-feedback, knowledge-of-response, answer-until-correct, knowledge-of-correct-response, topic-contingent, response-contingent, bug-related, and attribute-isolation (Kulhavy & Stock, 1989; Merrill, 1987). An aggregate score based on the number of correct answers with no reference to individual questions is the no-feedback intervention. Knowledge-of-response feedback indicates whether individual answers are correct or incorrect. Answer-until-correct feedback requires the learner to continue to answer until the correct answer is selected. Knowledge-of-correct-response feedback provides item verification and identifies the correct response to each item (Kulhavy & Stock). Topic-contingent feedback verifies correctness of response or provides additional information that will assists students in finding the correct answer if the student response is incorrect. 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). 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. 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).

Written and verbal or audio feedback delivery methods are perhaps the most commonly used varieties of feedback delivery (Cohen, 1985; Kluger & DeNisi, 1996; Merrill, 1987). Wunsch (1982) found no differences between written and verbal feedback delivery methods. Wunsch tested for differences by providing both written and group oral feedback with students developing business letter writing aptitude and found both to be effective. Moore (1977) found no differences in achievement, but did find that audio feedback had positive effects on the classroom environment. Moore 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 slightly less time was required to provide audio feedback than written feedback. DaRosa, Mazur, and Markus (1982) found that written feedback was more effective than verbal feedback delivery, and 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.

Another aspect of 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 to test 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. Smith & Wight (1988) found that students favored immediate feedback delivery methods, and were more enthusiastic in their assessment of the technique and believed that it helped

facilitate learning. DiBattista, Mitterer, & Gosse (2004) also found that students 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 et al. concluded that the immediate feedback delivery process had a broad appeal to a variety of students. King, Young, and Behnke (2000) found that the use of a combination of both immediate and delayed feedback was the most effective approach to learning. 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 et al.). Clariana (1992) 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.

During the past few decades, technology has increasingly been used to implement feedback systems (Kulik & Kulik, 1988; Mory, 1994; Sturges, 1978; 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 hand-held wireless feedback systems. All of these feedback systems can be used in a variety of settings, but according to other feedback research, each of these systems will work best for particular educational settings (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 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 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. Audience response systems 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). A disadvantage of a technology-based feedback system is that the use of these systems has been mainly focused on feedback for discrete responses.

Several studies have determined that technology based feedback did not influence students' achievement (Merrill, 1987; Mory, 1994). More research describes technology-based feedback as tools that enhance learning and positively affect student achievement (Clariana, 1992; Clariana & Lee, 2001; Clariana, Wagner, & Rohrer-Murphy, 2000; Morrison, Ross, Gopalakrishnan, & Casey, 1995; Pridemore & Klein, 1991; 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.

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. Feedback can be effective in one scenario and not effective in another (Cameron &

Cotrell, 1970; Quigley & Nyquist, 1992). Kluger and DeNisi proposed that feedback interventions related to meta-task processes or those such as treats or praise actually inhibit performance; while feedback is centered on task motivation or the process of learning enhance student achievement.

Methodology

This study used a post-test only, quasi-experimental design. This design 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. This 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 intended to be implemented, requiring four intact groups. However, two class sections were combined, creating only three intact groups.

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.

As each instructional unit was completed, 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 that was implemented. After the second instructional unit test, the data collected were standardized on the same scale before analysis. The two tests had a different number of total questions, so the students' scores on each of the unit tests were standardized based on a one hundred-point scale. Table 1 represents the experiment design of this study.

Table 1
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

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 purposely 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 in each section. Enrollment for classes 1, 2 and 3 were 23, 20 and 18 respectively. The total sample size was 61 students. Each of the students experienced a lesson with both the audience response system feedback and the non-technology based feedback. 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, Data Collection and Analysis

The instruments in the quantitative phase of the study were instructional unit tests for each of the two instructional units that were created by a collaborative effort of the three instructors. The test items were drawn from a statewide test bank maintained by the department of public instruction. The tests were examined for both validity and reliability. A panel of experts verified content validity. To assess reliability, the Kuder-Richardson coefficient was used to determine coefficients of 0.79 for test one and 0.76 for test two.

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. 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, 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.

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* was used to analyze any differences present between the two groups. Every student participated in either the treatment group for instructional unit one or instructional unit two.

Findings

Table 2 represents the descriptive data collected from combining achievement scores calculated on a 100-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 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 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 2
Achievement Scores by Group

Group		*N*	*M*	SD	SE
Treatment	1	61	89.98	8.71	1.11
Comparison	2	61	84.41	12.61	1.61

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 examine any differences 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 3 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, demonstrating 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 3
Test of Homogeneity for the Variable of Achievement

Levene Statistic	df1	df2	*p*
7.335	1	120	.008

Table 4 represents the results of the independent samples t-test calculations, that compared 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 independent samples t-test revealed 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 5.567 with a standard error of proportion of 1.964, and a 95% Confidence Interval of the difference of 1.674.

Table 4
Comparison of Achievement Mean Scores

Achievement	*t*	df	*p*	Mean Difference	Std. Error Difference	95% Confidence Interval	
						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

Conclusion and Recommendations

This study sought to determine if differences in student achievement existed between groups of agriscience applications students who used an audience response system and those who used more traditional written and verbal response-contingent feedback methods. It is concluded that students receiving feedback through an audience response system have higher achievement scores than those who received feedback through non-technology based methods. Based upon the findings of this research the null hypothesis was rejected.

The implementation of an audience response system in the agriscience classroom environment resulted in a statistically significant difference in student achievement, when compared to students receiving the more traditional written and verbal response contingent feedback methods. Student achievement improved when using an audience response system as a primary feedback method. The conclusion of this study also reflected in earlier studies conducted by Abrahamson (1998) and Everett and 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 and Ranker including the perception that using an audience response system was more time consuming than providing written and verbal feedback.

Recommendations

This research recommends that the audience response system could be integrated into agriscience applications classrooms with some degree of confidence of success. The availability of funding, training time, preparation time, and implementation time should be considered when implementing the audience response system. Furthermore, this study was conducted with a relatively small sample and under a particular set of circumstances. 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. Finally, testing and additional research should be done with new technologies as they emerge.

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