Clicker Use as an Instructional Strategy: Effects on Student Engagement and Achievement in a College-Level Digital Literacy Course

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ABSTRACT

The authors of this study sought to determine the impact of clicker (student response system) use as an instructional strategy on student engagement and achievement in a college-level digital literacy course taught in face-to-face classroom settings. This was also an attempt to explore students' learning experiences and attitudes toward instruction utilizing clicker technology-based strategies. This study was conducted in a public college with an open-access admission policy in the rural South. The college has a significant racially and ethnically diverse student population. The students' levels of preparation to enter college are just as diverse, and there is a large number of students requiring "learning support." This course in this study had no prerequisites, allowing learning support students to enroll along with everyone else, creating a challenge to teach this course effectively.

Eight classes were selected where students were already pre-registered, resulting in convenience sampling. This study used quasi-experimental control group time series design. Data collection continued throughout the duration of a semester. Students' academic achievement was measured using a series of assessments. Students' learning experiences and attitudes toward learning were measured using data collected through survey instruments. Descriptive statistics, reliability analysis, effect size, t-test of independent samples, and multivariate analysis of variance (MANOVA) were used for data analysis. A content analysis technique was used to identify trends and themes in qualitative data collected through open-ended survey items.

Findings of this study revealed that the academic achievement of students in the group that was taught with extensive use of clicker technology was higher than the achievement of students in the group that was taught using traditional methods. They also revealed that the students who were taught with extensive use of clicker technology reported that they had substantially positive learning experiences. Furthermore,

the results revealed that the students who were taught using instructional strategies focused on extensive use of clicker technology demonstrated a more positive attitude toward learning than students who were taught using traditional methods. Overall, the results suggested that frequent feedback through clicker technology is more effective in circumstances where improved understanding of the current topic is essential to establish a good foundation for the next learning experience.

Introduction

The challenge of ensuring the best learning experience for an increasingly diverse student body in an open-access post-secondary institution is a difficult one. Historically, these open-access institutions, most of them being community colleges, have no admission restrictions or enrollment limits (Roman, 2007). In absence of a credible screening process for admissions, students come with various levels of preparedness from secondary schools. A large number of these students lack the required skill-levels in basic computation, composition, and reading to successfully complete post-secondary coursework. Thus, they are required to take at least one or more learning support or remedial courses to develop those required skills and competencies. A digital literacy course, the focus of this study, is part of the general education core curriculum and appears on the list of required or optional courses for almost all majors offered by most post-secondary institutions. This course does not have prerequisites, thus almost all students registered in it are entry-level freshmen. Because the student preparedness-levels are so varied, it is a challenge to ensure the best learning experience for all students in the class.

This lack of basic computation, composition, and reading skills makes it difficult for instructors to improve student retention and progress towards graduation. Therefore, instructors must develop creative ways to reach out to students of all levels to develop competency and level the field for learning. For this millennial generation of students, technology is considered one of the most promising tools to accomplish that goal.

This study was guided by the following research questions:

1. How does student achievement differ between a group of students who were taught a college-level digital literacy course with heavy use of clicker technology and a group of students who were taught using traditional methods?
2. What are the learning experiences of students who were taught a college-level digital literacy course with heavy use of clicker technology?
3. How do instructional strategies focused on enhanced use of clicker technology influence students' attitude about learning?

Statement of Problem

Among others, John Dewey has clearly voiced the core idea of the theory that learners individually construct knowledge for themselves. Dangle and Guyton (2003) stressed that active participation and engagement in the learning process enhance the acquisition of knowledge by promoting assimilation of new concepts into the existing body of knowledge.

Technological tools are needed that effectively connect teaching with learning (Brewer, 2004). Increased student achievement can only be ensured through the use of high-leverage technological tools and the teacher's increased ability to incorporate them in classroom instruction (Green, 2000). Abdallah (2008), Brewer (2004), and Skiba (2006) claimed that clicker-technology-aided instruction has demonstrated a significant positive effect on student achievement. When clicker technology is used to engage students in individual and collective learning processes, a higher level of knowledge acquisition takes place that enhances comprehension and knowledge retention for the learners (Guthrie & Carlin, 2004).

The purpose of this study was to examine the impact of clicker-technology-aided classroom instruction on student engagement and achievement in a college-level digital literacy course. This study was also an attempt to explore the impact on student learning experiences and students' attitudes toward instruction utilizing technology-based strategies.

Related Literature

There are many research studies where participatory practice in classroom instruction using clicker-technology produced enhanced levels of academic achievements in a variety of subject areas. Brewer (2004) conducted a study on the effect of using clickers for real-time assessment of student learning and comprehension in her large-enrollment introductory Biology class. Brewer found that with instant feedback, she was able to pace her instruction and make sure students grasped the correct interpretation before moving on to the next topic. Moreover, she claimed that the students' improved understanding of the current topic established a better foundation for the next learning experience. Beuckman, Rebello, andZollman(2007) adopted clickers in their university Physics classes with large enrollments. They reported significant improvement in student engagement in class and better academic achievement using clickers. To adopt clickers technology they redesigned the pedagogy for the course. They demonstrated that using clickers to engage students improved learning outcomes and student grades. Masikunis, Panayiotidis, and Burke(2009) conducted a study using the clicker system in university Business and Management courses as a measure of innovative teaching in their very large classes that had as many as 500 students. They reported a substantial increase in the mean scores across the board for those classes. Shaffer and Collura (2009) conducted a study using clickers in their university Introductory Psychology. As a result, they discovered that students rated their lectures as more interactive, more interesting, and more entertaining. Students in the classes taught using clickers also performed significantly better on exam questions compared to another group of students who did not use the clickers.

Watkins and Sabella (2008) conducted a study in an introductory university Physics class. They found that the use of clickers made the class a more dynamic learning environment, and they also observed a significant improvement in student engagement and student performance during class Question and Answer (Q&A) sessions. However, interestingly enough, when asked the same or similar questions in a test, the students did not perform significantly better anymore. The researchers attributed that outcome to a lack of improved knowledge retention.

Methodology

Participants

The study sample (N = 153) was selected from the general student population of a college in the rural South. All students in the selected study sample, except one, were enrolled full-time. The average age of all students in the study sample was 18.7 years, their average high school graduation GPA was 3.0, and their average current semester load was 13.8 credit hours. Additionally of all students in the study sample, 39.2% were required to take at least one learning support course. The students in this study sample were already pre-registered in the selected sections of the course, resulting in convenience sampling rather than random sampling as required for true experimental design.

Procedures

The study of the clicker technology used in the digital literacy course was carried throughout the length of a semester. The course topics included essentials of computer concepts and fundamentals of major computer applications. The sections of the course selected for the study were taught in face-to-face classroom settings. The digital literacy course, itself being a technology-related course, did make use of

some technology tools for teaching and learning purposes. Therefore, even the traditional method of instruction for this course in this study used lectures with a projector, hands-on exercises on computers, and a training and testing software application, Skill Assessment Manager (SAM). All assessments were administered using SAM and had two components: objective questions to test understanding of concepts and hands-on task-related questions to test mastery of skills.

The instructional strategies were the same for both the control and treatment groups at the beginning of the semester. There were five assessments during the duration of the course in the form of unit tests. Both instructors participating in the study contributed to the development of the assessments. Of the five assessments, three were administered towards the middle part of the semester before clicker-technology-aided instructional strategies were introduced to the treatment group. Once the clicker-technology-aided instructional strategies were implemented with the treatment group, they continued through the remainder of the course. After the treatment was introduced, two more assessments were administered.

Clicker-technology-aided instructional strategies made use of clicker-questions integrated seamlessly with pedagogical objectives to enhance student engagement and learning. Once the treatment was initiated, all major content topic discussions in the treatment-group sessions were followed by clicker questions embedded in a PowerPoint presentation used to manage and sequence the topics of discussion. The questions addressed understanding of the topic as well as common misconceptions. Students submitted their answers to the projector-displayed question using their clicker-keypads. Students were allowed time to think through the question before they submitted their answers. The anonymous process of answering questions was expected to relieve students from the fear of embarrassment, thus enhancing participation (Cunningham, 2009). The clicker-software instantly generated a bar chart using student response data. A green colored bar informed students of the correct answer to the question. This instant feedback was used to pace the instructor's presentation and assure students grasped the correct interpretation of the current topic before moving on to the next. In the event that student responses indicated, through the bar chart, that the current topic needed further discussion, the instructor did so by using a different example or using a different approach. The instructors for both the experimental and the control groups participating in the study agreed to use 70-percent correct student responses as the cut off level to move forward to the next learning topic. That means that if less than 70 percent of the students answered the projector-displayed question correctly, the topic of discussion would be revisited. For all critical topics, there was a backup clicker-question to ask the students once the repeat-explanation of the topic was concluded. All of the clicker-questions used in the treatment group were also used for class discussions and test reviews as well as made available online to students in the control group to make sure that students from both groups had exposure to the same course content.

Data were collected throughout the fall 2012 semester. For Research Question 1, only quantitative data were collected through the series of five assessments using SAM. For Research Questions 2 and 3, both quantitative and qualitative data were collected. Quantitative data were collected through survey instruments using Likert-scale items. Qualitative data were collected through survey instruments using open-ended questions, interviews, and an Instructor's Log. A Student Learning Experience survey and a Student Attitude Toward Learning survey were conducted two weeks prior to the end of the semester when students in the treatment group had experienced the maximum exposure to the treatment.

Data Analysis

Quasi-experimental control group time series research design was used in this study. Figure 1 shows the study design. In Figure 1, O_i represents the series of observations or measurements applied to both control and treatment groups, and X represents the treatment applied only to the treatment group. Wagner,

Soumerai, Zhang, and Ross-Degnan (2002) described control group time series design as one of the strongest approaches in quasi-experimental research design.

***Figure* 1**
A Basic Control Group Time-Series Design

O_1	O_2	O_3	X	O_4	O_5	O_6
O_1	O_2	O_3		O_4	O_5	O_6

Descriptive statistics were used to describe the basic features of the data and to form the basis of the analysis. The *t* test of independent samples was used to determine whether the means of the control group and the treatment group on the five course content assessments were statistically different from each other. Multivariate Analysis of Variance (MANOVA) was used on the attitude survey to determine any differences between the groups with suspected correlation among dependent variables. SPSS software was be used to analyze all quantitative data. Qualitative data collected through open-ended survey questions, interviews, and the Instructor's Log were analyzed for trends and themes using content analysis techniques.

Results

Research Question 1 Results

Table 1 shows the results of a *t*-test for independent samples for all three pre-treatment assessments. On all three assessments, the *t* test revealed no statistically significant difference between the mean scores of students in the control group (n = 74) compared to those in the treatment group (n = 58). Cohen's effect sizes (d = 0.09, d = 0.19, d = 0.27, respectively) suggested very little practical significance. Thus, the analysis of these assessments established the statistical equivalence of the two groups under observation.

Table 1
Independent Samples Test for Assessments 1, 2, and 3

	t-test for Equality of Means		
	t	*df*	*p* (2-tailed)
Assessment 1	.54	130	.59
Assessment 2	-1.05	129	.29
Assessment 3	1.54	130	.13

Table 2 shows the results of a *t*-test for independent samples for both post-treatment assessments. On Assessment 4, the *t*-test revealed a statistically significant difference between the mean score of students in the control group (n = 74, M = 72.64, SD = 10.47) and the mean score of students in the treatment group (n = 59, M = 79.49, SD = 12.14), $t(131) = -3.50$, p = .001, α = .05. Cohen's effect size (d = 0.60) suggested moderate to high practical significance. However, on Assessment 5, the *t*-test revealed no statistically significant difference between the mean score of students in the control group (n = 73, M = 77.16, SD = 9.88) and the mean score of students in the treatment group (n = 59, M = 79.14, SD = 10.54), $t(131) = -1.11$, p = .27, α = .05. Cohen's effect size (d = 0.19) suggested very small practical significance.

Table 2
Independent Samples Test for Assessment 4 and 5

	t-test for Equality of Means		
	t	*df*	*p* (2-tailed)
Assessment 4	-3.50	131	.001
Assessment 5	-1.11	131	.269

Research Question 2 Results

A Student Learning Experience survey, with items using a five-point Likert response scale from 5 = strongly agree to 1 = strongly disagree, was used to collect quantitative data for research question 2. Also, open-ended questions embedded in the survey instrument, interviews, and Instructor's logs were used to collect qualitative data. Analysis of responses to the survey, administered to the treatment group, indicated that the students were engaged by using the clickers and were positive about their use. For example, the students agreed that they were more engaged while clicker-technology was used in class (M = 3.72) and that the clicker questions, instant feedback, and repeated explanations helped them with knowledge retention (M = 4.05).

Research Question 3 Results

The Student Attitude Toward Learning survey, also with a five-point Likert response scale for many of the items, was used to measure attitudes of students in both groups towards their learning in this course and in general. MANOVA revealed an overall significant difference between the two groups on survey responses, Wilk's Λ = .43, $F(11, 126) = 15.51$, $p < .001$, partial $\eta 2 = .58$. As an example of item responses, the students in the treatment group (M = 4.52) liked the instructional strategies employed more than did the students in the control group (M = 4.15), $F(1,136) = 3.41$, $p = .003$, partial $\eta 2 = .06$. Also, more so than the students in the control group (M = 3.83), the students in the treatment group (M = 4.30) reported that they understood the course materials adequately, $F(1,136) = 11.93$, $p = .001$, partial $\eta^2 = .08$. Open-ended questions embedded in the survey instrument, interviews, and Instructor's logs were used to collect qualitative data.

Discussion

Research Question 1 Discussion

The results for the first research question revealed that the academic achievement of students in the group that was taught with extensive use of clicker technology was higher than the achievement of the students in the group that was taught using traditional methods.

The analysis of the first post-treatment assessment revealed that there was a statistically significant difference between the mean score of students in the control group and the mean score of students in the treatment group. In addition, the Cohen's effect size (d) also suggested moderate to high significance in the difference of the two means. However, the analysis of the second post-treatment assessment revealed that there was no statistically significant difference between the mean score of students in the control group and the mean score of students in the treatment group. Similarly, Cohen's effect size (d) also suggested small practical significance.

To try to understand this disparity between the results for the two assessments during the intervention period may involve considering the differences in the topics covered by those assessments and how the students engaged with that content. Assessment 4 covered what the students were to learn about

Microsoft Excel. For that unit of the course, the students had to process numbers, manipulate cell addressing, use functions, construct formulas, create various types of charts, etc. The unit involved more than learning a procedure such as changing document margins. A moderate degree of understanding of spreadsheet features was necessary. If a student did not grasp the way cell addressing features worked, that student could not effectively construct formulas to be copied across a range of cells. With the instant feedback from clicker technology, the instructors were able to pace instruction and make sure students grasped the content before moving on to the next topic. Thus, the improved understanding of the current topic established a better foundation for the next learning experience for students. When the topic of classroom instruction is not very easy to grasp, when distinguishing misconception from correct interpretation is not very obvious, or when improved understanding of the current topic is essential to establish a good foundation for the next learning experience, frequent feedback through clicker technology is invaluable (Brewer, 2004). After conducting a similar study, Masikunis, Panayiotidis, and Burke (2009) concluded that clicker-technology-aided interactive lectures driven by educational ends can enhance student learning and comprehension.

Microsoft Access was the topic of the content related to Assessment 5. In this unit of the course, students had to learn basic concepts and terms, create simple database tables, enter and edit records, create a simple query and a simple form, use navigation, modify field formats, modify table structures, specify primary key, etc. This unit was largely about learning procedures. The unit did not include database features such as normalization, enforcing data integrity, complex query design, or Sequential Query Language (SQL), features that require in-depth understanding of procedures as well as concepts. The procedure of creating a simple query was independent of the procedure for creating a simple form. Similarly, specifying primary key for a table was independent of the procedure for editing a record, or modifying a table structure. In this unit briefly covering Microsoft Access, there was not much building upon understanding in a step-by-step approach that was necessary in the Excel unit. Therefore, frequent feedback was not as necessary or as critical in this unit as it was in the Excel unit. Judson and Sawada (2002) emphasized that use of clicker technology would not produce substantial improvement unless the course content could be seamlessly adopted into clicker-technology-based pedagogical approaches. Basics of Microsoft Access did not fit that model.

Research Question 2 Discussion

The results for the second research question revealed that the students who were taught with extensive use of clicker technology reported that they had substantially positive learning experiences. It should not be surprising to find that the higher academic performance by the treatment group revealed by Research Question 1 was accompanied by enjoyment and appreciation for the learning experience. It was evident that use of clicker technology as an instructional tool contributed to the positive learning experiences. Shaffer and Collura (2009) also found that the use of clicker technology in classroom instruction made the learning process more interactive, more engaging, and more entertaining for students, contributing to positive learning experiences and improved academic success. It was also evident from the results in the present study that positive learning experiences were directly associated with active participation and engagement of the students in the learning process. Evidence for these associations came from all of the data collection methods used with this research question: Likert-scale survey items, open-ended survey questions, instructor's log entries, and focus-group interviews. Marti (2009) noted that the more the students can be actively engaged in their own learning process the better the chance they will have academic success and positive learning experiences.

Research Question 3 Discussion

The results for the third research question revealed that the students who were taught using instructional strategies focused on extensive use of clicker technology demonstrated a more positive attitude about learning than students who were taught using traditional methods. Analysis of student responses revealed that students in the treatment group enjoyed the class more than those in the control group. It appears that the clicker-technology-aided classroom instruction significantly influenced student opinion on how much they enjoyed the class. Consistently, students in the treatment group believed at a much higher level than those students in the control group that the use of technology could improve classes, that the use of clicker-technology was an effective means for aiding in instruction, and that they liked the instructional strategies employed by the instructor. These students' first-hand exposure to technology-aided instruction most likely shaped their favorable attitude towards the potential of technology use in classroom instruction. Furthermore, these students reported at a higher level than those in the control group that they understood the course materials adequately. This finding was especially important since it corroborates the test achievement results for Research Question 1. It appears that clicker-technology-aided instruction promoted student engagement, which is one of the established prerequisites to academic achievement (Dangle & Guyton, 2003).Skiba (2006) reported, that when using clickers, students were not fearful of providing incorrect answers. They were encouraged to think through the questions and submit their answers anonymously. She also submitted that use of clicker technology encouraged active learning, student-teacher contact, and cooperation, and provided prompt feedback on students' level of comprehension. These benefits resulted in positive experiences, attitudes, and academic success (Brewer, 2004; Shaffer &Collura, 2009).

Limitations

This study used convenience sampling and thus, a quasi-experimental research design. In absence of a true experimental research design with random sampling, the generalizability of the findings of this study is questionable. The relatively small study sample size was a limitation as well.

Studies have suggested that the degree of achievement in increased comprehension and knowledge retention through clicker-technology-aided classroom instruction is largely and directly proportional to the extent of redesigned pedagogical approach of instruction (Judson & Sawada, 2002; Beuckman, Rebello, &Zollman, 2007). Redesigning the pedagogy for the course is essential to maximize the potential of clicker technology. Yet, "the biggest challenge with clickers or personal response devices is figuring out how to integrate them into the heart of the lesson rather than tagging them on at the end" (Derringer, 2011). Even though the instructors committed their time and effort, it was possible that they lacked skills to develop effective clicker lessons.

This study used classes largely comprised of incoming freshmen students, where 39% of them were also required to take at least one learning support course. Clicker-technology-aided classroom instruction in a different setting, such as a senior-level course, could have produced a different outcome.

Implications

The study results were similar to other studies that reported significant student achievement attributed to clicker-technology-aided classroom instruction (Brewer, 2004; Masikunis, Panayiotidis, & Burke,2009; Dunham, 2011). The first post-treatment assessment (Assessment 4) supported that assertion.

Effectiveness of the use of clicker technology in the classroom relies heavily on the degree of appropriate integration of clicker technology with course content. Since it may require developing some experience to harness the full potential, instructors may wish to ease into clicker use slowly without having to commit significant time and resource at one time. Clicker technology can be used without clickers as

well; any computer connected to the Internet or any smart phone can be used instead, eliminating a major cost component.

Clicker technology is a teaching tool – an instructional aid. It cannot replace student responsibilities such as reading the textbook, doing homework, or taking class notes. Furthermore, improper use of it may mute its effectiveness as well.

Conclusions

The results of the first research question demonstrated that the academic achievement of students in the group that was taught with extensive use of clicker technology was higher than the students in the group that was taught using traditional methods. The results for the second research question revealed that the students who were taught with extensive use of clicker technology had a substantially positive learning experience. Also, the results of the third research question revealed that the students who were taught using instructional strategies focused on extensive use of clicker technology had their attitude about learning more positively influenced than students who were taught using traditional methods.

Ifclicker-questions, instant feedback, and repeat-explanations help students with knowledge retention, as a large number of the students in this study actually reported, then that reason alone may justify the use of clicker-technology-aided classroom instruction. After all, the fundamental objective of classroom instruction is learning, and the longer the knowledge can be retained the better.

This technology can be adapted at all levels and in all subject areas ranging from K-12 through higher education. It appeared throughout the study that there was no significant downside to using clicker technology in classroom instruction beside substantial commitment of effort on the part of the instructors. And as the clicker technology advances, it may require less effort.

Future research suggestions include an expanded research study with a much larger study sample and multiple participating instructors trained in the use of clicker technology. Using different types of courses (Mathematics versus Ethics), different levels of courses (introductory versus advanced), as well as different sizes of classes (small versus large) would increase generalizability of findings. Similarly, this research could be done at different levels of institutions such as junior colleges, research universities, private colleges, public colleges, etc. Finally, this research could be done to study the effect of clicker-technology-aided instructional strategies specifically on learning support and non-learning support student groups.

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