Journal of the Scholarship of Teaching and Learning, Vol. 11, No. 4, December 2011, pp. 1 – 11.

Using clickers in large college psychology classes: Academic achievement and perceptions

Selma Powell[1], Carrie Straub, Jacqueline Rodriguez, and Barbara VanHorn[2]

Abstract: This research study explored the effects of the use of clicker technology as a means of formative assessment in large, college introductory psychology courses. Academic achievement, as measured by performance on tests of knowledge, was compared between students who used clickers and students that did not use clickers. There was a significant difference between the two groups, although a small effect was noted. Students using the clickers responded to survey items created to solicit information regarding student perceptions of increased understanding, ability to self-identify content deficits, fun, and financial value of clickers. Data from the survey indicated that the majority of students perceived the usage of clickers increased their understanding of and ability to self-identify concept areas. All of the students reported that using clickers was fun, although approximately only one third of those same students reported that purchasing a clicker was worthwhile. Implications for administrators are discussed and alternative technologies are explored.

Keywords: clickers, psychology, formative assessment, education technology

It is not uncommon for undergraduates in public colleges and universities to find themselves faced with their first college lecture in an auditorium-style classroom (Kenwright, 2009; Mayer et al., 2009). Lecture-hall classrooms accommodate large numbers of learners, and lessons are delivered using a teacher-centered lecture format. Within this context, researchers and faculty from a small public college in the southeast United States located in a diverse urban community sought to establish effective instructional supports for large, lecture-style classes, specifically through the use of class wide electronic response systems. The purpose of this research is to examine the use of clicker technology on student achievement and perception. In the spirit of Boyer's (1990) call to action, the research team examined classroom teaching practice as a means of "transforming and extending" the knowledge base for instructors with large class enrollments (p.24).

I. Background.

Instructors of mass classes rely on traditional, lecture-style lessons to deliver information to large numbers of students; however this lesson format provides little or no interaction or discussion (Geske, 1992; Gleason, 1986). Although large lecture halls may accommodate more students by making efficient use of faculty and facility resources, student understanding of content can be compromised. This learning environment may seem passive and impersonal for undergraduates (Hoekstra, 2008). Hall, Collier, Thomas, and Hilgers (2005) identified two problems that

[1] Department of Child, Family and Community Sciences, University of Central Florida, 4000 Central Florida Blvd., Orlando, FL 32816-1250, selmapowell@knights.ucf.edu

[2] Department of Social Sciences, Indian River State College, 3209 Virginia Avenue, Fort Pierce, FL 34981, bvanhorn@irsc.edu

students in mass class settings face: (1) lack of engagement in the lesson and (2) lack of meta-cognitive awareness or ability to self-identify deficits in subject area awareness. The lack of engagement coupled with the students' inability to self-identify deficits in subject area knowledge may result in an inability to master course content. Furthermore, Edmonds and Edmonds (2008) stated that mass class learning environments do not provide opportunity for instructors to gauge students' understanding of subject areas until the exam results are presented, a scenario leaving instructors and students in the dark regarding subject area understanding until it is too late to remediate misconceptions.

According to generative theory of learning, learners actively engage in cognitive processing during learning by attending to relevant material, mentally organizing the selected material, and integrating the organized material with prior knowledge (Mayer, 2001; Mayer et al., 2009; Wittrock, 1974). Therefore, instructors optimize learning by engaging in instructional activities which "prime active cognitive processing in learners" (Mayer et al., 2009, p.53). The research on generative learning theory indicates that the outcome of active cognitive processing is a meaningful learning outcome (Mayer et al., 2009). Anderson et al. (2001) theorize that learning outcomes, including the knowledge and skills learned in class, can be evaluated using a variety of measures, including academic test items of class content.

To foster the generative learning process, instructors may use questioning methods (King, 1992; Rosenshine, Meister, & Chapman, 1996). Yet, faced with the challenge of assessing student knowledge and increasing engagement in mass classrooms, how do instructors gain knowledge about student understanding to provide responsive instruction? In classes with smaller groups of students, instructors may use questioning methods to assess student understanding, as incorrect student responses provide opportunity for instructors to provide corrective feedback to change student misconceptions (Kenwright, 2009; Mayer et al., 2009). However, in large, lecture-style class's students may be intimidated by asking or responding to questions (Poirier & Feldman, 2007). One method for increasing student understanding and engagement is through the use of electronic clickers, a tool for generative learning.

Clickers, also referred to as electronic response systems, personal response systems, audience response systems, classroom communication systems, or student response systems, allow students to individually respond to closed-ended questions posed by the instructor. Anonymous student responses are gathered via a remote handheld device, commonly referred to as a "clicker", and responses are immediately provided to the instructor. The instructor may then broadcast the results to the class using a multi-media projection device. Publicly examining student responses achieves a variety of objectives, which include but are not limited to, assessment of student understanding, increasing student engagement in the lesson, and providing students with a venue for objectively self-assessing their knowledge of the subject area (Mayer et al., 2009). The clicker system is comprised of two parts: a classroom-wide response system and a set of individual, handheld, remote clicker devices. Colleges generally incur several thousand dollars in initial cost to install the classroom-wide response system, passing along the cost of the reusable handheld clicker device (between $10 and $40) to students. Periodic maintenance as well as technical support costs are incurred by the college over time.

Clicker-based pedagogy has the potential to counteract the passive, teacher-centered instruction often encountered in mass classes of today's colleges and universities. Teachers and students may benefit from the real-time assessment of subject area knowledge. Additionally, increased student engagement in class may result in increased perceptions of fun, providing motivation to return to class. Although there is evidence to suggest that clickers increase

academic achievement, as measured by performance on tests of knowledge, as well as provide ability to assess student knowledge, and increase student perceptions of fun, it is also critical to understand student perceptions of the value of clickers as a learning tool.

A. Utilization Of Clicker-Based Pedagogy Increases Academic Achievement.

A growing body of research has been used to provide evidence for increased academic achievement, as measured by performance on tests of knowledge, using clickers. Active learning has been linked to increased student achievement, which can be measured by final grades (United States Department of Education, 1996). A study of 11 parallel courses taught at the University of Wisconsin over two years showed a statistically significant impact of clicker use on student academic achievement (Kaleta & Joosten, 2007). Similarly, Salmonson, Andrew, and Everett (2009) reported that increasing the engagement of non-participatory students through the use of clickers resulted in an increase in grades. El-Rady (2006) found statistically significant differences in exam scores between classes compared in two consecutive semesters and furthermore found evidence to suggest that clickers improved student retention. In a comparison of clicker technology versus paper pencil technology, Mayer et al. (2009) found that students who experienced in-class questioning and responded with paper and pencil scored significantly lower on class exams than those who responded using clickers. Therefore, the research team hypothesized that the use of clickers would increase students' performance. Thus, the first research question is:

RQ_1: To what extent does the use of clickers increase student academic achievement in a large, college-level introductory psychology class as measured by final grade percentage score?

B. Increased Understanding Of Content Through Formative Assessment.

Clickers ostensibly serve as vehicles to increase student understanding of content by providing instructors with the opportunity to take on the role of agile teachers who can quickly assess student comprehension and modify instruction to student needs (Beatty, Garace, Leonard & Dufrense, 2006; Mayer et al, 2009; Mula & Kavanaugh, 2009). Researchers distinguish between pedagogy and technology, highlighting the clicker's role as a piece of formative assessment technology (Beatty et al., 2006), which provides "college instructors with a non-intrusive, effective pedagogy and students with a more engaging learning format" (Mula & Kavanagh, 2009, p. 2). Researchers suggest that clickers alone do not increase academic achievement, but rather the utilization of clickers increases opportunities for instructors to engage students by using interactive questioning methods which, in turn, are related to increased academic achievement (Mayer et al., 2009). Kaleta and Joosten (2007) reported survey results yielding that 100% of instructors appreciated the ability to assess student knowledge and understanding, while 74% agreed or strongly agreed that clickers improved student learning. The research team hypothesized that students using clicker technology would perceive an increase in understanding of the topic based on the use of clickers. Thus, the second research question is:

RQ_2: Did students using clicker technology in a large, college-level introductory psychology class perceive that clickers increased "understanding of the topic"?

C. Using Clickers To Self-Identify Content Knowledge Deficits.

While instructors report value in assessing understanding of content, clicker responses also provide valuable information for students to identify personal deficits in understanding. In an examination of meta-cognition skills of individuals, Flavell (1979) identified limitations in the ability to self-monitor comprehension, reporting that individuals were often unable to identify holes in understanding. The use of clickers may reveal misconceptions to students; when instructors broadcast anonymous responses to questions using clickers, students are able to compare individual responses to the correct answers in an unobtrusive setting. In this way, each student has the opportunity to practice formative assessment at the individual level (Beatty et al., 2006). Student-identified deficits in content knowledge have the potential to allow students to create a customized, focused plan of study. Clickers may provide one method for students to gather objective information about their learning. The research team hypothesized that students using clicker technology would perceive an increase in their ability to identify areas of deficit in their subject matter knowledge. Thus, the third research question is:

RQ_3: Did students using clicker technology in a large, college-level introductory psychology class perceive that the use of clickers helped them find out what they "still needed to study"?

D. Using Clickers to Increase Student Perception of Fun.

Although there is minimal research related to student perception of fun in a clicker-based classroom (Fies & Marshall, 2006), investigating student perceptions of clicker use is worthwhile to establish social validity of the utilization of clickers (Wolf, 1978). Beatty et al. (2006) writes, "By fostering an active, interactive classroom environment, classroom communication system-based pedagogy helps keeps students interested and attentive" (p. 6). In a large introductory psychology class, Poirier and Feldman (2007) found that students using clickers earned higher final exam scores and reported positive attitudes toward utilizing clickers in class. Researchers report that students find clicker-based classes to be more fun than non-clicker based classes (Burnstein & Lederman, 2001; Dufresne, Gerace, Leonard, Mestre, & Wenk, 1996; Fies, 2005). Based on these results, the research team hypothesized that students using clicker technology would perceive using clickers as fun. Thus, the fourth research question is:

RQ_4: Did students using clicker technology in a large, college-level introductory psychology class perceive that the use of clickers to respond to questions was "fun"?

E. Financial Value of Clickers.

A primary concern of colleges and universities using the clickers is the issue of cost. Students enrolled in classes using clicker-based pedagogy are required to purchase the handheld clicker device that may cost between $10 and $40. Students may re-use the device each semester, but if lost, students must purchase and register another. Although some researchers report that students "appreciate the system's value" (Beatty, 2004, p.6), researchers of two recent literature reviews of clicker technology did not discuss whether or not students perceived the clicker was worth purchasing (Fies & Marshall, 2006; Roschelle, Abrahamson, & Penuel, 2004). Because students must incur the cost of utilizing clickers after the decision to invest in the system has already been

made by administrators, it is important to investigate whether or not students perceive the clicker is worth purchasing to establish social validity of the utilization of clickers (Wolf, 1978). The research team hypothesized that students using clicker technology would indicate that they would be willing to purchase a clicker for a class to help them learn. Thus, the fifth research question is:

RQ_5: Did students using clicker technology indicate that they would be "willing to purchase a clicker that cost $30 - $40" to help them learn?

II. Methodology.

A. Participants.

Participants in this study were enrolled in an urban public college located in the southeast United States in introductory psychology classes and were grouped according the section of the course in which they were enrolled. The same instructor taught both of the sections sampled for this study. The sample (N = 145) was established when students met the criteria of enrollment in the introductory course in psychology and completion of the final exam. Students self-selected their participation in the study and were not provided monetary compensation, nor were they promised any benefits not normally associated with using a learning tool. Participant information was numerically coded to maintain anonymity and all identifiable information was maintained in a secure location by the principal investigator. Participation for this study totaled 183 students across two separate introductory psychology classes and students were assigned into control and treatment groups. Of the 183 participating students, 145 students received a final grade in the course and were subsequently involved in the analysis. The control group did not receive clickers and consisted of 78 students from one class. The treatment group received clickers at varied intervals and consisted of 67 participants from two other classes. Participants responded to a demographic questionnaire, information on gender was broken down as follows: 56 of the participants were male while 127 of the participants were female, while responses to questions about ethnicity were as follows: Caucasian, 91; African–American, 52; Hispanic, 24; Asian, 2; Other, 14. Only 7 of the participants were under the age of 18, while the preponderance of the participants were between the ages of 18-24 (152), and 24 students were over 25 years old.

B. Instruments.

Primary outcomes were academic and measured by final class grades. For the purposes of this study, a common grading rubric was used for both of the introductory classes as defined in PASW as: A = 100-90%, B = 89-80%, C = 79-70%, D = 69-60%, and F = 59% or less.

Data on student perception was collected using a researcher-created questionnaire comprised of 11 items with responses on a 5-point *Likert* scale. Questions selected for use in this research study were as follows: a) Using a clicker increased my understanding of the topic, b) Using a clicker helped me find out what I still needed to study, c) Using a clicker to respond to questions was fun, and d) I would be willing to purchase a clicker that cost $30-$40 to help me learn. *Likert* responses were as follows: 1) I strongly disagree, 2) I somewhat disagree, 3) Neutral, 4) I somewhat agree, and 5) I strongly agree. Demographic information for all participants was collected using a 21-question survey at the beginning of the course. At the

completion of the course, the group who used the clicker technology completed a questionnaire that consisted of 10 items related to attitude toward using the clickers.

C. Data Collection and Analysis Procedures.

In this quasi-experimental study, measures of academic performance were compared across two groups of students: one class utilizing clickers (consisting of embedded questions and procedures for responding using clickers) and one class that did not utilize clickers. The same doctoral level professor with 10 years of experience taught each class, and each of the classes participating in this study met over the course of a semester. In all the courses, content was delivered via PowerPoint and lecture in a face-to-face setting. For the course with embedded questions, the average percentage of question to content slides was 21%, and the professor utilized clickers throughout the delivery of the lecture. Upon response to question, results were immediately displayed on a bar graph. If the distribution showed 10% or more of incorrect student responses, the feedback would be used to re-teach the topic by providing additional explanations or responding to questions. If more than 90% of students chose the correct response, the instructor would confirm the correct response, giving a brief explanation and then moving on. In both courses, online review quizzes allowed students to review content prior to administering class exams. The clickers system employed for the study was the iClicker manufactured in partnership with the Worth-Freeman Publishing Company.

III. Findings.

Participants in all the psychology classes totaled 183 students. Of the total student participation, 145 received a final grade for the course, 78 of the participants were in the control group and 67 participants were in the experimental group. Due to missing data, 38 cases were not included in the analysis. Thus, data was analyzed using 78.2% of the 183 total students (N=145). Using Predictive Analytics Software (PASW), the researchers compared the 38 missing cases to determine if the ratios of missing data were similar between groups. Results yielded similar rates of missing data when compared across groups. Of the 38 cases, 20 cases of missing data occurred in the control group (accounting for 20.5% of the total control group), while 18 cases of missing data occurred in the experimental group (accounting for a loss of 21.2% of the experimental group). Inferential statistical analysis was performed for the first research question comparing experimental and control groups. Descriptive statistics on the perception of clicker technology usage were collected on the experimental group only for research questions two through five.

RQ_1: To what extent does the use of clickers increase student performance in a large, college-level introductory psychology class as measured by final grade percentage score?

Student performance was measured by final grades, defined by a percentage score of cumulative total points earned divided by cumulative total points possible. An independent *t* test was conducted to determine if there was a significant difference ($p < 0.05$) in mean score of final percentage course grades of students in a college-level introductory psychology class using a clicker system versus students who did not using a clicker system. The test was conducted using an alpha of 0.05. Levene's test indicated that the assumption of homogeneity of variances was met ($F = 2.029$, $p = 0.157$). The test was statistically significant, $t(143) = 8.367$, $p < 0.05$. Students using the clicker system scored higher on average ($M = 83.43$, $SD = 11.88$) than

students not using the clicker system (M = 76.82, SD = 15.13). The 95% confidence interval for the difference between means was -11.13 to -2.09. The effect size was calculated by eta squared and found to be 0.055 indicating that approximately 6% of the variance in scores was accounted for by whether or not the student used clickers. Approximately 81.27% of the treatment group (n = 67) received a grade of C or better compared to 76.92% of the non-treatment group (n = 78). The results provide evidence to support the hypothesis that students using clickers score higher in measures of academic performance.

RQ_2: Did students using clicker technology in a large, college-level introductory psychology class perceive that clickers increased "understanding of the topic"?

In order to address the second research question, the questionnaire results (n = 67) from the treatment group were dichotomized based on responses. The responses of 1 or 2 were classified as "disagree" and the responses of 4 or 5 were classified as "agree," and the response of 3 was neutral and not included in this comparison. Based on analysis, approximately 91% of students perceive that clickers increased their understanding of a topic, leaving only 9% of students in disagreement with the statement that using clickers increased their understanding. The survey results provide evidence to support the hypothesis that the majority of students perceive that using clickers increase their understanding of the topic.

RQ_3: Did students using clicker technology in a large, college-level introductory psychology class perceive that the use of clickers helped them find out what they "still needed to study"?

In response to the third research question and based on the dichotomized responses, approximately 81% of the students (n = 67) who responded to the survey agreed that clickers improved their ability to identify their individual deficits in the subject matter during the lecture. Only approximately 6% disagree that clickers had an impact on their ability to identify their individual deficits in the content. Once again, the survey results support the hypothesis that the majority of students perceive that clickers improved their ability to self-identify subject matter they still need to study.

RQ_4: Did students using clicker technology in a large, college-level introductory psychology class perceive that the use of clickers to respond to questions was "fun"?

Based on the dichotomized results of the survey, the fourth research question had an overwhelming positive response, with 100% of the students (n = 67) reporting that the use of clickers was fun as related to learning the content in an introductory Psychology course. The results of the survey support the hypothesis that using clickers in the course was fun.

RQ_5: Did students using clicker technology indicate that they would be "willing to purchase a clicker that cost $30 to $40" to help them learn?

Finally, for the last research question, the responses were dichotomized, however, this time the majority, approximately 35% of those who responded to the survey (n = 67) disagree that purchasing a clicker was worthwhile, with approximately 32% of students agreeing that purchasing a clicker was worthwhile. The results of this question on this survey were not in line with the original hypothesis.

IV. Conclusion.

Overall, there is evidence to suggest that the use of clickers in a large, college level introductory psychology class contributed positively to learning. Students using clickers performed significantly better when compared with a group of students not using clickers, although the

effect size was minimal. Students using clicker technology reported that they felt utilization of clickers increased their understanding of the topic and allowed them to self-identify areas of deficit in their learning. All of the students in the experimental group agreed that using clickers to respond to questions was fun; however, only approximately one-third of those same students thought that purchasing a clicker was worthwhile. While these students may have benefited from and enjoyed using the clickers, they do not seem to be willing to bear the expense.

This study contained limitations that may bring in to question the validity of the findings. The results may not be generalizable to other instructional settings because this research was conducted with large, college level introductory psychology classes. Researcher bias may also exist, as this study was conceptualized and conducted by researchers who were also involved in delivering instruction to the experimental and control groups. Another limitation in this study may be a consequence of the fact that the sample was not randomly selected and the conditions were not randomly assigned, leading to unequal groups. Error in measurement may exist for research questions two through five, as the measure was researcher-generated and not field-tested for reliability and validity.

Future research into the use of clickers should engage methods to compare procedures for embedding questions in lecture (e.g., pre-post lecture, throughout the lecture, etc.). To further explore the academic achievement of students using clickers, it would be worthwhile to link questions presented using the clicker system to questions on course tests, to determine if utilization of the clickers contributes to specific knowledge acquisition. Examining the reliability and validity of the researcher created measure would decrease measurement error and lend credibility to the findings of students' perceptions.

V. Implications for Higher Education Administrators and Faculty.

Since this research was conducted by professors engaging in scholarship of teaching and learning (Boyer, 1990), the researchers' aim was to improve instructional practice within the college, while at the same time informing purchasing decisions of clickers. Currently, clickers are often used in large, college-level classes to increase student engagement, allowing teachers to poll classes by posing a question and providing an opportunity for students to respond in real-time via individual clickers. It appears that the utilization of clicker technology supports the generative theory of learning, by priming the cognitive processes used when learning, as demonstrated by improved academic performance. Faculty of large, lecture-style classes seeking to engage students may be able to use clicker technology as one means of increasing generative learning, and therefore increasing student performance.

Yet, teachers, administrators, and students may question the efficacy of clickers because of the costs associated with adoption of the technology. Students are often required to purchase clickers, which range in cost from $10 to $40, while administrators must adopt the clickers, which require a substantial financial investment. Before assuming these costs and requiring students to make financial commitments, administrators are wise to ask whether or not the use of clickers increases student academic achievement, as well as what other options are available for formative assessment. Other options, such as Polleverywhere.com, provide instant audience feedback using mobile devices of audience members at significantly less expense (e.g., the cost of a text message). Polleverywhere.com provides free templates for PowerPoint slides which can be customized with questions about course content and embedded into existing PowerPoint presentations. Audience members are able to respond using SMS texting for the cost of a text

message, with no cost to the higher education institution for groups of up to 30 participants at a time, and $65 per month for 250 participants at a time. As new technologies develop, higher education administrators, instructors, and students have increasingly diverse options to improve academic achievement. New developments in technology should be evaluated to determine if perceived benefits outweigh the costs.

References

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., et al. (2001). *A Taxonomy of Learning for Teaching: A Revision of Bloom's Taxonomy of Educational Objective*s. New York, NY: Longman.

Beatty, I. (2004, February). Transforming student learning with classroom communication systems. *Educause Research Bulletin, 2004*(3), 1-13.

Beatty, I., Garace, W., Leonard, W., & Dufrense, R. (2006). Designing effective questions for classroom response system teaching. *American Journal of Physics, 74*(1), 31-39.

Boyer, E.L. (1990). *Scholarship Reconsidered: Priorities of the Professoriate.* Princeton, NJ: The Carnegie Foundation for the Advancement of Teaching.

Burnstein, R., & Lederman, L. (2001). Using wireless keypads in lecture classes. *The Physics Teacher*, *39,* 8-11.

Dufresne, R.J., Gerace, W.J., Leonard, W. J., Mestre, J. P., & Wenk, L. (1996*)*. Classtalk: A classroom communication system for active learning *Journal of Computing in Higher Education, 7,* 3-47.

Edmonds, C.T., & Edmonds, T.P. (2008). An empirical investigation of the effects of SRS technology on introductory managerial accounting students. *Issues in Accounting Education, 23*(3), 421-434.

El-Rady, J. (2006). To click or not to click: That's the question. *Innovate 2*(4), 1-5.

Fies, C. (2005). *Classroom response systems: What do they add to an active learning environment?* Unpublished Doctoral Dissertation, The University of Texas, Austin, TX.

Fies, C., & Marshall, J. (2006). Classroom response systems: A review of the literature. *Journal of Science Education and Technology, 15*(1), 101–109.

Flavell, J.H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry, *American Psychologist, 34*, 906 - 911.

Geske, J. (1992). Overcoming the drawbacks of the large lecture class. *College Teaching, 40*(4), 151–154.

Gleason, M. (1986). Better communication in large courses. *College Teaching, 34*(1), 20–24.

Hall, R., Thomas, M., Collier, H., & Hilgers, M. (2005). *A student response system for increasing engagement, motivation, and learning in high enrollment lectures.* Paper presented at Eleventh Americas Conference on Information Systems, Omaha, NE.

Hoekstra, A. (2008). Vibrant student voices: Exploring the effects of the use of clickers in large college courses. *Learning, Media, and Technology, 33*(4), 329-341.

Kaleta, R., & Joosten, T. (2007). *Student Response Systems: A University of Wisconsin System Study of Clickers.* Boulder, CO: Educause Center for Applied Research.

Kenwright, K. (2009). Clickers in the classroom. *TechTrends, 53*(1), 74-77.

King, A. (1992). Comparison of self-questioning, summarizing, and note taking review as strategies for learning from lectures. *American Educational Research Journal, 29*, 303–323.

Mayer, R. E. (2001). *Multimedia Learning.* New York, NY: Cambridge University Press.

Mayer, R. E., Stull, A., DeLeeuw, K., Almeroth, K., Bimber, B., Chun, D., Bulger, M., Campbell, J., Knight, A., & Zhang, H. (2009). Clickers in college classrooms: Fostering learning with questioning methods in large lecture classes. *Contemporary Educational Psychology*, *34*(1), 51-57.

Mula, J.M., & Kavanagh, M. (2009). Click go the students, click-click-click: The efficacy of a student response system for engaging students to improve feedback and performance. *e-Journal of Business Education & Scholarship of Teaching, 3*(1), 1-17.

Poirier, C. R., & Feldman, R. S. (2007). Promoting active learning using individual response technology in large introductory psychology classes. *Teaching of Psychology, 34*, 194-196.

Roschelle, J., Abrahamson, L., & Penuel, W. (2004). *Integrating classroom network technology and learning theory to improve classroom science learning: A literature synthesis.* Paper presented at the meeting of the American Educational Research Association, San Diego, CA.

Rosenshine, B., Meister, C., & Chapman, S. (1996). Teaching students to generate questions: A review of intervention studies. *Review of Educational Research, 66*, 181–221.

Salmonson, Y., Andrew, S., & Everett, B. (2009). Academic engagement and disengagement as predictors of performance in pathophysiology among nursing students. *Contemporary Nurse, 32*(1-2), 123-132.

United States Department of Education. (1996). *Getting America's students ready for the 21st century: Meeting the technology literacy challenge, a report to the nation on technology and education.* Retrieved from http://www.ed.gov/about/offices/list/os/technology/plan/ national/ title.html

Wittrock, M.C. (1974). Learning as a generative process. *Educational Psychologist, 19*(2), 87–95.

Wolf, M.M. (1978). Social validity: The case for subjective measurement or how applied behavior analysis is finding its heart. *Journal of Applied Behavior Analysis, 11*(2), 203-214.