Perceptions and Effects of Classroom Capture Software on Course Performance Among Selected Online Community College Mathematics Students: A Mixed Methods Research Study

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ABSTRACT

In this mixed methods research study, we examined the perceptions and effects of classroom capture software (CCS) on course performance among selected online community college mathematics students. We analyzed the grades of 1,476 students in 79 online mathematics classes during the 2012-2013 academic year (Quantitative Phase). Also, we conducted interviews with 10 students and 6 instructors (Qualitative Phase). A statistically significant difference in course grades emerged between students who were enrolled in a class where the instructor used CCS and their counterparts who did not receive CCS. In the qualitative phase, the students’ perceptions (6 themes) were similar to instructors’ perceptions (5 themes) in that both sets of participants found positive value in using CCS in the online mathematics courses.

KEYWORDS

Classroom capture software; community college; mathematics; mathematics students; mixed analysis; mixed methods research; mixed research; online community college

With the continued growth in online enrollments, colleges and universities continue to offer a diverse listing of courses in the online format (I. E. Allen & Seaman, 2008). Among the different online courses offered are a variety of different mathematics courses (I. E. Allen & Seaman, 2008). Online instruction differs significantly from face-to-face instruction, and the transition to an online mathematics environment presents challenges (Hardy & Bower, 2004; Ko & Rossen, 2004; McLean, 2005; Palloff & Pratt, 2001).

Although most instructors are prepared to deliver content in face-to-face formats (Varvel, 2007), instructors in general are underprepared to teach in online environments (McQuiggan, 2007). Online mathematics instructors continually search for new ways effectively to teach mathematics in online environments. Technology continually evolves and changes at a pace faster than the higher educational environment can adapt. A recent advancement in technology is the development of classroom capture software (CCS). Some of the leading CCS companies include Accordent, Arrive, Camtasia, Echo360, Galicaster, Opencast, Panopto, Presentations2Go, Screencast-O-Matic, and Tegrity.

CCS companies advertise multiple educational uses for their products. Panopto (2012) markets numerous uses for their product, including: (a) lecture capture (i.e., giving students the ability to pause, to search, to review and to add notes to lectures); (b) webcasting of campus events (i.e., giving a community the ability to plan, to capture, and to share events of any scale with any audience around the world); (c) creating course material from anywhere (i.e., giving instructors the ability to record course content from a laptop or iOS device); (d) student recording (i.e., giving students the ability to submit recordings to the instructor); (e) broad range of mobile platforms (i.e., allowing users the ability to record or to view material on mobile devices); (f) integration with a Learning Management System (i.e., allowing integration with a range of systems, such as Moodle, Canvas, Desire2Learn, Sakai, Blackboard, WebCT, and Angel); and (g) construction of comprehensive video libraries (i.e., allowing institutions to maintain, to organize, and to share video libraries). Thus, one of the functionalities of CCS is to solve the problem of synchronously recording both audio and video components...
Instructors can record both entire lectures during a traditional classroom lecture and short segments outside the traditional classroom. The online instructors can provide their students with access to these recordings, thereby enabling their students to have a face-to-face experience in an online course.

Although online enrollment continues to increase (Aud et al., 2011), the lack of student success in online courses continues to plague administrators (Chyung, 2001). As technology makes a stronger impact in higher education, there is a need to assess its impact on student learning. There is currently a lack of data from research conducted on CCS and the online mathematics classroom. It is unclear as to whether CCS has an effect on student success in the online mathematics environment. Additionally, it is unknown as to whether the benefits of CCS outweigh the expenses associated with this tool (e.g., the financial commitment for the purchase of the software and the financial/time commitment needed to train individuals to use the software). In order to enhance both teaching and learning in the online mathematics environment, we need pragmatic information collected from both the instructors’ and students’ perspectives. These challenges suggest that administrators should explore how to provide better access to and training of technological software that contribute to student success.

Due to a lack of knowledge as to whether CCS has had an effect on student success in online mathematics courses, the purpose of this mixed methods research study was twofold. First, we compared the findings of the success rates of online mathematics students with the perceived effects of CCS in hopes to find convergence (i.e., triangulation; Greene, Caracelli, & Graham, 1989). Second, we used mixed methods in different phases of the study to expand the breadth and range of the effects of using CCS in the online environment (i.e., expansion; Greene et al., 1989).

Using Plano Clark and Badiee’s (2010) classification, we utilized combination research questions (i.e., at least one mixed research question combined with separate quantitative and qualitative questions), as follows:

**Quantitative Research Question**

The following quantitative research question was addressed:

1) What is the difference in success rates—as defined by overall numeric course grade—between community college students who are taught an online mathematics course in which CCS is used and community college students who are taught an online mathematics course in which CCS is not used?

**Qualitative Research Questions**

The following qualitative research questions were addressed:

2) What are select online mathematics community college students’ perceptions about the effect of CCS on their performance in the online course?
3) What are select online mathematics community college instructors’ perceptions about the effect of CCS on their students’ performance in the online course?
4) To what extent are perceptions of select online mathematics community college students regarding the effect of CCS on their performance in the online course similar to those of their instructors?

**Mixed Methods Research Questions**

The following mixed methods research questions were addressed in this study:

5) What is the prevalence of each of the perceived effects of CCS by select online mathematics students?
6) How are the perceived effects of CCS by select online mathematics students related to one another?
7) What is the relationship between online mathematics community college students’ self-reported use of CCS and their success in the course?
8) What is the prevalence of each of the perceived effects of CCS by select online mathematics instructors?
9) How are the perceived effects of CCS by select online mathematics instructors related to one another?

**Theoretical Framework**

This mixed methods research study was guided by Bruner’s (1966) constructivist theory, which states that learning is an active process in which a learner constructs new concepts or ideas based upon his or her current/past knowledge. Online mathematics courses, like traditional face-to-face mathematics courses, are organized to build upon previously learned mathematics skills. Bruner (1966) addressed four features in his theo-
ry of instruction: (a) predisposition to learn, (b) structure (i.e., organization) of knowledge, (c) modes of representation (i.e., delivery), and (d) effective sequencing (i.e., form and pacing of reinforcement). These features were applied to instruction in the online mathematics environment. By using CCS, the online mathematics instructor can present topics in a specific order (i.e., structure the course according to objectives; Heimer, 1969). The students can view the recordings in the order in which the recordings are presented, or they can view the recordings in an order that best fits their needs of learning (Panopto, 2012; Tegrity, 2005). For example, when learning a new concept (e.g., solving quadratic inequalities), if a student knows that he or she is deficient in a previously learned concept (e.g., solving quadratic equations), then he or she can view the recordings out of sequence and review previous concepts. The use of CCS also allows the mode of delivery in a traditional face-to-face course to be replicated in the online course (“Tegrity campus,” 2011).

From a constructivist perspective, effective teaching requires the learner to be responsible and accountable for the learning that takes place. In the online environment, instructors make course information available, and the students are responsible for demonstrating understanding and mastery of the material. The use of CCS is one of many emerging technologies that have been used in the online environment to enhance student learning (Ford, Burns, Mitch, & Gomez, 2012).

Quantitative Hypothesis

Based on Bruner’s (1966) constructivist theory, in the quantitative phase of the study, we tested the hypothesis that there is a difference in overall numeric course grades between community college students who are taught an online mathematics course in which CCS is used and community college students who are taught an online mathematics course in which CCS is not used.

Rationale for Using a Mixed Methods Research Approach

Collins, Onwuegbuzie, and Sutton (2006) provided four rationales for conducting mixed methods research: (a) participant enrichment (i.e., the mixing of the quantitative and qualitative techniques for the rationale of optimizing the sample), (b) instrument fidelity (i.e., the procedures taken to maximize the utility and/or appropriateness of the instruments used in the study), (c) treatment integrity (i.e., the mixing of the quantitative and qualitative techniques to assess the fidelity of interventions, treatments, or programs), and (d) significance enhancement (i.e., the mixing of quantitative and qualitative techniques to maximize the interpretations of findings). In this study, significance enhancement was used as the primary rationale; however, the rationales of instrument fidelity and treatment integrity also were pertinent. With respect to instrument fidelity, the goal was to maximize the appropriateness of each instrument being used in the study. In particular, after the primary researcher conducted one instructor interview to collect qualitative data (e.g., responses to interview questions), she participated in a debriefing interview to assess the appropriateness of the questions asked during the interview (Onwuegbuzie, Leech, & Collins, 2008). In this debriefing interview, her initial interview was assessed via the collection of both qualitative data (e.g., observations made during the interview such as quality of each response and nonverbal communication data; Denham & Onwuegbuzie, 2013; Onwuegbuzie & Byers, 2014) and quantitative data (e.g., time taken for the interview, length of each response). Further, the insights gained from analyzing all the interviews provided insights into treatment integrity and led to the assessment of implementation bias (i.e., the extent to which the implementation of intervention deviated from protocol; Onwuegbuzie, 2003b). With respect to significance enhancement, we collected both quantitative and qualitative data during the study. Collection of both types of data allowed us to obtain richer data than we would have obtained if we had chosen only to collect one type of data, thereby it enhanced the significance of our findings (Onwuegbuzie & Leech, 2004).

Method

Quantitative Research Phase

Two instruments were used—one instrument to obtain the overall course grade for each student, and one instrument to obtain CCS usage data. The overall course grades were collected from the Division Office for the students in the online mathematics classes taught by the online instructor participants. The reliability and validity of grades assigned by these instructors were addressed (J. D. Allen, 2005). Prior to conducting any analyses on the students’ grades, all participating instructors were asked to grade (i.e., to score) a common exami-
nation that the lead author developed, which we called the Common Graded Examination. This Common Graded Examination represented a 40-problem examination that contained both multiple-choice items \((n = 30)\) and free-response items \((n = 10)\). Had there been a statistically significant difference between online mathematics instructors who did use classroom capture software and online mathematics instructors who did not use classroom capture software, the ensuing examination scores would have been used to calibrate the overall numeric course grades for each instructor by using the Common Graded Examination as a covariate. If needed, it was expected that this calibration would address the issue of inconsistent grade assignments among the instructors. In addition, a course syllabus was collected for each online mathematics course that was used in the study. Each course syllabus was examined to determine how the instructor assigned a numeric value for the overall numeric course grade. If an instructor’s grading policy would have differed significantly from the grading policy of other instructors, this issue would have been addressed in the form of follow-up questions during the interview with the aforementioned instructor in the qualitative research phase. At the branch of the community college that was used in this study, online mathematics instructors had the option of assigning homework through an online software program; thus, homework grades assigned to students using the online software program were consistent due to the scoring of the assignments by the online software program.

The second instrument used in the quantitative research phase was the measures that yielded classroom capture software usage data. These measures were determined by the usage statistics provided by the classroom capture software reporting tool. Data (e.g., total number of views, number of unique views, and total minutes viewed) were retrieved from graphical reports generated by the reporting tool.

An a priori power analysis (Cohen, 1988) was conducted using the G*Power 3 software program (Faul, Erdfelder, Lang, & Buchner, 2007). This analysis was used to determine the sample size needed to achieve a desired statistical power given the nominal level of Type I error rate and desired effect size \((\text{Onwuegbuzie} & \text{Daniel}, 2002a\)) in order to obtain a statistically significant (i.e., 5% level) and moderate (i.e., Cohen’s \([1988] d = .5\)) difference between the two groups (i.e., unavailable vs. available classroom capture software; independent samples \(t\) test) with statistical power of .80, the number of student participants in the quantitative phase needed to be at least 102. The quantitative phase involved 1,476 students in 79 online mathematics classes during the 2012-2013 academic year—yielding more than adequate statistical power.

In addition to descriptive statistics, we conducted a series of independent samples \(t\) tests to compare students who were taught an online mathematics course in which CCS was used and their counterparts for whom CCS was not used. A 5% level of statistical significance was used. Effect sizes were reported for all statistically significant findings. Cohen’s (1988) criteria were used to assess the magnitude of the resultant effect sizes and, hence, to assess the practical significance.

**Qualitative Research Phase**

This phase involved a collective case study (Stake, 2005) to examine student and instructor perceptions of the usage of CCS in an online mathematics course. Specifically, the lead author conducted semi-structured interviews with 10 students (Table 1) and six instructors (Table 2). Guest, Bunce, and Johnson (2006) demonstrated that 12 interviews are sufficient to “understand common perceptions and experiences among a group of relatively homogeneous individuals” (p. 79). Further, Guest et al. (2006) demonstrated that six interviews might be “sufficient to enable development of meaningful themes and useful interpretations” (p. 78). Therefore, it was expected that the sample sizes for both the students and instructors would yield data saturation, which occurs when the collection of more data appears to have no additional interpretive worth (Sandelowski, 2008; Saunder, 2008).

For the student interviewees, questions such as the following were asked: (a) What were the benefits and challenges, if any, associated with using classroom capture software in the online mathematics course?; and (b) How would classroom capture software influence your future decisions to enroll in another online mathematics course? The instructor interviewees were asked questions that mirrored the student questions, such as the following: (a) What were the benefits and challenges, if any, associated with incorporating classroom capture software in your online class?; and (b) How would classroom capture software influence your future decisions to teach in another online mathematics course?
QDA Miner Version 5.0.7 (Provalis Research, 2016) was used to code the open-ended responses provided by both sets of interviewees. Two qualitative analyses were performed on the interview data. First, an exploratory analysis was conducted via constant comparison analysis (Glaser, 1965). The interview responses provided by the students were analyzed separately from those provided by the instructors. We underwent Glaser and Strauss’s (1967) three stages of constant comparison analysis: (a) open coding (i.e., the process of identifying, naming, categorizing and describing phenomena found in the text), (b) axial coding (i.e., the process of relating codes [categories and properties] to each other), and (c) selective coding (i.e., the process of choosing one category to be the core category, and relating all other categories to that category). In each analysis (i.e., the analysis of student interview data and the analysis of instructor interview data), the data were coded, and these codes were grouped into categories. The categories then were grouped into themes. The themes that emerged from the student data were compared to the themes that emerged from the instructor data in order to address the extent of similarities between the perceptions of students regarding the effect of classroom capture software on their performance levels and those of their instructors. Second, we conducted a classical content analysis (Berelson, 1952). This analysis focused on how frequently the codes were used in order to determine which concepts were most cited throughout the data. We chunked and coded the data, then counted the frequency of use for each code. The data produced from this analysis were reported using descriptive statistics and/or inferential quantitative procedures (Kelle, 1995).

**Mixed Research Phase**

In the first stage of the mixed research phase, we conducted an exploratory analysis by quantitizing the themes identified via the constant comparison analysis of the students’ responses (Tashakkori & Teddlie, 1998). Quantitizing involved transforming qualitative data to a numerical form (Tashakkori & Teddlie, 1998). When quantitizing, “qualitative ‘themes’ are numerically represented, in scores, scales, or clusters, in order more fully to describe and/or interpret a target phenomenon” (Sandelowski, 2001, p. 231). Thus, quantitizing allowed us to determine the hierarchical structure of the emergent themes (Onwuegbuzie & Teddlie, 2003). In order to determine the prevalence rate of each theme, we computed percentages by placing either a score of “1”—if a student’s response contained a characteristic that was assigned to the particular theme—or a score of “0”—otherwise. This dichotomization yielded an inter-respondent (participant x themes) matrix (Onwuegbuzie, 2003a; Onwuegbuzie & Teddlie, 2003). By calculating the frequency of each theme from the inter-respondent matrices, percentages were computed to determine the prevalence rate of each student theme.

### Table 1. Pseudonyms and Descriptions of Student Participants

<table>
<thead>
<tr>
<th>Student</th>
<th>Age</th>
<th>Ethnicity</th>
<th>Online experience</th>
<th>Total number of mathematics courses taken online</th>
<th>Bachelor’s degree attained?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denise</td>
<td>20</td>
<td>Hispanic</td>
<td>0-24%</td>
<td>7+ classes</td>
<td>No</td>
</tr>
<tr>
<td>George*</td>
<td>50</td>
<td>White</td>
<td>25-49%</td>
<td>7+ classes</td>
<td>Yes</td>
</tr>
<tr>
<td>Grace*</td>
<td>30</td>
<td>White</td>
<td>75%+</td>
<td>4-7 classes</td>
<td>No</td>
</tr>
<tr>
<td>Jos</td>
<td>30</td>
<td>White</td>
<td>25-49%</td>
<td>7+ classes</td>
<td>Yes</td>
</tr>
<tr>
<td>Justine</td>
<td>25</td>
<td>African American</td>
<td>75%+</td>
<td>7+ classes</td>
<td>Yes</td>
</tr>
<tr>
<td>Michelle*</td>
<td>39</td>
<td>White</td>
<td>75%+</td>
<td>1-3 classes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mika</td>
<td>24</td>
<td>White</td>
<td>75%+</td>
<td>4-6 classes</td>
<td>No</td>
</tr>
<tr>
<td>Robert</td>
<td>36</td>
<td>White</td>
<td>50-74%</td>
<td>1-3 classes</td>
<td>Yes</td>
</tr>
<tr>
<td>Robin</td>
<td>22</td>
<td>Hispanic</td>
<td>0-24%</td>
<td>1-3 classes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tabby</td>
<td>20</td>
<td>Middle Eastern</td>
<td>0-24%</td>
<td>1-3 classes</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: *Requested to be interviewed via telephone.

### Table 2. Pseudonyms and Descriptions of Instructor Participants

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Age</th>
<th>Ethnicity</th>
<th>Teaching experience in years</th>
<th>Online teaching experience in years</th>
<th>Number of online courses taught (2012-2013)</th>
<th>Highest degree held</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corie</td>
<td>51</td>
<td>White</td>
<td>29</td>
<td>9</td>
<td>5</td>
<td>Master’s</td>
</tr>
<tr>
<td>Felicity</td>
<td>61</td>
<td>White</td>
<td>24</td>
<td>11</td>
<td>4</td>
<td>Master’s</td>
</tr>
<tr>
<td>Marcie</td>
<td>55</td>
<td>African American</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>Bachelor’s</td>
</tr>
<tr>
<td>Megan</td>
<td>38</td>
<td>White</td>
<td>14</td>
<td>8</td>
<td>9</td>
<td>Master’s</td>
</tr>
<tr>
<td>Samantha</td>
<td>41</td>
<td>White</td>
<td>18</td>
<td>12</td>
<td>8</td>
<td>Master’s</td>
</tr>
<tr>
<td>Sophie</td>
<td>51</td>
<td>White</td>
<td>25</td>
<td>11</td>
<td>6</td>
<td>Master’s</td>
</tr>
</tbody>
</table>
and instructor theme. Further, we conducted correspondence analyses via QDA Miner 5.0.7 (Provalis Research, 2016) using the extracted themes from both the student data and the instructor data.

Research Design

The mixed methods research design was what Leech and Onwuegbuzie (2009) called a fully mixed concurrent dominant status design. Specifically, (a) the quantitative and qualitative approaches were mixed within multiple stages of the research process, namely, the data analysis and data interpretation stages; (b) the quantitative and qualitative data were collected and analyzed concurrently; and (c) the qualitative phase was given more weight.

Results

Quantitative Results

Comparison of Common Graded Examination scores between the two groups of online mathematics instructors. With respect to the Common Graded Examination scores, both the standardized skewness (i.e., skewness coefficient divided by the standard error of skewness = 0.36) and standardized kurtosis (i.e., kurtosis coefficient divided by the standard error of kurtosis = 0.17) coefficients for online mathematics instructors who did use CCS were within the range of normality of -3.00 to 3.00 (Onwuegbuzie & Daniel, 2002b). Similarly, for the online mathematics instructors who did not use CCS (standardized skewness = -0.17; standardized kurtosis = -0.40), the Common Graded Examination scores indicated no serious departure from normality. Thus, a parametric independent samples t test was justified. This independent samples t test revealed no statistically significant difference \( (t[12] = -1.42, p = .182) \) between the online mathematics instructors who did use CCS \((M = 74.25, SD = 6.93)\) and the online mathematics instructors who did not use CCS \((M = 78.91, SD = 5.3)\). Additional parametric independent samples t tests were conducted to compare (a) online credit-level mathematics instructors who did use CCS and online credit-level mathematics instructors who did not use CCS and (b) online developmental-studies mathematics instructors who did use CCS and online developmental-studies mathematics instructors who did not use CCS. These independent samples t test revealed no statistically significant difference \( (t[6] = -0.54, p = .61) \) between online credit-level mathematics instructors who did use CCS \((M = 73.88, SD = 3.57)\) and online credit-level mathematics instructors who did not use CCS \((M = 75.25, SD = 3.59)\). Similarly, no statistically significant difference emerged \( (t[9] = 0.55, p = .08) \) between online developmental-studies mathematics instructors who did use CCS \((M = 74.25, SD = 6.93)\) and online developmental-studies mathematics instructors who did not use CCS \((M = 81.45, SD = 4.54)\). Thus, the difference in the mean scores on the Common Graded Examination for students who completed an online mathematics course with CCS available—regardless of credit-level mathematics or developmental-studies mathematics—and students who completed an online mathematics class without CCS could not be accounted for by a difference in the way that the online mathematics instructors graded. This finding was supported by our observation that the syllabi of all 79 online mathematics courses taught during the academic year under study did not indicate a statistically significant difference in the grading policy between the online mathematics instructors and the other instructors. Because no issue of inconsistent grade assignments among instructors existed, we did not need to calibrate the overall numeric course grades for each instructor by using the Common Graded Examination scores as a covariate.

Comparison of overall numeric course grades between the two groups of online mathematics students. Because the normality assumption was not met for the overall course grades, a series of nonparametric independent samples t tests (i.e., Mann-Whitney U tests) was conducted. The nonparametric independent samples t test revealed a statistically significant difference \( (U = 567,662.50, p < .0001) \) in overall course grade between online mathematics students who used CCS \((M = 68.97, SD = 27.65)\) and online mathematics students who did not use CCS \((M = 62.59, SD = 31.25)\). A small effect size of 0.22 emerged (Cohen, 1988). Thus, the online mathematics students who used CCS, to a small degree, outscored the online mathematics students who did not use CCS by a mean difference of 6.38.

Additional nonparametric independent samples t tests were conducted to compare (a) online credit-level mathematics students who did use CCS and online credit-level mathematics students who did not use CCS and (b) online developmental-studies mathematics students who used CCS and online developmental-studies mathematics students who did not use CCS. The nonparametric independent samples t test revealed no statistically significant difference \( (U = 63,352.00, p = .30) \) between online credit-level mathematics students who did...
use CCS ($M = 75.71, SD = 28.38$) and online credit-level mathematics students who did not use CCS ($M = 75.15, SD = 21.36$). In contrast, the nonparametric independent samples $t$ test revealed a statistically significant difference ($U = 56,272,50, p < .0001$) between online developmental-studies mathematics students who used CCS ($M = 62.15, SD = 30.66$) and online developmental-studies mathematics students who did not use CCS ($M = 50.42, SD = 34.67$). A small-to-moderate effect size of 0.36 emerged (Cohen, 1988). Consequently, the online developmental-studies mathematics students who used CCS, to a small-to-moderate degree, outscored the online developmental-studies mathematics students who did not use CCS by a mean difference of 11.72.

**Comparison of overall numeric course grades between the two groups of online mathematics students who successfully completed the course.** A nonparametric independent samples $t$ test revealed a statistically significant difference ($U = 126,886.00, p = .03$) between online mathematics students who successfully completed the course and did use CCS ($M = 83.06, SD = 11.02$) and online mathematics students who successfully completed the course and did not use CCS ($M = 81.67, SD = 10.12$). A small effect size of 0.13 emerged (Cohen, 1988). Therefore, the online mathematics students who successfully completed the course and did use CCS, to a small degree, outscored the online mathematics students who successfully completed the course and did not have CCS by a mean difference of 1.38.

Additional nonparametric independent samples $t$ tests were conducted to compare (a) online credit-level mathematics students who successfully completed the course and used CCS and online credit-level mathematics students who successfully completed the course and did not use CCS and (b) online developmental-studies mathematics students who successfully completed the course and used CCS and online developmental-studies mathematics students who successfully completed the course and did not use CCS. The nonparametric independent samples $t$ test revealed no statically significant difference ($U = 21,026.00, p = .29$) between online developmental-studies mathematics students who successfully completed the course and used CCS ($M = 83.94, SD = 11.42$) and online developmental-studies mathematics students who successfully completed the course and did not use CCS ($M = 82.25, SD = 9.87$). Contrastingly, a statistically significant difference emerged ($U = 43,687.00, p = .03$) between online credit-level mathematics students who successfully completed the course and used CCS ($M = 81.91, SD = 10.40$) and online credit-level mathematics students who successfully completed the course and did not use CCS ($M = 80.72, SD = 10.47$). A small effect size of 0.16 emerged (Cohen, 1988). Thus, the online credit-level mathematics students who successfully completed the course and used CCS, to a small degree, outscored the online credit-level mathematics students who successfully completed the courses and did not have CCS by a mean difference of 1.69.

**Comparison of dropout rates between the two groups of online mathematics students.** When examining the total number of students enrolled, the percentage of students who withdrew from courses who did have CCS (25.51%) was greater than was the percentage of students who withdrew from courses and who did not have CCS (20.91%). Although at first glance, this finding might seem to be counter-intuitive, we believe that this was due to the fact that students who have access to CCS can visually “see” the material that they do not understand; thus, although not statistically significant ($X^2[1] = 1.47, p = .21$), they have a greater propensity to withdraw from the course. Conversely, students who do not have access to CCS cannot see the material that they do not understand; thus, they continue to have a false sense of hope and remain in the course. Also, when examining the total number of students enrolled, the percentage of students who did not complete the course successfully (i.e., received a grade less than 59.5%) was less in courses that did have CCS (19.39%) than in courses that did not have CCS (25.03%), which, again, was not statistically significant ($X^2[1] = 1.78, p = .18$). Lastly, when examining the total number of completers (i.e., students who received a grade for the course), the percentage of students who successfully completed the course (i.e., received a grade of 59.5% or more) in courses that did have CCS (73.90%) was statistically significantly ($X^2[1] = 4.12, p = .04$) greater than the percentage of students who successfully completed the course in courses that did not have CCS (68.32%). The effect size associated with this statistically significant difference, as measured by Cramer’s $V$, was .06, which represents a small difference. Table 3 provides a comparison of success rates, failure rates, withdrawal rates, and incomplete rates.

**Qualitative Results**

**Student participants.**

**Results of constant comparison analysis.** Using QDA Miner 5.0.7 qualitative software (Provalis Research, 2016), the following six themes were extracted from the 10 student interviewees: (a) inclusiveness, (b) flexibility, (c) future outlook, (d) guidance, (e) elimination of isolation, and (f) challenges. Each of these themes is discussed in what follows.
Table 3. Comparison of Success, Failure, Withdrawal, and Incomplete Rates

<table>
<thead>
<tr>
<th>Category</th>
<th>Courses with CCS</th>
<th>Courses without CCS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All Students</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successfully Complete (Out of Completers)</td>
<td>73.90%</td>
<td>68.32%</td>
</tr>
<tr>
<td>Unsuccessfully Complete (Out of Completers)</td>
<td>26.10%</td>
<td>31.68%</td>
</tr>
<tr>
<td>Successfully Complete (Out of Total Enrolled)</td>
<td>54.90%</td>
<td>53.96%</td>
</tr>
<tr>
<td>Unsuccessfully Complete (Out of Total Enrolled)</td>
<td>19.39%</td>
<td>25.03%</td>
</tr>
<tr>
<td>Incomplete (Out of Total Enrolled)</td>
<td>0.20%</td>
<td>0.10%</td>
</tr>
<tr>
<td>Withdraw (Out of Total Enrolled)</td>
<td>25.51%</td>
<td>20.91%</td>
</tr>
<tr>
<td><strong>Credit-Level Students</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successfully Complete (Out of Completers)</td>
<td>83.33%</td>
<td>86.68%</td>
</tr>
<tr>
<td>Unsuccessfully Complete (Out of Completers)</td>
<td>16.67%</td>
<td>13.32%</td>
</tr>
<tr>
<td>Successfully Complete (Out of Total Enrolled)</td>
<td>59.80%</td>
<td>67.44%</td>
</tr>
<tr>
<td>Unsuccessfully Complete (Out of Total Enrolled)</td>
<td>11.96%</td>
<td>10.36%</td>
</tr>
<tr>
<td>Incomplete (Out of Total Enrolled)</td>
<td>0%</td>
<td>0.21%</td>
</tr>
<tr>
<td>Withdraw (Out of Total Enrolled)</td>
<td>28.24%</td>
<td>21.99%</td>
</tr>
<tr>
<td><strong>Developmental-Studies Students</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successfully Complete (Out of Completers)</td>
<td>64.36%</td>
<td>50.53%</td>
</tr>
<tr>
<td>Unsuccessfully Complete (Out of Completers)</td>
<td>35.64%</td>
<td>49.47%</td>
</tr>
<tr>
<td>Successfully Complete (Out of Total Enrolled)</td>
<td>49.57%</td>
<td>40.51%</td>
</tr>
<tr>
<td>Unsuccessfully Complete (Out of Total Enrolled)</td>
<td>27.45%</td>
<td>39.66%</td>
</tr>
<tr>
<td>Incomplete (Out of Total Enrolled)</td>
<td>0.43%</td>
<td>0%</td>
</tr>
<tr>
<td>Withdraw (Out of Total Enrolled)</td>
<td>22.55%</td>
<td>19.83%</td>
</tr>
</tbody>
</table>

Note: CCS = Classroom Capture Software.

Theme 1, **Inclusiveness**, consisted of codes that helped the students to describe benefits associated with the concept of inclusiveness. The students expressed enjoyment of feeling included in the online class, as if they were attending class. Jos captured this feeling:

I would say that the biggest thing about CCS was that I felt I was still getting that classroom environment, which is one of the reasons why I liked being a student in the college atmosphere. A lot of times when you take an online class, you are very isolated. It’s you and yourself. You don’t get a lot of interaction with your peers or your instructor. So having the videos allowed me to still feel like part of the process.

CCS helped to provide Jos with the feeling of being included. Some students also mentioned the added benefit of being able to take notes while they watched the videos. Tabby stated:

I just wrote down my own notes as she was writing. I just followed along with her, as she did each problem, step-by-step. I wrote everything down as she was going through it. None of my other only classes had that software. You would just have to read the book, by yourself, kind of like s teaching yourself type of thing.

The second theme extracted was **Flexibility**. Codes related to this theme included the ability to start and to stop the videos. Students also mentioned how CCS provided them with the ability to learn at their own pace. Both of these concepts were captured in Mika’s comment:

I liked the videos because if I was going along and I came to a part where I didn’t understand how she got to a specific number, I could pause it, back it up a little bit, and rework it, especially if I had reached the wrong answer. Doing that in a classroom setting would be more difficult. When you are doing the software, you are able to move at your own pace and learn the material the best way possible for you.

**Future Outlook** was the third theme extracted from the student data. Students discussed having fear and doubts about enrolling in an online mathematics course. Few students knew about CCS prior to enrolling in the course in the study. After her exposure to CCS, Denise stated:

A lot of people see online [math] and they are like “I just don’t have the mental discipline to do that – to sit there and do this online class, I will probably blow it off.” But in reality, I think it is easier to do an online math class. You can do it whenever you want. So, I think people should share their experiences with CCS, and just let people know that it is an op-
tion. I think it made our class experience more memorable than all the other ones. It was one of my first online classes. Since then, I’ve taken a lot more. It was definitely my favorite one, and it kept me taking online classes. CCS made it interesting and better than the other ones.

Mika shared advice that she would give to a future online student:

I would tell all future online students to throw all of their expectations that they had before on how online classes are run, out the window. Because I absolutely believed that it would be set up like my previous home school class. Or that I would have no interaction. I would be stuck behind a computer screen. And I would just have to read out of my textbook. And that’s it. That’s the only thing I would get. And it’s not like that. It’s not that much different from being in a regular classroom. In fact, in some ways, the benefits of the online classroom outweigh being in a regular classroom.

The fourth extracted theme was Guidance. Students shared examples of how CCS helped explain solutions to problems. Mika shared comments that she told her friends who were thinking about taking an online mathematics class:

Don’t dwell on “If I take an online class, then I might fail it. I’m not going to be good at an online class. I need to be able to ask questions. I’m not going to see anybody work the problems.” That’s not how it is. All my expectations before I went in were blown out the window after I took this class online.

Other students, like Michelle, compared online mathematics courses to other online courses:

Most online classes will present their Powe rPoints, and you can just read through it yourself. But when you are talking about math, you are talking about steps that are involved. So, I was extremely happy to see how that [CCS] technology was used. And I could hear the lecture, and on the screen, I could literally see line-by-line, her writing, as she was talking.

These comments about how CCS provided a way to overcome the challenges of taking mathematics in an online format (i.e., it enabled the instructor to demonstrate step-by-step explanations) helped the theme Guidance to emerge.

The fifth theme to emerge was Elimination of Isolation. The videos not only eliminated the necessity of self-teaching the material, but they also removed the feeling of being all alone in the online course. Statements such as “I feed off questions and responses. If I didn’t have those videos, I would feel isolated. I would feel like it was just me. If I got confused on something, I wouldn’t even know where to start,” helped this theme to emerge.

The last theme to emerge from the student data was Challenges. When asked about what challenges she experienced when using CCS, Mika responded:

You had to make sure that you have the necessary stuff on your computer to run the videos, like the plugins and stuff like that. The only downside that I would even think was there was just if you had a question—you’re not in a classroom, so you can’t just raise your hand and ask when you don’t understand. You have to email and then wait for a response.

Jos replied to the same question, “Since it was an online class, if I didn’t have access to the Internet, then I was not able to watch the videos.” Because several students made reference to hardware and/or software issues, the theme Challenges emerged.

Results of classical content analysis. After the six themes had been identified, a classical content analysis was conducted in order to count the codes that emerged within each theme that was extracted from the constant comparison analysis. The organization of these codes into themes can be viewed in Table 4. Overall, as can be seen from Table 4, the codes associated with the theme inclusiveness occurred most frequently (28.34%), followed by codes associated with the theme flexibility (23.48%). The codes associated with the theme challenges were the least prevalent, with a prevalence rate of 4.05%.

Table 5 displays the frequency for the prominent code within each theme that stemmed from the classical content analysis. Based on these coding frequencies (see Table 5), it can be seen that the student participants placed the most emphasis on the codes provided feeling of being in a classroom—representing Theme 1, followed by provided ability to start/stop/pause/rewind video—representing Theme 2, and then followed by provided step-by-step explanations and solutions to problems—representing Theme 3. Within the 10 transcribed student interviews, the 19 emergent codes were assigned to 247 different chunks of data.
Table 4. Constant Comparison Analysis and Classical Content Analysis on Student Data: Themes, Codes, and Frequencies

<table>
<thead>
<tr>
<th>Theme</th>
<th>Codes Used</th>
<th>Frequency of Codes within Theme</th>
<th>% of Codes within Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclusiveness</td>
<td>provided feeling of being in a classroom, provided experience of a classroom lecture, provided the ability to take notes, provided the ability to hear questions asked by other students, provided quick responses to questions</td>
<td>70</td>
<td>28.34</td>
</tr>
<tr>
<td>Flexibility</td>
<td>provided ability to start/stop/pause/rewind video, provided ability to learn at own pace, provided an environment free of distractions</td>
<td>58</td>
<td>23.48</td>
</tr>
<tr>
<td>Future Outlook</td>
<td>provided a new perspective of online math classes, provided a feeling of confidence, provided desire to have CCS in future courses, encouraged exposure to other technology</td>
<td>54</td>
<td>21.86</td>
</tr>
<tr>
<td>Guidance</td>
<td>provided step-by-step explanations and solutions to problems, provided personal touch of instructor, provided a way to overcome challenges of online math</td>
<td>39</td>
<td>15.79</td>
</tr>
<tr>
<td>Elimination of Isolation</td>
<td>eliminated the feeling of being alone, eliminated to feeling of self-teaching the material</td>
<td>16</td>
<td>6.48</td>
</tr>
<tr>
<td>Challenges</td>
<td>challenge associated with using technology, challenge of not asking questions in real time</td>
<td>10</td>
<td>4.05</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>247</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Table 5. Classical Content Analysis on Student Data: Prominent Codes and Frequencies

<table>
<thead>
<tr>
<th>Theme</th>
<th>Most Prominent Code in Theme</th>
<th>Frequency of Code</th>
<th>% Code Used Within Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclusiveness</td>
<td>Provided feeling of being in a classroom</td>
<td>35</td>
<td>50.00</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Provided ability to start/stop/pause/rewind video</td>
<td>27</td>
<td>46.55</td>
</tr>
<tr>
<td>Future Outlook</td>
<td>Encouraged exposure to other technology</td>
<td>18</td>
<td>33.33</td>
</tr>
<tr>
<td>Guidance</td>
<td>Provided step-by-step explanations and solutions to problems</td>
<td>24</td>
<td>61.54</td>
</tr>
<tr>
<td>Elimination of Isolation</td>
<td>Eliminated feeling of self-teaching the material</td>
<td>14</td>
<td>87.50</td>
</tr>
<tr>
<td>Challenges</td>
<td>Challenge associated with using technology</td>
<td>8</td>
<td>80.00</td>
</tr>
</tbody>
</table>

Note: Obtained using QDA Miner Version 5.0.7.

Instructor participants.

Results of constant comparison analysis. Upon completion of the instructor interviews, a constant comparison analysis was performed on the data. This analysis involved reading through each instructor transcript and identifying any significant ideas communicated by the participants. The instructor transcripts were significantly longer—and consequently more dense with data—than were the student transcripts. In fact, the instructor interviews \( (M = 40.86, SD = 10.30) \), ranging from 31 to 55 minutes, were statistically significantly longer \( (t[14] = 5.30, p < .0001) \) than were the student interviews \( (M = 19.50, SD = 5.97) \), which ranged from 13 to 33 minutes. Initially, there were 48 codes assigned to the instructor data. However, after the multiple rounds of coding, the analysis revealed 28 codes that then were organized into the following five major themes: (a) Theme 1: Benefits for Students, (b) Theme 2: Challenges, (c) Theme 3: Benefits for Instructors, (d) Theme 4: Online Teaching, and (e) Theme 5: Future Students.

Theme 1, Benefits for Students, consisted of codes that instructors used to describe benefits for students that were associated with the use of CCS in their online mathematics courses. Several codes in this theme had previously emerged as codes during the constant comparison analysis of the student data. In other words, benefits that students observed also were observed as benefits for the students by the instructors. For example, both students and instructors listed \( \text{provides ability to start/stop/pause/rewind video} \) and \( \text{provides classroom experience} \) as benefits of CCS. However, two codes within the Benefits for Students theme of the instructor data were extracted as themes for the students’ data, namely, \( \text{provides flexibility} \) and \( \text{decreases feeling of isolation} \).

The second theme, Challenges, emerged from codes associated with five different challenges faced by instructors who used CCS. Before the software can be used, the software must be purchased. Although some software is less expensive than are other software, money is still required for the purchase. Another code that
contributed to the Challenge theme was time related—time to create the videos and time to upload the videos. Samantha captured her frustration:

From the front end, the biggest challenge of getting the videos into the online classroom is actually making the videos. Making the videos is very time consuming, even if you don’t edit them. You still have to go to the classroom, get everything set up, and make sure everything is working. Inevitably, you are going to get a video that doesn’t work right, and you are going to have to re-do it. Then, you have to produce the video before you can upload it to the LMS [learning management system].

Benefits for Instructors was the third theme that emerged. Several instructors explained that CCS provided them with the opportunity to bond with coworkers (e.g., attending professional development to learn about CCS, sharing of videos). Megan stated, “I didn’t really mind sharing, because I am one of those people—I like to work together with everyone. We are a department. We work together. It’s better for the students.” Another benefit seen from the instructors’ perspectives was the flexibility provided by CCS (i.e., they could create videos from multiple locations to use in their online courses). Students made comments about the ability to view step-by-step explanations, and the instructors made comments about the ability to demonstrate step-by-step instructions, as exemplified by the following comment: “I use my working notes—there is some explanations, then we do an example or two. Then some more explanation. Then we do an example or two.” Sophie explained how she knew that the students watched her explanations of how to solve problems: “When I grade their exams, I can see my organization, the way I write in the recordings. I can see it line-by-line, all the way through the problem.”

The fourth theme, Online Teaching, included codes such as how CCS reduced the difficulties unique to math online, how CCS transformed explanations from written to visual, and how CCS alters preferences to teach online. Several instructors explained how mathematics differed from other disciplines in the online environment and how CCS had changed the online mathematics environment. For example, Corie stated the following:

It is very different in an online math class versus an online history class. In history, they can read the chapter, take a test, and they are done. In math, you can’t do that. I always have to remind them. At the first of the semester, I send out an email that says, “You do realize that you are going to have to teach yourself the math?” And without classroom capture, they had to go Google, they had to go search, they had to go find.

The fifth and last theme was Future Students. This theme emerged from statements about how CCS applied to future students, rather than to current students. Some instructors commented that students contact them—prior to registering for the class—in order to confirm that videos will be provided. Sophie commented, “Your online class has to be good enough for them to want to take it, to feel like they can pass it.”

Results of classical content analysis. After the five themes had been identified, a classical content analysis was conducted in order to count the codes that emerged within each theme that was extracted from the constant comparison analysis. A list of the five instructor themes and their prevalence rates can be viewed in Table 6. The theme Benefits for Students was the most prevalent (37.84%), followed by the themes Challenges (23.87%) and Benefits for Instructors (18.17%). The most prevalent theme for Felicity was Challenges; however, the most prevalent theme for the remaining five instructors was Benefits for Students. Thus, all instructors—except Felicity—discussed the benefits CCS provided to students more than any other theme. Lastly, the theme Future Students was the least prevalent, with a prevalence rate of 7.66%.

Based on coding frequencies, the instructor participants placed the most emphasis on the codes increases confidence - makes student feel more successful—representing Theme 1 and cost of product and other necessary technology products—representing Theme 2. The 28 codes were assigned to 666 different chunks of data within the six transcribed instructor interviews. Overall, the codes associated with the themes benefits for students and challenges occurred most frequently, as compared to codes associated with the remaining three themes. Table 7 displays the frequency for the most prominent code within each theme.

Mixed Research Results

Results of correspondence analysis of students. Figure 1 illustrates the 10 student participants mapped, via a correspondence analysis, onto the space that displays the six emergent student themes (i.e., Theme 1: Inclusiveness, Theme 2: Flexibility, Theme 3: Future Outlook, Theme 4: Guidance, Theme 5: Elimination of Isolation, and Theme 6: Challenges). This figure displays how the student participants are related to each other with regard to these six student themes.
### Table 6. Constant Comparison Analysis and Classical Content Analysis on Instructor Data: Themes, Codes, and Frequencies

<table>
<thead>
<tr>
<th>Theme</th>
<th>Codes Used</th>
<th>Frequency of Code within Theme</th>
<th>% of Code within Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits to Students</td>
<td>increases confidence – makes student feel more successful, provides classroom experience, provides alternative explanations for different learning styles, shows instructor cares and explains expectations, testing environment similar to face-to-face (f2f) classroom, provides flexibility, provides ability to start/stop/pause/rewind video, provides sense of belonging, decreases feeling of isolation, decrease study time</td>
<td>252</td>
<td>37.84</td>
</tr>
<tr>
<td>Challenges</td>
<td>cost of product and other necessary technology products, time required to create/post videos, hardware/software issues – damaged files, motivating students to watch videos, abiding by laws governing usage</td>
<td>159</td>
<td>23.87</td>
</tr>
<tr>
<td>Benefits to Instructors</td>
<td>provides opportunity to bond with coworkers, provides ability to lecture, provides flexibility to teach from any location, provides time to focus on course improvement, provides ability to demonstrate step-by-step explanations, provides ability to give immediate feedback, focus on student needs/questions</td>
<td>121</td>
<td>18.17</td>
</tr>
<tr>
<td>Online Teaching</td>
<td>reduces difficulties unique to math online, transformed explanations from written to visual, alters preferences to teach online, increases accountability of student</td>
<td>83</td>
<td>12.46</td>
</tr>
<tr>
<td>Future Students</td>
<td>increases enrollment, changes expectations of online courses</td>
<td>51</td>
<td>7.66</td>
</tr>
</tbody>
</table>

### Table 7. Classical Content Analysis on Instructor Data: Prominent Codes and Frequencies

<table>
<thead>
<tr>
<th>Theme</th>
<th>Prominent Code</th>
<th>Frequency of Code within Theme</th>
<th>% of Code within Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits for Students</td>
<td>Increases confidence – makes student feel more successful</td>
<td>50</td>
<td>19.84</td>
</tr>
<tr>
<td>Challenges</td>
<td>Cost of product and other necessary technology products</td>
<td>53</td>
<td>33.33</td>
</tr>
<tr>
<td>Benefits for Instructors</td>
<td>Provides opportunity to bond with coworkers</td>
<td>36</td>
<td>29.75</td>
</tr>
<tr>
<td>Online Teaching</td>
<td>Reduces difficulties unique to math online</td>
<td>28</td>
<td>33.73</td>
</tr>
<tr>
<td>Future Students</td>
<td>Increases enrollment</td>
<td>39</td>
<td>76.47</td>
</tr>
</tbody>
</table>

Note: Obtained using QDA Miner Version 5.0.7.

Recall that, in order to determine the prevalence rate of each effect theme, frequencies were computed by placing either a score of “1” (if a student’s response contained a characteristic that was assigned to the particular theme) or a score of “0” (otherwise). This dichotomization led to the formation of an inter-respondent matrix of student themes (i.e., student x theme matrix) (Onwuegbuzie, 2003a; Onwuegbuzie & Teddlie, 2003). The inter-respondent matrix (student x themes) is provided in Table 8. The prevalence rate of each student is located in the last column. Michelle and Mika were the two most prevalent students, with prevalence rates of 16.19% and 12.96%, respectively.

**Meta-Theme 1: Full-time employed.** The first observed meta-theme on the correspondence plot (Figure 1), **Full-time Employed**, contained the isolated student who had the highest prevalence rate, Michelle. During the time of the study, Michelle was a newly returning (i.e., nontraditional) student with a pre-teenage son at home. She was the only student who was enrolled in class while being employed full-time. She discussed her obligations in detail:

I work at least 40+ hours per week. I have a family, with at this point now, a 16-year-old son. He was younger when I first started this journey. So, I still needed to be able to attend his sporting events, and still be a productive member of my family. To fit those things in, I had to stay up late ‘til midnight doing class work.

She emphasized how the use of CCS helped to provide flexibility with outside demands that she faced in life. She also spoke about how CCS allowed her to learn at her own pace:
There wasn’t anything that was going to deter me from pausing, or rewinding, and refocusing on what the math was. The technology provided me with an actual lecture, and a visual, and the auditory, that I could see and hear at the same time ... if there was a concept or a point that I was having a hard time wrapping my head around, I could pause it, and rewind it, and go back to it, until I got it.

*Figure 1. Correspondence plot of students.*
Although other students discussed the concept of distractions, Michelle was the only student to discuss CCS helping to eliminate the distractions:

With CCS, I didn’t have the other classroom distractions that usually typically go on in the classroom setting, people messing with their phones, people having private conversations in the classroom while you are trying to focus on what you are doing, loud distractive noises—someone eating and munching on chips, and when you’re frustrated, the slightest little noises can just get under your skin. So, I enjoyed being able to be in control of that and staying in my bedroom—it is the only quiet place in my home. It’s a quiet place where I have nothing else that could distract me from what I am trying to focus on.

These statements helped to explain why Michelle was contained in the Full-time Employed meta-theme. **Meta-Theme 2: Home-schooled.** The second observed meta-theme on the correspondence plot contained the isolated student Mika. In high school, Mika did not attend a brick-and-mortar school—she was home-schooled. When she spoke about her experience of homeschool mathematics, she stressed that there was no interaction with an instructor and no guidance on how to solve the mathematical problems. During her home school experience, she was unable to ask questions to her high school instructor. She related this home school-based struggle with the challenge of not being able to ask questions to her online mathematics instructor in real time. She stated:

I actually did homeschooling. I just got a booklet, and it resulted in me having to try and find videos to find out how to do the problem. I had no interaction. It was just a little small booklet that they sent. That’s the only thing I would get. I wasn’t doing all that well when I went through high school. I have done much better in college than I did in high school, but it has still been hard. I think it is a direct result of being able to have that software readily available, being able to watch how the problems are worked out. I benefited a lot more from those videos then I did through any textbook.

When watching the videos in the online mathematics class, Mika admitted that she had enjoyed being able to take notes and having guidance to work through the problems. Mika acknowledged the challenges that she faced as a college student that resulted from being required to self-teach mathematical concepts as a home-schooled high school student. These statements helped to explain why Mika was closest in proximity to the Challenges theme. Additionally, Michelle’s statements helped to explain why Michelle was contained in the Home-Schooled meta-theme. **Meta-Theme 3: Pre-transient.** The third observed meta-theme on the correspondence plot, Pre-transient, contained the isolated student Robin. During the interview, Robin disclosed that she had completed an online mathematics course at a four-year institution prior to the course in the study:

The class I took through [another institution], it was basically a self-taught class. It was also self-paced. That was a very terrible idea. All the professor would basically do was email us, “On page 20, you need to do questions 1-30, and then turn it in.” So, there was no actual professor teaching you how to do it. So, I had to basically get somebody else to tell me how to do it. And then try to do it myself. So, that class was very difficult. I remember how terrible it was.
When speaking about the class in the study, Robin expressed the satisfaction of the class not being different from her first online mathematics class at her previous institution:

I think it was very similar to just going to a class, because you’re more or so just watching the professor even when you are in a class—same thing of watching it in the comfort of your own home. It was a very different experience.

Additionally, Robin was the only student to discuss attending a four-year institution prior to taking classes at the institution in the study. All other students indicated that the two-year institution in the study was the first institution of higher education that they had attended. These statements helped to explain why Robin was contained in the Pre-transient meta-theme.

*Meta-Theme 4: Software seeker for continued coursework in mathematics.* The fourth meta-theme, Software Seeker for Continued Coursework in Mathematics, contained Jos, George, Justine, and Tabby. They were located near the Future Outlook theme. After completing the mathematics course in the study, three of these students (i.e., Jos, George, and Justine) completed more than seven additional online mathematics courses. As a returning student seeking a new career field, Robert explained:

I was a 45-year-old freshman when I went back to school. It had been a long time since I had taken any kind of math class. So I went through all of it. And I think it [CCS] really helped.

Robert disclosed that soon after he had completed the course in the study, he transferred to a four-year institution and completed a bachelor’s degree in accounting. When reflecting back on his educational experience, he commented:

I think it [CCS] helped a lot. If I were to rewind and do it all over again, if there was a way to—you know, when you are signing up for class—if there was a little asterisk by one that says “This one has classroom videos that you can watch,” that would probably help me choose that class over a class that didn’t offer it.

Robert completed more than 75% of the coursework for his bachelor’s degree online, and he attributed his early exposure to CCS with providing a new perspective of how to view returning to school and taking online courses.

Similar to Robert, both Jos and Justine continued taking additional mathematics courses after the course in the study. During the interview, Justine revealed that she would be completing her bachelor’s degree with a minor in mathematics at the end of the next semester. Jos revealed that following the completion of her bachelor’s degree in mathematics and her master’s degree in education, she began teaching eighth-grade mathematics. During her interview, she shared a unique experience with me: Because of her exposure to CCS in her online mathematics course, she was able to explain to the administrators at her school how CCS might benefit her homebound students in her class. Shortly after providing this explanation, the school district purchased CCS for her to use with the homebound student. These statements helped to explain why Jos, Justine, George, and Tabby were closest in proximity to the Future Outlook theme—after their experience with CCS, they had gained a different perspective of online mathematics courses. In fact, Jos, Justine, and George sought degrees earning mathematics as a major or minor.

However, one student (i.e., Tabby) revealed that the online mathematics course in the study fulfilled the mathematics requirement for her undergraduate coursework. Tabby stated:

I personally don’t like to take math courses online because I like to be with a physical professor, because I am not good at math. So it’s easier for me to be in an actual class. It was beneficial to have the video of a professor doing the problems in this class. But for me, personally, I want to take math classes in an actual classroom.

When asked what format she would prefer if she were required to take an additional mathematics course, Tabby confessed:

I would try to find a class that had that software, just so I can like see the professor doing it. It is easier for me to understand when I am looking at the professor instead of like having worksheets and the answer is just there. I need to see it step-by-step, to see how you got to the answer. And if I had to take another math class, I would definitely want the software.

These statements helped to explain why Tabby was located in the Software Seeker for Continued Coursework in Mathematics meta-theme encompassing the Future Outlook theme—if she were required to take an-
other mathematics course, she would seek another course that offered CCS because of her experience with CCS.

**Meta-Theme 5: Nontraditional student.** Both the Future Outlook theme and the Flexibility theme were contained in the fifth meta-theme called Nontraditional Student. All students in this meta-theme (i.e., George, Grace, and Michelle) were nontraditional students who enrolled in online developmental-studies mathematics courses. The remaining seven students who were not in this meta-theme (i.e., Robin, Jos, Justine, Tabby, Denise, Robert, and Mika) were enrolled in online credit-level mathematics courses. Additionally, George and Michelle were the oldest student participants. As nontraditional students, they all acknowledged the confidence that CCS gave to them as they returned to school. George stated, “If I didn’t know something, I knew there was a video on there [LMS] that I could watch over and over again until I got it.” Additionally, Michelle explained how CCS helped to remove her fear of mathematics in the online environment:

> I was extremely frightful of taking it online. I had a lot of anxiety about it. I was really worried because I know I can struggle with math. The videos were not part of your grade, but it would be a huge waste of my time to try to figure out how to do that math without watching the lecture. I essentially would have had to go out and teach myself. The teacher is giving you what you need, the knowledge you need to do the assignments.

Although Grace was not as old as were George and Michelle, she was still a nontraditional student. Like Michelle, Grace admitted to struggling in mathematics and explained how CCS helped her to gain confidence:

> Being able to stop and go back and rewind and watch the videos over and over again—that kind of thing was very beneficial because sometimes I am a little slow. It takes going over things a couple of times before I get it.

All three nontraditional students obtained their educational goals: George earned a bachelor’s degree in accounting; Michelle earned a bachelor’s degree in nursing; and Grace earned her associate’s degree. Their comments about how CCS helped to improve their confidence, how CCS provided them with the ability to stop and to rewind the lectures, and how CCS provided them with the ability to earn at their own pace helped to explain why these students were grouped in the Nontraditional Student meta-theme.

**Results of an exploratory analysis to determine the prevalence rate of each instructor theme.** Five instructors indicated nine or more years of teaching experience at the beginning of the 2012-2013 academic year. At that time, Marcie was the only instructor who had minimal teaching experience—it was only her third year of teaching. Although four instructors were seasoned teachers, they did not have the same length of teaching experience in the online environment. The instructor with the most online teaching experience indicated only eight years of online teaching experience at the time of the study. It is important to know that most brands of classroom capture software became available for use in the late 2000s (e.g., Panopto in 2007, Camtasia in 2009, EduCreations in 2010). This meant that at the time of the study, not only were the instructor participants relatively inexperienced teaching in this online environment, but also they had limited experience using classroom capture software. Because the data collection occurred more than four years after the academic year of study, the instructors were able to provide substantially more information about CCS than they would have been able to provide at the end of the academic year of study. Further, because the online instructors had continued to use CCS, they were able to share how their use of CCS has evolved during the last four years. Also, due to the length of time that they had used CCS and the feedback that they had received from students, the instructors provided insight about the benefits and challenges from both the instructor and the student perspectives. The next five sections provide results pertaining to the prevalence rate of each of the five instructor themes, namely: (a) Theme 1: benefits for students, (b) Theme 2: challenges, (c) Theme 3: benefits for instructors, (d) Theme 4: online teaching, and (e) Theme 5: future students.

**Theme 1: Benefits for students.** The Benefits for Students theme had a prevalence rate of 37.84%. Most instructors spoke with ease about the benefits that they perceived CCS provided for the students. Data from Corie, Marcie, Megan, Samantha, and Sophie provided data in support of codes within the Benefits for students theme more than codes within any other theme. Felicity was the only instructor who made statements that were coded under the Challenges theme more often than codes under any other theme.

The second most prevalent code in the Benefits for Students theme was *provides classroom experience*, with a prevalence rate of 17.86%. Instructors stated that the videos allowed the online student to “be in the classroom” while sitting at home. Felicity shared her thoughts, “I think online students watching the video, who see me interacting with a student, [it] gives them more of a feel of the traditional classroom.” When asked if they edited the recordings prior to posting them in the online classroom, some of the instructors laughed and sarcastically asked where to find the time needed in order to edit the videos. Sophie, however, shared a different
philosophy, “I don’t want to edit it, I want it to feel alive, you know. If I mess up or if a student calls me on something, and we cut up about it, I want them to hear it.” Sophie truly wanted her online students to experience the environment of her traditional classroom.

Theme 2: Challenges. With a prevalence rate of 23.87%, the Challenges theme encompassed codes about challenges faced by instructors both with using CCS and with having CCS available to students. The biggest perceived challenge faced by the instructors using CCS was the costs associated with purchasing not only the CCS product, but also other technological products that are associated with using CCS. The second most prevalent code within the Challenges theme was time required to create/post videos. Samantha voiced her frustration, “Making those videos is very time-consuming, and I don’t even edit them.” With respect to building the online course in a Learning Management System, Corie complained, “To put together a class now online, is not near as easy as just putting up my resources, and being done. With the videos, there’s much more now that has to happen on my end.” One instructor explained that if she wanted to record a lecture in the classroom, she had to arrive in the classroom early to set up her computer and get the software program ready to record. After the class ended, she had to produce the video (i.e., convert the video into an mp4 file) and upload the video into the LMS. Three instructors also mentioned the additional time required when converting their lecture notes into Portable Document Format (i.e., PDF) files and uploading notes into the LMS.

Because the use of a computer was required in all the online mathematics courses, the instructors stated that they expected students to have issues related to hardware and software. However, using CCS yielded additional challenges—to both students and instructors. All instructors who created their own videos mentioned that, on occasion, video files became damaged (e.g., the audio would no longer sync with the video, or the audio was no longer heard). When this situation occurred, the instructors stated that they received immediate feedback from students. Megan explained, “I get emails from students because they are freaking out—they can’t open a particular video.” The students relied so heavily on the videos that they came to expect the videos to be posted. Corie added, “If I don’t have a video that’s working, or a video that’s posting correctly, or I just forgot to put one up there. They let me know. And they let me know quickly.” Lastly, the instructors voiced concerns about the challenges that they faced with respect to the code how to motivate the students to watch videos. This code had a prevalence rate of 16.35%, and it was discussed by four instructors.

Theme 3: Benefits for instructors. The prevalence rate for the Benefits for Instructors theme (18.17%) was slightly less than was the prevalence rate for the Challenges theme (23.87%). Instructors placed more emphasis on challenges than on perceived benefits for themselves. The code that emerged as being the most prevalent within the Benefits for Instructors theme was provides opportunity to bond with coworkers, with a prevalence rate of 29.75%. All six instructors mentioned how CCS promoted comradery and unity among members of the mathematics department.

The second most prevalent code within the Benefits for Instructors theme was provides ability to lecture. Samantha explained how she recorded her face-to-face lectures in the classroom. Instead of writing on the chalk board, she displayed the screen of her tablet onto the screen at the front of the classroom. She spoke about the different features that she used on her tablet while making the videos:

I have different colored pens, and can use a different thickness with each color … I can use the snipping tool, grab a graph, copy it into the Journal file, and write stuff next to and on the graph … or I can pull up the Virtual TI—a virtual calculator that looks just like their calculator—and show them what buttons to push step-by-step. And all of this gets recorded for students to watch whenever they want.

Theme 4: Online teaching. With a prevalence rate of only 12.46%, the Online Teaching theme encompassed beliefs and feelings that instructors associated between CCS and online teaching. The most prevalent code within this theme was reduces difficulties unique to online math, with a prevalence rate of 33.73%. The instructors were asked to share how teaching mathematics in an online environment differed from teaching mathematics in a traditional classroom. Corie stressed that her expectations remained the same, regardless of the format: “My online class has the same tests, they have the same homework, they have the same everything as my face-to-face class. Exactly the same, I don’t do anything different.” When attempting to explain other known differences between mathematics and other disciplines, most instructors shared similar thoughts as did Corie: “In history, they can read the chapter, take a test, and they are done. In math, they can’t do that. They can’t read math and learn math, very few students can do that. They have to see the math.”

Although the code alters preferences to teach online was the third most prevalent code within the Online Teaching theme, I believed it was the most powerful of all instructor codes. Instructors spoke about their teaching experiences, in both the traditional and online environments. Some instructors reminisced about
teaching prior to CCS, and discussed how CCS changed their perspectives of online mathematics. During her interview, Sophie radiated with passion about using CCS as she spoke:

I guess I never realized, until talking with you, that I’ve never taught a class online without recordings. I don’t think I would teach online if there was no capture. In fact, I wouldn’t. That’s the only reason I started teaching online. I’ve never taught a math class online without recordings in it. I just can’t imagine ever doing that.

Corie displayed the same kind of passion for CCS: “I wouldn’t teach another online course without using classroom capture software. It’s just too important a part of the class now.” In recognizing what an important part technology plays in the online environment, Felicity took it one step further: “It’s not just making the content work with the technology anymore. It’s making the content better with the technology.”

**Theme 5: Future students.** The least prevalent instructor theme was the Future Students theme, with a prevalence rate of 7.66%. This theme contained only two codes: *increase enrollment* and *changes expectations of online courses*. All six instructors provided comments about both codes within this theme. Corie provided the most information about how CCS could increase enrollment:

There are several initiatives going on at our school. There is an online task force that’s looking at how to make our online classes stand out, if you will, from others. So, everybody can offer everything online—that’s the way of education now. But what makes our online classes stand out? I think what does make our stand out, particularly our math classes, is this classroom capture software. That really makes our classes different. We get students from all over the area.

The second, and last, code in the Future Students theme was *changes expectations of online courses*, with a prevalence rate of 23.53%. Sophie commented, “I think that most students at this point expect videos. Maybe I’m wrong. Especially in the upper-level math classes, I think they expect it.”

**Results of correspondence analysis of instructors.** Figure 2 illustrates the instructor participants mapped, via correspondence analysis, onto the space that displays the five emergent instructor themes (i.e., Theme 1: Administration Viewpoint, Theme 2: Challenges, Theme 3: Benefits for Instructors, Theme 4: Online Teaching, and Theme 5: Future Students). This figure displays how the instructor participants are related to each other with regard to these five themes.

The inter-respondent matrix (instructor x themes) is provided in Table 9. The prevalence rate of each instructor is located in the last column. The two instructors who generated the most themes were Corie and Megan—with prevalence rates 28.23% and 18.77%, respectively. The length of the instructor interview had no influence on the prevalence rate of the instructor. Corie’s interview was the longest in duration, whereas Megan’s interview was the shortest in duration.

**Meta-Theme 1: Administrative department chair.** Administration Viewpoint was the first observed meta-theme on the correspondence plot of instructors, which contained only Samantha. During the interview, Samantha revealed that she served in a dual role at the institution—both as a teaching faculty member and as an administrative department chair. Part of Samantha’s job responsibility was to build the course schedule for the mathematics department each semester. Aware of the trend of increasing enrollment in online courses, Samantha stated:

Our department does place a lot of value on the videos. We are always thinking: What can make our classes stand out? We are geographically landlocked, so we cannot incorporate any additional school districts to increase our enrollment. Our budget is tied to enrollment growth. Thankfully, our online enrollment has increased significantly.

Also, she indicated that the institution was developing a link called “Meet Your Online Professor” that would be placed on the institution’s webpage. The instructors had been asked to record small videos introducing who they were, telling the discipline and courses that they taught, and explaining what made their online courses unique. Samantha’s job responsibilities and her comments about how CCS was being used to help recruit future students helped to explain why she was located as the only instructor in the Administrative Department Chair meta-theme.

**Meta-Theme 2: Upper-level online mathematics courses.** The second meta-theme on the correspondence plot, Upper-level Online Mathematics Courses, comprised Sophie, Samantha, and Corie and contained the Online Teaching theme. At the institution, these three instructors were responsible for teaching the upper-level online mathematics courses, namely, the three courses in the calculus sequence. When asked to recall how she taught her first online courses, Samantha stated, “The first semester, I started doing lecture notes and scanning them. That was before I had a multi-page scanner. I would post 10 files for 10 pieces of paper—that
corresponded to just one section in the textbook." Corie confirmed the scanning of notes when she first started to teach online courses:

When I started [teaching online], I had nothing. I had no choice but to just give them a whole bunch of websites, and tell them to go make it happen. Then, I realized this isn’t working. The students were withdrawing. They weren’t sticking to the class. The pass rate wasn’t good. I had actually started uploading notes before we had the video. I would upload my lecture notes. If you look at a set of math lecture notes, it’s not all that exciting. I do a lot of stuff in color, so they would see things in different color, and not necessarily know why it was in a different color or what the meaning behind the different color was.

Figure 2. Correspondence plot of instructors.
Table 9. Inter-Respondent Matrix (Instructor x Themes)

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Theme 1</th>
<th>Theme 2</th>
<th>Theme 3</th>
<th>Theme 4</th>
<th>Theme 5</th>
<th>Frequency</th>
<th>Prevalence Rate of Each Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corie</td>
<td>60</td>
<td>43</td>
<td>39</td>
<td>30</td>
<td>16</td>
<td>188</td>
<td>28.23</td>
</tr>
<tr>
<td>Felicity</td>
<td>32</td>
<td>36</td>
<td>19</td>
<td>10</td>
<td>5</td>
<td>102</td>
<td>13.53</td>
</tr>
<tr>
<td>Marcie</td>
<td>36</td>
<td>15</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>75</td>
<td>11.26</td>
</tr>
<tr>
<td>Megan</td>
<td>56</td>
<td>25</td>
<td>26</td>
<td>13</td>
<td>5</td>
<td>125</td>
<td>18.77</td>
</tr>
<tr>
<td>Samantha</td>
<td>27</td>
<td>18</td>
<td>11</td>
<td>9</td>
<td>11</td>
<td>76</td>
<td>11.41</td>
</tr>
<tr>
<td>Sophie</td>
<td>41</td>
<td>22</td>
<td>13</td>
<td>15</td>
<td>9</td>
<td>100</td>
<td>15.01</td>
</tr>
<tr>
<td>Frequency (Manifest)</td>
<td>252</td>
<td>159</td>
<td>121</td>
<td>83</td>
<td>51</td>
<td>666</td>
<td></td>
</tr>
<tr>
<td>Effect Sizes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevalence Rate of Each Theme</td>
<td>37.84</td>
<td>23.87</td>
<td>18.17</td>
<td>12.46</td>
<td>7.66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Theme 1 = Benefits for Students; Theme 2 = Challenges; Theme 3 = Benefits for Instructors; Theme 4 = Online Teaching; Theme 5 = Future Students.

Later in the interview, Corie explained how CCS helped to transform her online courses from containing only written notes to containing videos:

We would just put our paper under the doc [document] camera and record. We were tethered to the podium—the station that you were sitting at, so you couldn’t move around or do anything. You couldn’t move around, so that took a little bit of time to get over. We had no technology, other than a record button on a computer hooked up to a doc camera and a microphone. If you go back and look at those videos, they seem archaic compared to what we have now. When we got the tablet, the software went through the computer that we were writing on, and that made everything better.

Unlike Corie, Sophie had never taught online without the use of CCS. Sophie admitted, “I’ve always used it when teaching online.” However, Sophie recounted a semester when she was made to remove the videos from her online course due to the recordings not being closed captioned:

It was terrible. It was just terrible. It was like I had my hands tied. I felt like I had done my students the most horrible injustice. Students were really struggling, and I just felt like it was a just a lousy class. And whenever they couldn’t watch my recordings, they could send me questions, and I could answer them. They could still see my handwritten notes. But, it just felt like it was so empty. The class just felt like it was so plain. And just truly empty, like it was a shell of a class—it was like it was missing the heart of the information.

All three instructors shared the passion they had for CCS. They saw the value that the videos provided to their online courses. Moreover, they saw how CCS had helped to transform online teaching to what it is currently.

*Meta-Theme 3: Benefits.* The third meta-theme, Benefits, included Megan and Marcie. These instructors placed high value on both the Benefits for Students theme and the Benefits for Instructors theme. Megan taught both developmental-studies and credit-level mathematics courses; however, Marcie taught only developmental-studies mathematics courses. Both Megan and Marcie stressed the concept of flexibility—for both the student and the instructor. Megan informed me that she had “a lot of students that travel a lot for work.” Marcie confirmed the busy schedules of her students, “They have a lot on their plate. They are busy, and an online course is the way to go.” Additionally, Megan enjoyed the flexibility that CCS provided to her:

I have made recordings from home, and in my office, and in the classroom when I’m teaching face-to-face. At home, I can get up early in the mornings, before anyone else, and make a video or two. It’s worth it—for the students.

Megan’s and Marcie’s comments about CCS being beneficial for both the students and the instructors helped to explain their location in the Benefits meta-theme.

*Meta-Theme 4: Technology-minded.* The last instructor meta-theme included only Felicity. As the oldest participant, she not only had the most teaching experience of all the instructors, but she was also the only instructor who had an undergraduate degree in Information Technology. She glistened with excitement as she spoke about advancements in technology that she had witnessed in the field of education. In addition to recording short video lectures in her office or at home, she used CCS to record chatroom sessions with her online students. One of the biggest challenges related to CCS that she discussed was overcoming the expense of the CCS
and other related software that she used while recording videos. She was proud of having located free software:

The one I use now is called [product name]. I got in when it was still free; so, I pay a nominal price. That was several years ago. Since then, they have become so popular, now they charge. I got grandfathered in for like $15 a month—which is worth it for me. Now, I think they charge somewhere like $25 to $30 a month. What I pay for it, there is a ceiling of how many can be in a room. And my ceiling is 10.

Also, she was the only instructor who discussed the limitation of the software that she used as it related to different devices: “It does not run on tablets or phones, and it’s not supported by Mac. I did look into other companies that support those platforms, but they are quite a bit more.” Lastly, she discussed creative ways that she overcame the challenges associated with using technology:

Sometimes, we just run across software issues. One time, my microphone just refused to work. And I don’t know what it was. And we ended up just chatting and writing on the white board for the whole session. So, that could be an issue. And, I had an older version of Camtasia. And it didn’t mesh especially well at first with the software. I had to go and do a bunch of searches on Google. And eventually, I discovered there were settings that I had to play with to make it hang better.

Because of her passion for using different types of technology in her online courses, Felicity had experienced challenges that other instructors had not experienced, or at least did not discuss during their interviews. Her use of CCS in conjunction with other software helped to explain why she was the only instructor in Meta-Theme 4.

Discussion

Discussion of the Findings in the Context of Theoretical Framework

This study was guided by Bruner’s (1966) Constructivist Theory, which posits that learning is an active process in which a learner constructs new concepts or ideas based upon his or her current/past knowledge. The four features addressed in Bruner’s (1966) theory of instruction were: (a) predisposition to learn, (b) structure (i.e., organization) of knowledge, (c) modes of representation (i.e., delivery), and (d) effective sequencing (i.e., form and pacing of reinforcement). Based on the findings from the current study, all four features apply to a student’s learning of mathematics in the online environment. First, prior to enrolling in an online mathematics course, the student held a particular attitude and/or expectation about the online learning environment. The student was aware of the difference between the online learning environment and the traditional face-to-face environment. Second, using CCS helped instructors to organize their online mathematics course in ways that differed from online mathematics courses that did not use CCS. By providing students with an additional resource contained (i.e., recordings) within the LMS, the instructors reduced the amount of time required by students to search alternative methods of explaining the material. Third, results of the study confirmed that the use of CCS provided better delivery of material (i.e., mode of representation) which, in turn, enhanced student learning. Last, CCS was perceived to be effective in helping students to progress through the course material. When a student recognized personal difficulty in the understanding of a mathematical concept, the student could reference recordings that would help in learning the concept.

Implications for Students

As technology continues to advance, we as a society become more and more mobile. Enrollment in the traditional face-to-face courses is on the decline, whereas enrollment in online courses continues to grow (Kena et al., 2015). With busy schedules and the high demands of life, work, and family, students are opting to take courses that offer more flexibility (i.e., online courses). For text-based disciplines (e.g., history), the transition from the face-to-face environment to the online environment has been almost seamless. Instructors of these disciplines have posted content of the course within the LMS in the form of text-based documents (e.g., lecture notes, PowerPoint slides). Additionally, instructors of text-based disciplines have utilized discussion boards and chatrooms as a medium for classroom conversations to occur, either between the instructor and a student or among students.
Unlike the text-based disciplines, the process-driven disciplines have not experienced a seamless transition to the online environment. Both instructors and students in the study identified the uniqueness of online mathematics courses compared to online courses in other disciplines. The student participants expressed apprehension about taking mathematics in the online format due to this uniqueness, and the instructors expressed reluctance—prior to CCS—of teaching mathematics in the online format. However, the most prominent student theme (i.e., changes to how online mathematics courses are viewed) suggests that students’ opinions of learning mathematics in the online format was changed as a result of being exposed to CCS in the online mathematics courses.

One important outcome of this study concerns students who are unable to attend traditional face-to-face courses (e.g., those who live in remote rural areas, stay-at-home moms). Some of these students do have the opportunity to take online courses, but they are aware of difficulty that they face in particular subject areas (e.g., mathematics). Some of these potential students might eliminate the possibility of furthering their education after the completion of high school due to fear and anxiety of taking classes from particular subject areas in the online format. The theme *face-to-face classroom experience* suggested that CCS transformed the online environment into a face-to-face environment. In other words, CCS provided a *hands-on* experience of learning mathematics. If colleges advertised the use of CCS online mathematics courses, these individuals who do not seek to further their education after completion of high school might be more willing to seek an online program or degree.

Analyses in the quantitative phase confirmed that CCS helped to improve overall student success in the online mathematics classroom. Furthermore, analyses in the qualitative phase confirmed that CCS helped to increase the students’ confidence in the online mathematics classroom. One way in which a student’s confidence was increased included the student’s ability to identify his or her instructor’s expectations. For example, directions on an examination often instruct a student to show his or her work in order to receive full credit for a problem. One instructor, Sophie, shared how she confirmed that CCS clearly communicated her expectations to her students: “When students take my test, I can see my MY organization, the way I write in my notes, in the recordings. I can see it line by line, coming right through.” Thus, because of CCS, students more clearly see instructors’ expectations.

Lastly, as technology continues to improve, new possibilities of implementing CCS in the online environment might emerge for students. For example, what if students were allowed to create and to post recordings using CCS? This feature would allow students to post small video clips next to their discussion board posts, to a document attached to an email, or to a submission in Dropbox. Students could ask not only written questions, but they could verbally and/or visually explain where they needed help in understanding a concept or solving a problem. Additionally, students could demonstrate a process or procedure using CCS as part of an assignment for an online course.

**Implications for Instructors**

Instructors in the study began using CCS soon after the developers had released the software, and the instructors disclosed that they still used CCS in their online courses at the time the data were collected. During the interviews, instructors shared only positive comments about CCS as it pertained to the students—the only negative comments about CCS from the instructors’ perspectives pertained to the high costs of the CCS products and to the time requirement of creating the recordings. As other instructors become aware of the results of this study (i.e., the effects of CCS on course performance), then more instructors might use CCS in their online courses. Because the reporting tools that are now available within the LMS can provide more information about CCS viewing statistics than the reporting tools provided at the time of the study, instructors would be able to locate which recordings the students accessed more frequently. Using these new reporting tools, instructors might identify trends (e.g., particular topics/recordings being viewed more frequently than others are). As a result, the instructors might provide students with additional recordings to explain better those topics to students.

The instructors acknowledged the common misconception that was shared by students—taking a mathematics course in the online format is *easier* than taking the same course in a traditional face-to-face format because the instructor lowers expectations of the students’ performance. Prior to using CCS, the instructors admitted to being more lenient with respect to grading due to the inability to convey exactly what was expected from the students on the assignments. Using CCS allows mathematics instructors to replicate their traditional face-to-face courses in the online environment. In doing so, instructors can better explain step-by-step processes and better communicate their expectations. Thus, instructors could take an active part in helping to
eliminate the misconception that courses in the online format are easier than are courses in the traditional format.

As technology continues to advance, instructors might see new uses of CCS emerge in online courses. For example, instructors complained about the amount of time required currently to make recordings using CCS. If the amount of time for creating and posting a video response was reduced (e.g., a radio button was placed with a discussion board post), an instructor might provide quicker video responses to questions posted on the discussion boards. Additionally, these responses might contain step-by-step explanations to the students’ questions. The ability to respond with videos using CCS currently exists, but as previously stated, creating and posting recordings is time consuming. As capture technology becomes more user friendly, online instructors will be able to provide better and faster feedback.

One of the most prevalent perceptions of CCS shared among both instructors and students was that it provided students with a face-to-face experience. Instructors could extend the use of CCS to more than delivery of content and delivery of question/answer sessions. For example, the instructors could assess a student’s knowledge by requiring the student to submit assignments that are recorded using CCS. This concept was discussed previously in the Implications for Students section. Again, this technology currently exists, but it is too time-consuming and burdensome for the instructors. For this reason, it would be more convenient if the capture software was integrated into the LMS (i.e., a radio button was placed next to different features within the LMS that would allow recordings to be made). An instructor might require a student to demonstrate a particular process using CCS. After the student submitted the assignment, the instructor could watch the student’s recording and provide video feedback—by either confirming the student’s correct answer or by explaining why the student’s answer is incorrect. Thus, the instructor could provide another component (i.e., one-on-one feedback to individual assignments) within an online course that replicated a component in a traditional face-to-face course. An extension of using CCS in this manner would include providing an environment that replicated visiting an instructor during office hours—questions could be submitted, answers could be provided.

**Implications for Administrators**

Often times, college budgets are tied to key performance indicators (KPIs)—measurable values aimed to improve student success. Some KPIs include the following: headcount, First Time in College (FTIC) persistence Fall to Spring, FTIC persistence Spring to Fall, developmental mathematics completion within one year, developmental reading completion within one year, developmental writing completion within one year, completion of 30+ college-level credits within three years, transfer to four-year institutions, number of degrees/certificates awarded by the college, and percentage of overall successful course completion. If administrators were to advocate for the use of CCS in the online environment, the potential would exist to increase funds allocated to the college. Based on the findings from this mixed methods research study, we concluded that students who enrolled in online mathematics courses that used CCS had a higher mean overall course average than did students who enrolled in courses that did not have CCS, particularly in the developmental-studies mathematics courses. If online developmental mathematics students are more successful in courses that use CCS, then there is a potential of gaining more momentum points associated with the KPI complete developmental mathematics within one year—resulting in more funding. Additionally, student participants who took additional mathematics courses shared that they returned to the same institution and searched for more online mathematics instructors who used CCS in their online mathematics courses. If the use of CCS encourages students to return the following semester, the college has the potential to earn momentum points associated with the KPI persistence.

Currently, we do not know the impact that CCS has on the rate of student enrollment nor the impact that CCS has on student enrollment numbers. A great marketing opportunity for online courses and fully online programs exists for colleges who want to promote the use of CCS. On the marketing flyers and brochures, a college could provide quotations from former students about how CCS transformed their online courses/programs into traditional face-to-face experiences. If marketed to the correct population, then enrollment in those courses or programs could increase. Thus, the college has the potential to earn momentum points associated with the KPI headcount.

**Recommendations for Future Research**

Several research studies exist that could expand the findings of this mixed methods research study. In our study, we grouped the online mathematics students according to whether or not the instructors used CCS. At
the time of our study, the LMS did not communicate with the capture software (i.e., students did not have to authenticate into the LMS in order to view recordings). Consequently, we were unable to collect data related to which students viewed the recordings or to how long each student viewed each recording. As a result of advancements in technology, an instructor is now able to track a student's progress within the LMS (i.e., reporting tools exist within the LMS that show details about student login information). Therefore, our first suggestion for a future study would be to replicate the study according to student usage of CCS (i.e., group the online mathematics students according to whether or not the student within the online mathematics course used CCS instead of whether or not the instructor of the online mathematics course used CCS).

Second, another research study could be conducted to examine the effect that the number of minutes spent viewing the recordings had on course performance. If, indeed, the mean grades of students who watched recordings was greater than was the mean grades of students who did not watch recordings, then how many recordings does a student need to watch in order for this outcome to be observed? Would there exist categories (e.g., students who watched at least 10 videos for a total of 200 minutes or more, students who watched at least 15 videos for at least 250 minutes) for observable measurable differences in student performance?

For a third study, researchers could examine in more depth how students use CCS. Are students watching videos in their entirety, or are students watching videos only when they need help solving a particular problem? These data could be collected using a survey tool and/or holding student focus groups.

Fourth, researchers could examine enrollment rates of online courses that use CCS compared to enrollment rates of online courses that do not use CCS. To what degree does the class of an instructor who uses CCS fill at a faster rate with students than does a class of an instructor who does not use CCS? Fifth, researchers could examine how the use of CCS affects retention rates of students. To what degree do students who are exposed to CCS return to the same institution the following semester, especially if the students know that CCS will be used in future courses available at that institution? Last, researchers might conduct a similar study (i.e., perceptions and effect of CCS on course performance) concerning online students in other Science, Technology, Engineering and Mathematics- (STEM-) related courses. Of particular interest would be science classes that involved demonstrations in a laboratory setting.

**Conclusion**

Living in the Information Age, we are surrounded by an abundance of digital information. However, we continue to have difficulty processing the numerical information due to high rates of innumeracy. Educational policy makers at both the national level and state level search for ways to decrease innumeracy among individuals in our society. To meet the demands of students, institutions of higher education have seen a shift from the traditional face-to-face learning environment to the online learning environment (I. E. Allen & Seaman, 2008, 2013; Kena et al., 2015). Both the busy lifestyles of the students and the rapid advancements in technology have helped to evolve the online courses that are currently offered to students.

Students and instructors continue to struggle in the online environment with the unique discipline of mathematics (Hardy & Bower, 2004; Ko & Rossen, 2004; McLean, 2005; Palloff & Pratt, 2001). This study involved an investigation of the effects and perceptions of classroom capture software on course performance in online mathematics courses. The findings of this study indicate that CCS helped to improve student success. The quantitative results were congruent with the perceptions of both students and instructors who indicated that CCS provided numerous benefits that helped students be more successful in the online mathematics environment. As such, these results have added to the knowledge base about using CCS in the online mathematics environment, as well as provided more areas of research to pursue.

**References**


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