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Student and Instructor Perceptions of a Flipped College Algebra Classroom

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Each year about half a million students fail to make planned academic progress due to college algebra, hence the need for researchers to find ways of improving the quality of instruction in the course. Recent research suggests that flipping college algebra to allow time for active learning in the classroom may improve student performance. Also, the costs of college textbooks have skyrocketed in the last few years, preventing or discouraging students from obtaining crucial learning resources. To address both concerns, the researcher implemented a flipped college algebra classroom and based all lessons on a free textbook. Videos and corresponding problem sets were created and made available to students on the Internet. Outside class, students viewed videos, took notes, and completed video problem assignments. Inside class, students worked with other students to complete in-class problem assignments. Students described their experience in the flipped classroom in an anonymous essay and an online survey, and the researcher recorded field notes of his observations throughout the term. This study reports student and instructor perceptions of the flipped college algebra classroom.

A large number of students enroll in college algebra each year in the United States. Based on a Conference Board of Mathematical Sciences survey (Blair, Kirkman, & Maxwell, 2013), enrollment in college algebra for the 2010 academic year was estimated to be approximately 849,600 students (Jaster, 2013), and Overmyer (2014) estimated that annual enrollment now exceeds 1,000,000 students. Unfortunately, success rates in college algebra are typically only about 40-60% (Haver et al., 2007; Ogden, 2014), meaning that each year approximately half a million students fail to make planned academic progress due to college algebra.

An alternative to the traditional classroom structure that has become increasingly popular during the last few years is the flipped classroom (Amresh, Carberry, & Femiani, 2013). Lage, Platt, and Treglia (2000) defined an inverted (or flipped) classroom as a classroom in which "events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa" (p. 32). As explained by Baker (2000) at about the same time, "a key online component for the 'flipped' class is the movement of lecture material out of the classroom through online delivery" (p. 12) so that "the professor is freed from the 'tyranny of the lecture'.… [and] is now free to use class time for other activities" (p. 13).

Recent research suggests that the flipped classroom is especially appropriate for college algebra. Van Sickle (2015) reported that the results of flipping four sections of college algebra over a period of two semesters were surprisingly positive, so much so that she now has a hard time denying the benefits of flipped instruction. In fact, Van Sickle found that "college algebra is a perfect fit for flipped learning" (p. 610), offering "all the opportunity to succeed and grow in their understanding of mathematics" (p. 610).

Learning in Flipped Classrooms

Most often in flipped classrooms, online videos are used to deliver course content outside class (Herreid & Schiller, 2013). Twenty-first century students may find videos appealing (Bergmann & Sams, 2012), and research has shown that students typically learn slightly more from visual-based instruction than from conventional teaching (Cohen, Ebeling, & Kulik, 1981).

But as explained by Sams and Bergmann (2013), flipped learning is not as much about using videos in the lessons as it is about how to best use in-class time with students. Replacing in-class lectures with outside-class videos makes time available inside the classroom for active learning. Student performance was compared in science, technology, engineering, and mathematics (STEM) classes taught under active learning versus traditional lecturing in the largest and most comprehensive meta-analysis of undergraduate STEM education published to date (Freeman et al., 2014). The meta-analysis found that in classes with active learning, the students performed better on final examinations and were less likely to fail than in classes taught with traditional lecturing. The meta-analysis also found that both results hold across STEM disciplines.

Research suggests that it is the presence of active learning, rather than the structure of the flipped classroom itself, that leads to higher student performance. Jensen, Kummer, and d. M. Godoy (2015) studied the effectiveness of the flipped model in biology instruction by comparing a flipped classroom to a non-flipped classroom. The researchers sought to vary only the role of the instructor and control for as many of the other potentially influential variables as possible. In the non-flipped classroom, the instructor facilitated content attainment. In the flipped classroom, the students were responsible for content attainment before class. Students in each of the two classes were engaged in active learning (in the non-flipped class, students worked in groups of three or four using a prepared study guide with brief whole-class discussions interspersed between group work). In both flipped and non-flipped classes, the instructor acted more as a guide than an authority figure. The researchers found equivalent learning and student satisfaction between the classes, and they concluded that any learning gains are most likely a result of the active-learning style of instruction rather than the order in which the instructor participates in the learning process.

Van Sickle (2015) used videos to flip two sections of college algebra in fall 2013 and two sections of college algebra in spring 2014. During most of the class time students were actively involved in completing a problem set. Students were encouraged to work with other students but could work alone if preferred. Six college algebra sections taught in a traditional format served as control sections. A one-tailed *t*-test showed that the final examination scores in the flipped classes were significantly higher than in the traditional classes, with $p = 0.0143$.

Ogden (2014) noted that for college algebra instruction, "the flipped classroom teaching model enables teachers to promote active learning in the classroom and to cultivate confidence in students who typically lack it" (p. 138). As Ogden explained, the flipped teaching model allows the use of multiple instructional strategies which can mediate the effects of math anxiety and low self-efficacy and increase a student's motivation to learn.

Results obtained by Overmyer (2014) are consistent with the theory that active learning leads to higher student performance in flipped college algebra classrooms. For the purpose of analysis, Overmyer (2014) divided 11 sections of college algebra into three groups. The traditional group consisted of those sections taught using the traditional method of lecture and homework. The flipped (no inquiry) group consisted of those sections that were flipped and taught by instructors who did not have experience with inquiry-based or cooperative learning methods. The flipped (inquiry) group consisted of those sections that were flipped and taught by instructors who did have experience with inquiry-based or cooperative learning methods. The mean of the final examination scores in the flipped (inquiry) group was higher than in either of the other two groups. Analysis revealed that the difference in mean scores between traditional and flipped (inquiry) groups was statistically significant ($p<.05$). Analysis also revealed that the difference in mean scores between the flipped (no inquiry) and flipped (inquiry) groups was statistically significant ($p<.05$). No statistically significant difference in mean scores was found between the traditional group and the flipped (no inquiry) group.

Student Expense

While the flipped classroom may lead to instructional improvement in college algebra, students and families still face the high cost of textbooks. The cost of college textbooks has skyrocketed in the last few years (Student Public Interest Research Groups [SPIRG], 2014), preventing or discouraging students from obtaining crucial learning resources. Although publishers have increased cost-saving options like e-books and rental programs, because the price of rental, used, and e-books is dictated by the price of the new print edition, the cost-saving options have had limited impact (SPIRG, 2014).

In fall 2013, a survey was conducted of 2,039 students from more than 150 different university campuses concerning textbook cost (SPIRG, 2014). The survey found:

- "High textbook costs continue to deter students from purchasing their assigned materials despite concern for their grades" (SPIRG, 2014, p. 4).
- "High textbook costs can have a ripple effect on students' other academic decisions" (SPIRG, 2014, p. 5).
- "Students want alternatives, expressing support for textbooks that are available free online and buying a hard copy is optional" (SPIRG, 2014, p. 5).

Students not required to have a textbook for a class may nevertheless be required to purchase costly access to an online learning system.

Research Questions

A flipped college algebra classroom was designed to increase learning and reduce student expense. To better understand the experiences of the instructor and the students, and to aid in assessing classroom design, this study sought to answer the following research questions.

1. What are students' perceptions of a flipped college algebra classroom?
2. What are the instructor's perceptions of a flipped college algebra classroom?

Method

Context

A community college in west Texas (with an enrollment of about 5,000 students) served as a place of instruction for the college algebra course. A total of twenty students remained enrolled in the course after the census date.

The college's summer semester consists of two consecutive terms, each approximately five weeks in length. The college algebra class met each morning, Monday through Thursday, for two hours and 15 minutes during the first term of summer 2015.

The class met in a newly constructed building dedicated to mathematics and science. The classroom was equipped with a computer and projector which the instructor used at the beginning of the term to demonstrate access to online course documents and videos. Desks were arranged to form five groups with four students per group so that students could work together in the classroom.

The Math Lab was located on the same floor as the classroom and was staffed with tutors and equipped with about 40 computers. Outside class time, students could visit the Math Lab to view videos, solve problems, and ask questions.

Course Preparation

Flipping the classroom required preparation prior to the beginning of the term. A textbook was chosen, and subsections of the textbook were selected for inclusion in the course. To reduce costs for the students, the lessons were based on the free textbook *College Algebra* (OpenStax College, 2015b) published by OpenStax College. An initiative of Rice University, OpenStax College is a nonprofit organization that develops free, peer-reviewed textbooks for higher education and is made possible through the generous support of several philanthropic foundations (OpenStax, 2015a).

The textbook was contained in a PDF file and made available to the students through the college's learning management system. The instructor used software to extract pages from the textbook and then merged those pages to create another PDF file that contained only the exercises from the textbook subsections included in the course. The file that contained only exercises was also made available to the students through the college's learning management system. If a student was able to access the file containing the exercises in class using a mobile device such as a smartphone, tablet, or laptop, then the student was not expected to have the exercises printed. Otherwise, students could pay about $30 to have the exercises printed and spiral bound at one of the several businesses in town offering copying and printing services.

Videos and corresponding sets of video problems were produced and made available at a website that would be accessible to the students. Long videos may negatively impact student impressions of the flipped classroom (Amresh et al., 2013; Jaster, 2013), so one relatively short video was produced for each textbook subsection included in the course. A total of 92 videos were produced for the course, with a mean length of 5 minutes 58 seconds and standard deviation of 4 minutes 8 seconds. The shortest video was 23 seconds in length, and longest video was 21 minutes 28 seconds in length. Only eight of the 92 videos were over 11 minutes in length.

In order to provide students with access to the videos quickly and as flexibly as possible, a website for the videos and video problems was created by the researcher. A screenshot of the website appears in Figure 1 and shows the instructor explaining content from one of the subsections of the textbook.

Other ways of providing students with access to the videos included having a webpage created as part of the college's website, or posting the videos at youtube.com or screencast.com. The video problems were contained in PDF files and could have been distributed from a location different than the instructor-created website, either online (perhaps through the college's learning management system) or as printed copies.

Producing each video involved first recording video clips of the instructor teaching at a whiteboard using a camcorder and wireless microphone. Video editing software was then used to concatenate the clips and delete any unnecessary or undesired footage. Once edited, the video was saved in MP4 format at a reduced resolution of 640 x 360 pixels to shrink file size. Video problems (usually only one or two) based on the video were created and saved in PDF format. Then both the video and the video problems were uploaded for delivery by the website.

Lesson Procedure

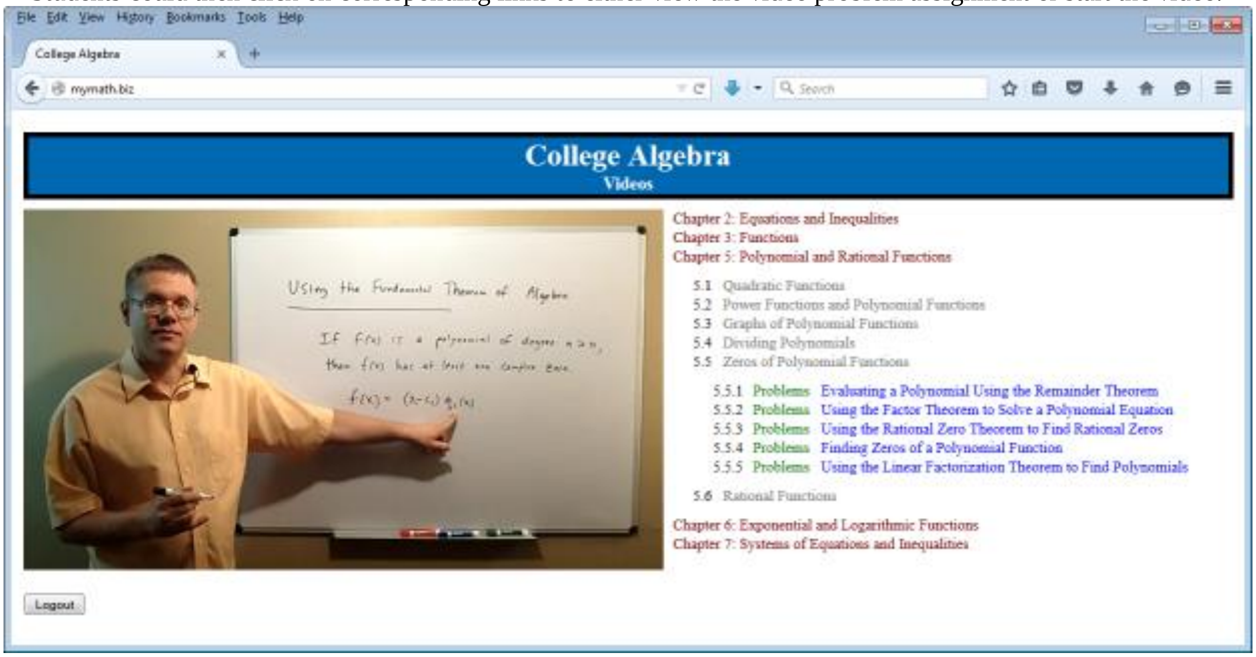
To learn the content of each textbook subsection, students engaged in learning activities both outside and inside class. Outside class, students viewed videos, took notes, and completed video problem assignments. Inside class, students worked with other students to complete in-class problem assignments.

Videos and video problems. A set of one to four video problems accompanied each video. To learn the content of each textbook subsection, students were expected to view its corresponding video and solve the associated video problems prior to coming to class. The video problems could be solved using the methods shown in the video.

One of the purposes of requiring the students to solve video problems was to provide students with an opportunity to practice the problem solving techniques demonstrated in the video. Another purpose of requiring the students to solve video problems was to encourage video viewing. As Gannod, Burge, and Hemlick (2008) explained, the viewing of videos outside class "must be incentivized in order to provide motivation for students to prepare for in-class exercises" (p. 785). Students were told that credit would

Figure 1

Website with corresponding links. Students were able to expand a collapsible menu to locate a subsection of interest. Students could then click on corresponding links to either view the video problem assignment or start the video.



be awarded for the video problems only if solved using methods explained in the video.

Note taking. Students took notes while viewing the videos. Although note taking was not required, students seemed to understand the importance of having notes for solving the assigned problems in class. The instructor encouraged students to take notes and would sometimes refer to a student's notes when answering a question posed by the student.

In-class problem solving. The instructor wrote the in-class assignment on the board at the beginning of each class. Upon arriving to class, students signed an attendance sheet, submitted their solutions to the video problems, and started working on the in-class assignment.

Research suggests that it is active learning, rather than lecture or the structure of the flipped classroom itself that leads to increased learning in flipped classrooms (Freeman et al., 2014; Jensen et al., 2015; Ogden, 2014; Overmyer, 2014). Consequently, the instructor did not explain course content to the class as a whole or conduct question and answer sessions. Instead, the instructor used almost all available class time circulating throughout the room helping individual students and helping small groups of students that were working together.

The instructor strove to create a relaxed atmosphere in the classroom that would be conducive to learning. During class many students worked with others in solving the assigned problems, while a few students chose to work alone.

Students were encouraged to solve as many problems as possible but were not prohibited from engaging in other activities during class. At times students would view videos (with earbuds) or send text messages on their phones. However, almost all students remained focused on problem solving until the quiz.

Assessments

Students were given daily quizzes and weekly exams. A final exam was administered at the end of the term.

Quizzes. A quiz, consisting of one to four problems, was given during the last 20-30 minutes of class and was based on the in-class assignment. Students were not allowed to refer to the textbook or any notes during the quiz.

The quiz served several purposes. First, the quiz allowed the instructor to see how well the students had learned the content of the textbook subsection(s). Also, the upcoming quiz likely helped students remain focused on the assignment during in-class problem solving. The quiz also served as a means of checking attendance at the end of class.

Exams. At the end of each of the first four weeks (on Thursday), instead of a quiz, students were given an exam over all the subsections taught during the week. The exams were designed to require about an hour to

Table 1
Survey Constructs and Corresponding Questionnaire Items

Survey Construct	Questionnaire Items
Learning contribution of video viewing with note taking	1
Learning contribution of video problem solving	2
Learning contribution of in-class problem solving	3
Video viewing engagement	4, 9, 14, 18
Learning opportunity afforded by the flipped college algebra classroom	5, 10, 15
Beneficialness of in-class problem solving	6, 11, 16, 19
Preference for the flipped format	7, 12, 17
Preparedness for the course	8, 13
Expected term grade	20

complete. At the end of the last week, students took a comprehensive final exam.

Instrumentation

Two instruments were used to gather data in this study. An essay assignment instructed students to provide data that described their perceptions of the flipped college algebra classroom. An online survey was used to gather additional data from students that also described their perceptions.

Essay assignment. To allow students freedom in describing their experience in the class, the only requirement of the essay assignment, other than formatting requirements, was that the essay describe what the student thought about the flipped college algebra classroom. A few questions were included in the assignment to provide students with ideas to write about, but it was clearly stated in the assignment that the student could answer all, some, or none of the questions. The complete essay assignment appears in Appendix A.

Reliability. One of the three types of reliability identified by Kirk and Miller (1986) was synchronic reliability, which "refers to the similarity of observations within the same time period" (p. 42). An observational protocol would be considered synchronically reliable if, within a given time period, it produces observations that are consistent with each other.

Students recorded their observations of the flipped classroom in anonymous essays. The consistency of those observations led to an identification of categories during qualitative analysis. Hence the essay assignment in this study could be considered a synchronically reliable instrument.

Validity. A valid instrument measures what it is supposed to measure (Carmines & Zeller, 1979). An instrument is *apparently valid* if it "is so closely linked to the phenomena under observation that it is 'obviously' providing real data" (Kirk & Miller, 1986, p. 22).

The essay assignment required students to describe what they thought about the flipped college algebra classroom. In describing their thoughts students described precisely what was to be measured: their perceptions. Thus the essay assignment could be considered an apparently valid instrument.

Questionnaire. A questionnaire was developed as the survey instrument. The questionnaire included a total of twenty closed-ended ordinal scale items with responses given on a 5-point Likert scale ranging from 1 to 5. The questionnaire was designed to measure nine constructs. Those constructs, and the items that correspond with each construct, appear in Table 1 below. All items contained in the questionnaire appear in Appendix B.

Reliability. A central concept in traditional experimental research, reliability refers to the degree to which research findings can be replicated (Merriam, 2009). Because students may have different conceptions, feelings, impressions, insights, and opinions of the flipped classroom, replicability of survey results was not a concern in this study. More important for qualitative research is the question of "whether the results are consistent with the data collected" (Merriam, 2009, p. 221). Measures of constructs derived from the survey should not contradict any results derived from the other data collected.

Five of the constructs shown in Table 1 were measured with multiple questionnaire items, and the items for measuring individual constructs should be "homogeneous, or all measuring the same construct" (Carroll, 2015a, para. 4). Cronbach's alpha tells the researcher "whether the individual subjects answered the questions consistently enough that their answers form a cluster that can meaningfully be studied together" (Vogt, 2006, p. 116). For each of the five constructs, Cronbach's alpha was calculated and used to estimate the internal consistency reliability of the responses to the corresponding items.

Validity. Determining whether the questionnaire measured what it was supposed to measure required determining whether the questionnaire measured each of the constructs listed in Table 1. Because there were no known measures of the constructs, such determination involved subjective estimation. As stated by Vogt (2006), "Another important difference between validity and reliability is that validity is often more a matter of judgment than statistics" (p. 118).

Carroll (2015b) explains "*face validity* is often used to indicate whether the instrument, on the face of it, appears to measure what it claims to measure" (para. 4). Table 1 lists four constructs that were measured by one item. Questions 1, 2, 3, and 20 asked students to provide a single measure of precisely what was to be measured. For example, Question 1 asked the student to estimate the degree to which viewing videos, and perhaps taking notes while doing so, contributed to their learning, and the construct to be measured was perceived learning contribution of video viewing with note taking. The portion of the questionnaire consisting of questions 1, 2, 3, and 20 appears to satisfy the requirements of face validity.

"*Content validity* is concerned with how well the content of the instrument samples the kinds of things about which conclusions are to be drawn" (Carroll, 2015b, para. 2). For example, to measure video viewing engagement students were asked to estimate the degree to which they tried to learn as much as possible while viewing the videos (Question 4), watched each assigned video at least once (Question 9), frequently paused or repeated segments of the video in order to increase understanding (Question 14), and watched all the videos that were assigned during the semester (Question 18). While it seems that each of the above items would provide some measure of level of engagement with video viewing, gauging the ability of those four items to provide an accurate measurement requires personal judgment.

Data Collection

This study sought to discover student and instructor perceptions of a flipped college algebra classroom. An essay assignment and an online survey were used to capture student perceptions. The researcher was the instructor of the flipped college algebra classroom, and recorded his observations in field notes as the term progressed.

Essay. At the end of the second week an essay assignment was distributed to the students. One week later, students were asked to submit their essay anonymously by inserting it into a large envelope passed around during class. Students signed a roll sheet taped to the front of the envelope so that extra credit could be awarded to those students who submitted an essay. A total of nine students submitted an essay.

Survey. At the end of the third week of the term, the students were presented with an opportunity to earn extra credit by completing an online survey. The purpose of the survey was to gather additional data regarding perceptions of the flipped classroom. Students were given one week in which to complete the survey. A total of 10 students completed the survey.

Unknown to the students, the website maintained a count of the number of times each student logged in to the website to view videos and access the video problems. After the term ended, the researcher downloaded the login counts and compared them with the measure of *video viewing engagement* derived from the survey data.

Field notes. The instructor worked closely with the students, circulating throughout the classroom to answer any questions that students had. Conversing with the students, viewing students' notes, and helping students solve problems gave the instructor opportunity to observe students and students' situations in the classroom. During the term the instructor assessed preparedness, confidence, attitude, gregariousness, and work ethic. The instructor also observed interactions between students, as well as individual student actions, facial expressions, and overheard comments concerning the class. As a participant observer, the instructor blended informal interviews and conversations with observations of students.

Observations are a primary source of data in qualitative research (Merriam, 2009). Throughout the term, the instructor recorded interactions and observations in a set of field notes. The field notes served as a source of data for reconstructing and reporting the instructor's perceptions.

Data Analysis

Two different types of data were collected: the essay data and field notes each consisted of text, whereas survey data were numerical. Thus both qualitative and quantitative analyses were performed to extract meaning from the data.

Essay data. The essays were qualitatively analyzed using the procedure described on pages 178 through 193 of Merriam's 2009 book *Qualitative Research: A Guide to Design and Implementation.* In a qualitative study it can be important to begin analysis early, as data is collected (Merriam, 2009). However, to prevent the essays from having any effect on instruction or grading, the instructor/researcher did not read and begin

Table2
Survey Constructs, Questionnaire Items, and Cronbach's Alpha

Survey Construct	Questionnaire Items	Cronbach's Alpha
Learning contribution of video viewing with note taking	1	
Learning contribution of video problem solving	2	
Learning contribution of in-class problem solving	3	
Video viewing engagement	9, 18	1.000
Learning opportunity afforded by the flipped college algebra classroom	5, 10, 15	0.920
Beneficialness of in-class problem solving	6, 11	0.848
Preference for the flipped format	7, 12	0.910
Preparedness for the course	8, 13	0.652
Expected term grade	20	

analyzing the essays until after the grades for the term were reported to the registrar.

Essay analysis began with reading the first essay and writing notes and comments next to any bit of data that seemed relevant to the study. After working through the entire essay, the researcher went back over the notations and grouped those notations that seemed to go together into tentative categories. The researcher then continued to read essays, make notations, and group notations into an evolving common set of tentative categories. After analyzing all the essays, the name of each category was finalized. The categories formed the results of the essay analysis.

Survey data. The survey data were quantitatively analyzed to produce descriptive statistics for describing student perceptions. For each of the nine survey constructs, the descriptive statistics calculated included a measure of central tendency (the mean) and a measure of variability (the standard deviation).

Field notes. The qualitative design of a research study is emergent (Merriam, 2009). And indeed, findings gradually emerged from field notes as analysis was performed throughout the term.

After recording each set of field notes, the researcher read and reread the data while making notes in the margins. As with the essay data, notations for the perceptions that seemed to go together were grouped into tentative categories. A notation may have suggested that a perception belonged to an existing tentative category, or that a new tentative category should be created for the perception. At the end of the term, the field notes were reread and the tentative categories refined and finalized. The categories of the perceptions that occurred most frequently in the field notes were identified and formed the results of the field note analysis.

Results

Quantitative analysis of survey responses led to a refinement of the data used in measuring three of the survey constructs. The first research question was then answered by describing student perceptions of the flipped college algebra classroom. Instructor perceptions of the classroom were described to answer the second research question.

Survey Instrument

As shown previously in Table 1, five constructs were measured by multiple items on the survey instrument. Cronbach's alpha was calculated for each of the five constructs to estimate the consistency of responses between the items corresponding with the construct.

Following the initial calculation of Cronbach's alpha for each construct, responses for different items where iteratively removed from the calculation to find the combination of items that resulted in the greatest value of Cronbach's alpha. For each construct, only the items that maximized the value of Cronbach's alpha were used in calculating the descriptive statistics for the construct. All constructs, the items used in calculating the descriptive statistics, and the resulting Cronbach's alpha (for the multiple-item constructs) are listed in Table 2.

Cronbach's alpha of 0.652 for the construct *preparedness for the course* is a little lower than the commonly accepted cutoff value of 0.700 (Vogt, 2006). Because the consistency between the responses to items

Table 3
Categorization of Perceptions Derived From Essays

Category of Perception	Percentage of Essays
In-Class Problem Solving	
In-class problem solving or working with other students is beneficial	33.3
In-class problem solving or working with other students is not beneficial	22.2
Amount of Work	
Requires more time or work outside class than a lecture-based class	55.6
Requires about the same amount of time or work as a lecture-based class	22.2
General Positive Perceptions	
Video viewing is beneficial	33.3
General Negative Perceptions	
Can't ask questions about video lessons without going to the Math Lab	66.7
Less learning occurs in a flipped classroom than in a lecture-based class	44.4
A flipped classroom requires self-teaching or is like an online class	33.3
Instructor not always available in class because he helps other students	22.2
Reluctant to ask other students for help, because either doesn't want to bother other students or others are not knowledgeable	22.2
Tutors in Math Lab may not be able to explain solution methods shown in the videos because they haven't viewed the videos	22.2
Overall Preference	
Prefer traditional lecture-based instruction over flipped classroom	77.8
Prefer flipped classroom over traditional lecture-based instruction	22.2

8 and 13 is somewhat weak, using those two items to measure the same construct is somewhat questionable.

Student Perceptions

Both qualitative and quantitative methods were used to capture and identify students' perceptions. Qualitative analysis of the essay data produced categories that described student perceptions, and quantitative analysis of the survey data produced descriptive statistics that further characterized the perceptions.

Essays. Table 3 lists the perception categories found through qualitative analysis of the essays. The categories listed describe how students felt about the flipped college algebra classroom. The table also shows, for each category, the percentage of essays in which perceptions were described that were determined to belong to the category. Only categories with a percentage of essays of at least 22.2% (representing at least two essays out of the nine collected) are reported.

Note that the most frequently mentioned perceptions suggest the students felt that the flipped college algebra classroom required more work, resulted in less learning, and was less preferred than traditional lecture-based instruction. Also, several students pointed out that they were unable to ask questions while viewing videos.

Survey. Quantitative analysis of the survey data revealed additional information concerning student perceptions. For each survey construct, the mean and standard deviation of the responses to all associated questionnaire items were calculated and reported. Results of the analysis appear in Table 4.

For the first three constructs listed in Table 4, a mean of 1 would indicate that the stated activity made the least possible learning contribution, and a mean of 5 would indicate that the stated activity made the largest possible learning contribution. The statistics shown suggest that, overall, students felt that all three activities: video viewing with note taking, video problem solving, and in-class problem solving, contributed to learning, with in-class problem solving making the greatest contribution of the three.

The high mean of 4.800 and low standard deviation of 0.600 for *video viewing engagement* reflects the fact that most survey participants reported both viewing most of the videos assigned during the term, and viewing most of each video. The number of times that each student logged in to the website to view videos and access the video problems was available to the

Table 4
Descriptive Statistics for Survey Constructs

Survey Construct	*M*	*SD*
Learning contribution of video viewing with note taking	3.700	1.269
Learning contribution of video problem solving	3.700	1.005
Learning contribution of in-class problem solving	4.300	1.269
Video viewing engagement	4.800	0.600
Learning opportunity afforded by the flipped college algebra classroom	2.567	1.257
Beneficialness of in-class problem solving	3.700	1.418
Preference for the flipped format	2.300	1.308
Preparedness for the course	3.150	1.492
Expected term grade	2.900	1.136

researcher from the website, and indeed that data did show that almost all students logged in frequently during the semester.

The constructs *learning opportunity afforded by the flipped college algebra classroom* and *preference for the flipped format* have the lowest means, each between 2.3 to 2.6. Among the survey participants, the measure of each the two constructs was lower than the midpoint of the response range of 1 to 5, which is 3.

The construct *beneficialness of in-class problem solving* had a mean of 3.700. The data shows that, on average, the survey participants felt that in-class problem solving was beneficial.

The construct *preparedness for the course* had a mean which is slightly greater than the midpoint of 3 and had the greatest standard deviation shown in the table. The survey data suggest that there were differences in prerequisite knowledge among the students, possibly with some students being well prepared for the course and other students very underprepared.

The mean for the construct *expected term grade* was 2.900. A response of 1 corresponded with an expected term grade of A, and a response of 5 corresponded with an expected term grade of F or W. The data indicates that, on average, survey participants expected a term grade slightly higher than a C.

Instructor Perceptions

Qualitative analysis of field notes yielded categories of instructor perceptions. The categories described in the following paragraphs are the categories of perceptions found most frequently in the field notes.

Students initially embraced the flipped college algebra classroom. In the beginning of the term the instructor explained the lesson procedure: viewing videos, taking notes, and solving video problems outside class, followed by solving more problems and then a quiz or exam inside class. Students accepted the flipped classroom as a different, but perfectly valid, method of learning mathematics.

On the second day of class students arrived, quickly turned in their video problems, and started working on the in-class assignment. The instructor reminded students that they were allowed, and even encouraged, to work together and to help each other in understanding how to solve problems. Many students began speaking with each other and seemed to enjoy getting to know each other as they worked on problems.

The material at the beginning of the semester was not difficult for most students. Nevertheless, several students asked the instructor questions during class, giving the instructor and student a chance to interact with each other.

Other researchers have found that students reacted quite differently, with some students finding it difficult to accept the flipped classroom as a viable form of instruction. When Willis (2014) flipped a precalculus class, some of the students notified him within the first three class sessions that they did not think they would be able to succeed in the flipped environment. As Willis explained, “Before they even understood completely the expectations of the class, they had decided it would not work for them because it was not like their high school math classes” (p. 45). The next time Willis flips, he plans to provide a transition period for the students, in which he will lecture a short amount of time in the first few classes and then show the students where the same information could have been found in a video or the textbook.

Van Sickle (2015) also found that students did not immediately buy in to the idea of the flipped classroom. Van Sickle employed several strategies to help students become enthusiastic about the flipped model, beginning with an email sent before the first day telling students that the class would be a bit different from their other classes, thus making it essential to attend the first class session. On the first day of class, after explaining the inadequacies with the lecture model, Van Sickle showed the students a lecture video and a sample quiz. Van Sickle then cited research that shows the flipped model is effective, possibly more effective than a lecture model.

Some students were unable, or unwilling, to complete the class assignments. At the beginning of the semester the instructor met students that had full-time jobs, other classes, and/or families, and seemed unaware of that several hours of study would be required outside class throughout the week in order to do well in the class. During the first week, the instructor emphasized the necessity of taking time to view the videos and solve the video problems prior to coming to each class. On the first day of class 24 students were enrolled, and after the census date 20 students remained in the class.

As the semester progressed students became more aware of the amount of work required in keeping up in the five-week college algebra course. Several students found that they were unable to keep up, and by the end of the term only 14 students remained enrolled. Of the 14 students that remained enrolled, only 10 continued to submit video problems until the end of the term.

Both Moroney (2013) and Van Sickle (2015) reported difficulty in getting students to prepare for class. In college algebra Moroney flipped the teaching of the topic of radicals over two consecutive four-hour class sessions and used short quizzes at the beginning of class to determine whether students were prepared. Moroney reported that for the first flipped class session it appeared that only about a third of the class was prepared, and for second flipped class session about two-thirds of the class was prepared. Van Sickle (2015) offered two strategies to employ to ameliorate the situation: accountability and acceptance. Van Sickle describes giving quizzes, assigning points for notes, or requiring students to respond to the videos on a discussion board as means holding students accountable. The other strategy offered by Van Sickle is to accept that students will not prepare and to allow them to use their smartphones, laptops, and tablets in class to watch videos. Less-efficient students will likely have problems to take home, and "may see that they have not used their time wisely, and this may encourage them to prepare more in the future" (Van Sickle, 2015, p. 607).

Several students were underprepared for the course. The flipped classroom gave the instructor the opportunity to work with students individually, answering their questions and explaining topics that were not clear. Working with students individually allowed the instructor to determine exactly why students were having difficulty in solving problems.

The instructor found that several students were mathematically underprepared for the course. There were students in the class that were unable to perform basic algebraic manipulations, such as grouping like terms or applying basic rules of exponents. Many students were unable to factor quadratic polynomials. Underpreparedness, combined with the accelerated pace of the five-week college algebra course, seemed to make the course overdemanding for several students.

Some students were unable to solve basic problems, even after taking a complete set of video notes. On several occasions a student would have a complete set of video notes in class but would still be unable to solve a basic pertinent problem. It appeared that some students had copied notes from the video without understanding the mathematics explained in the video.

Some students lacked confidence. Some students became discouraged with their ability to keep up in learning the course content and expressed concern that they might not be able to pass the class. The instructor sought to instill confidence in the students by making it clear to students exactly what they should do to have the best chance of succeeding in the class.

The instructor advised students to view the assigned videos, take notes, solve the video problems, and then to seek any help that might be needed in completing the video problems or understanding topics that were explained in the videos. The instructor reminded students that the video problems could be solved using the methods shown in the videos. The instructor also told students that he was always willing to answer any questions and that help was available in the Math Lab both before and after class.

Some students were hesitant to ask questions in class. Although most students seemed comfortable in asking the instructor questions as he moved throughout the classroom, a small number of students asked very few questions. The instructor was concerned because the students who asked very few questions were not doing well in the class.

Hoping to help the seemingly timid students feel more relaxed in the classroom, the instructor solicited questions from each of those students and patiently explained the topic or problem solution of interest in a calm and reassuring manner. Unfortunately, those students continued to ask very few questions for the remainder of the term.

Some students enjoyed working with other students, while others chose to work alone. Some students chose to work with the students in their group, while other students seemed to prefer working alone. Students were free to sit wherever they liked in the classroom, and during the five-week term many students moved to different locations in the classroom.

Students sitting together were free to socialize and discuss any topic they wished to discuss. Students were also allowed to remain working alone if they had chosen to do so. The learning theory of constructivism claims that people use both individual experiences and social interaction to create knowledge (Pelech & Pieper, 2010), so the instructor allowed students to learn in the manner in which they felt most comfortable.

Grading for the flipped classroom can be time consuming. In the flipped college algebra classroom, students submitted video problems at the beginning of class and submitted a quiz at the end of class. The instructor found that grading video problem assignments that included multiple problems and a multiple-problem quiz can be time consuming, especially during a condensed five-week summer term with classes meeting four consecutive days of the week.

Students performed well in spite of challenges. Of the 14 students that remained enrolled at the end of the term, six students received a semester grade of A, B, or C. The instructor is experienced in teaching college algebra, having done so over 30 times. Given that several students were underprepared for the course, and that the course was condensed from the typical 16-week long semester into a five-week summer term, it is the instructor's opinion that the students did as well as could be expected. In fact, the instructor was impressed at the level of understanding that was achieved by the six successful students in such a short amount of time.

Discussion

In the United States, college algebra is a difficult course for most students, as evidenced by its relatively low passing rates (Haver et al., 2007; Ogden, 2014). When the pace of the course is three times as fast as the pace of the course during the typical 16-week long semester, it is unsurprising that students find the course even more difficult, and many students are unable to keep up.

Flipping offers numerous advantages over traditional lecture-based instruction. Bergmann and Sams (2012) list the following reasons to flip a classroom—and benefits for doing so—in their book *Flip Your Classroom: Reach Every Student in Every Class Every Day*:

- Today's students grow up with Internet access, including access to websites for posting pictures, sharing videos, and online socializing. Students are comfortable with digital learning: "All we are doing is speaking their language." (p. 20).
- With lessons on video, students are able to pause and rewind their teacher. Lectures move too fast for some students and too slowly for others. The pause and rewind features of online video delivery given students the ability to process the lesson more slowly, and repeat it if necessary.
- Flipping increases student-teacher interaction by eliminating the need for in-class lecture. Bergmann and Sams point out that they "are not advocating the replacement of classrooms and classroom teachers with online instruction" (p. 25). Rather, the time made available inside the classroom by flipping gives students the opportunity for greater face-to-face interactions with their teacher. With increased student-teacher interaction, students and teachers have opportunity to build better relationships.
- Flipping increases student-student interaction because the role of the teacher changes. The teacher is no longer a presenter of content, but a facilitator of learning. Bergmann and Sams develop a culture of learning by getting students to identify learning as their common goal. Students then begin to form their own collaborative groups and help "... each other learn instead of relying on the teacher as the sole disseminator of knowledge" (p. 27).
- Flipping allows teachers to differentiate instruction. A flipped classroom allows an instructor to provide struggling students with help on basic concepts and explain more complex topics to advanced students in the same classroom.

Van Sickle (2015) lists the following benefits that she observed in flipping college algebra.

- Students spend class time thinking and doing problems, rather than listening to the instructor talk.
- The flipped model is very helpful for students with special needs, whether diagnosed or not.

Taking notes and recording lectures in class for students with learning disabilities is not necessary in a flipped classroom since the lectures are already recorded, and the student can pause and replay the video as many times as necessary.

- Students fearful of mathematics benefit from the flipped model. Instead of panicking, students can simply ask the instructor when they have trouble.
- Students who must be absent from class need not get behind. Students can view the videos and work on problems outside class and ask questions upon returning to class.
- Flipped instruction allows the instructor to forge better relationships with the students. This allows the instructor to better address the student's mathematical needs and helps the student feel more comfortable in coming to the instructor for help.
- In a flipped classroom, students have the opportunity to get to know and help each other. Even knowledgeable students benefit from explaining mathematics to other students.

- An instructor may be able to provide enough support for a hard-working student in need of remediation to pass the course.

Moreover, a survey of the research literature found that although student perceptions of the flipped classroom are somewhat mixed, overall they are generally positive (Bishop & Verleger, 2013).

A disadvantage of using online videos to flip a college algebra classroom, as noted in 66.7% of the essays in this study, is that students cannot ask questions about the video lesson outside class without going to the Math Lab. However, inside the classroom the instructor can answer questions concerning not only the video and video problems, but the problems assigned in-class as well. And the flipped classroom greatly increases the time available for student-teacher interaction, giving students much greater opportunity to ask questions, and allowing the instructor to take time to explain problem solutions, and underlying concepts, in as much detail as needed.

In this study some students asked very few questions during the term or usually worked alone. Those students did not seem to be aware of primary advantages of the flipped classroom, namely, the time made available inside the classroom for student-teacher and student-student interaction. Many students in the flipped college algebra classroom were either unable or unwilling to perform the work required outside class in order to succeed in the course. Many students were underprepared for the course. Also, the pace of the course was about three times faster than the pace of the typical 16-week college algebra course. Most likely it was a combination of such factors that resulted in less than favorable impressions of the flipped college algebra classroom.

Limitations of the Research

The findings that are reported in this study may have been influenced by factors not relevant to the flipped classroom itself. Such factors include those related to researcher bias, participant observation, participation bias, and the survey instrument.

Researcher bias. The researcher attempted to remain neutral regarding all aspects and activities of this study, including observation of the flipped classroom, analysis of data, and reporting of perceptions. Nevertheless, the possibility remains that results were influenced by the researcher's personal biases and idiosyncrasies.

Participant observation. Human perception is selective, and the perceptions recognized and recorded by the instructor might be different than perceptions that would be recognized by other instructors. In fact, even a single event or activity may be perceived differently by different individuals.

Participation bias. Students were awarded extra credit for submitting an essay and responding to the online survey. There were three students who earned a term grade of A or B and did not submit an essay, possibly because they did not feel that they needed the extra credit. Had those students submitted an essay, the reported student perceptions may have been somewhat more positive.

Survey instrument. It may have been possible to improve the survey instrument. Psychometric techniques may have found problems with the questionnaire and suggested changes to better capture student perceptions.

Recommendations

A flipped college algebra classroom, in which students view videos, take notes, and solve video problems outside class and then solve more problems in class under the guidance of the instructor, offers many advantages over a lecture-based class. The class may require as much work for the student as a lecture-based class, but in a flipped college algebra classroom, help is more readily available during problem solving, which is when the student will likely need it the most. The researcher anticipates more positive perceptions in the near future, when students will take the course during 16-week semesters and meet only twice per week.

Suggestions for flipping a college algebra classroom, as described in this article, follow. The recommendations are supported by the findings of this study.

Explanation of learning. In over half of the essays, students complained that they could not ask questions about video lessons without going to the Math Lab. This is a drawback inherent in learning from videos, but the time made available inside the classroom for both active learning and personal interaction between the instructor and student more than compensates for not being able to ask a few questions during a live lecture. During the class time made available in a flipped classroom, an instructor can more patiently and completely answer any questions that a student might have.

Nevertheless, it is important for students to understand that not being able to ask a limited number of questions during a live lecture does not prevent them from learning course content. As stated in Jaster (2013):

> It should be explained that the purpose of each video is to give students a basic understanding of the concepts and an overview of the problem solving techniques taught in the section. Students should expect most of their learning to occur during [in-class] problem solving, which will take place in the classroom where help is available from peers and the instructor. True, the video cannot

answer questions, but it should be explained that *many* more questions will arise during problem solving. Students need to understand that help will be available where most learning will occur and where they'll have the most questions. (p. 177).

Such an explanation may allow students to better accept and benefit from a flipped classroom.

Instructor workload. To manage grading, instructors could consider grading only a subset of the submitted video problems and quiz problems. For example, the instructor could choose to grade only one randomly chosen video problem and the one randomly chosen quiz problem, or the instructor could choose to grade only one problem randomly chosen from all the submitted video problems and quiz problems.

Also, to save time for both the students and the instructor, quizzes could consist of only one problem. Even consisting of only one problem, the quiz would still help students remain focused on the assignment during in-class problem solving and serve as a means of checking attendance at the end of class.

References

Amresh, A., Carberry, A. R., & Femiani, J. (2013). Evaluating the effectiveness of flipped classrooms for teaching CS1. *Proceedings of the 2013 Frontiers in Education Conference*, 733-735. Retrieved from http://fie2013.org

Baker, J. W. (2000). The 'classroom flip': Using web course management tools to become the guide by the side. In J. A. Chambers (Ed.), *Selected Papers from the 11th International Conference on College Teaching and Learning* (pp. 9-17). Jacksonville, FL: Florida Community College at Jacksonville.

Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. Arlington, VA: International Society for Technology in Education.

Bishop, J. L., & Verleger, M. A. (2013). The flipped classroom: A survey of the research. *Proceedings of the 2013 ASEE Annual Conference and Exposition*. Retrieved from https://peer.asee.org

Blair, R., Kirkman, E. E., & Maxwell, J. W. (2013). *Statistical abstract of undergraduate programs in the mathematical sciences in the United States*. Providence, RI: American Mathematical Society.

Carmines, E. G., & Zeller, R. A. (1979). *Reliability and validity assessment*. Thousand Oaks, CA: Sage.

Carroll, S. (2015a). *Instrument reliability*. Retrieved from http://www.dissertation-statistics.com/instrument-reliability.html

Carroll, S. (2015b). *Instrument validity*. Retrieved from http://www.dissertation-statistics.com/instrument-validity.html

Cohen, P. A., Ebeling, B. J., & Kulik, J. A. (1981). A meta-analysis of outcome studies of visual-based instruction. *Educational Communication and Technology, 29*, 26-36.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, USA*. doi:10.1073/pnas.1319030111

Gannod, G. C., Burge, J. E., & Helmick, M. T. (2008). *Using the inverted classroom to teach software engineering. 30th International Conference on Software Engineering*. doi:10.1145/1368088.1368198

Haver, W., Small, D., Ellington, A., Edwards, B., Kays, V. M., Haddock, J., & Kimball, R. (2007). College algebra. In V. J. Katz (Ed.), *Algebra: Gateway to a technological future*, 33-40. Washington, DC: Mathematical Association of America.

Herreid, C. F., & Schiller, N. A. (2013). Case studies and the flipped classroom. *Journal of College Science Teaching, 42*(5), 62-66.

Jaster, R. W. (2013). *Inverting the classroom in college algebra: An examination of student perceptions and engagement and their effects on grade outcomes* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Full Text. (Order No. 3577788).

Jensen, J. L., Kummer, T. A., & d. M. Godoy, P. D. (2015). Improvements from a flipped classroom may simply be the fruits of active learning. *Life Science Education, 14*(1). doi:10.1187/cbe.14-08-0129

Kirk, J., & Miller, M. L. (1986). *Reliability and validity in qualitative research*. Beverly Hills, CA: Sage.

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *Journal of Economic Education, 31*(1), 30-43. doi:10.2307/1183338

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco, CA: Jossey-Bass.

Moroney, S. P. (2013). Flipped teaching in a college algebra classroom: An action research project. *Proceedings of the 18th Annual TCC Worldwide Online Conference*. Retrieved from http://etec.hawaii.edu/proceedings/masters/2013

Ogden, L. (2014). *Flipping the classroom in college algebra: A design and development study* (Unpublished doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Full Text. (Order No. 3618131).

OpenStax College. (2015a). *About us*. Retrieved from https://openstaxcollege.org/about

OpenStax College. (2015b). *College algebra*. Retrieved from https://openstaxcollege.org

Overmyer, G. R. (2014). *The flipped classroom model for college algebra: Effects on student achievement* (Unpublished doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Full Text. (Order No. 3635661).

Pelech, J., & Pieper, G. (2010). *The comprehensive handbook of constructivist teaching.* Charlotte, NC: Information Age Publishing.

Sams, A., & Bergmann, J. (2013). Flip your students' learning. *Educational Leadership, 70*(6), 16-20.

Student Public Interest Research Groups. (2014). *Fixing the broken textbook market: How students respond to high textbook costs and demand alternatives*. Boston, MA: Author. Retrieved from http://www.studentpirgs.org/textbooks

Van Sickle, J. (2015). Adventures in flipping college algebra. *Primus: Problems, Resources & Issues in Mathematics Undergraduate Studies, 25*(8), 600-613. doi:10.1080/10511970.2015.1031299

Vogt, W. P. (2006). *Quantitative research methods for professionals in education and other fields.* Boston, MA: Allyn and Bacon.

Willis, J. A. (2014). *The effects of flipping an undergraduate pre-calculus class* (Unpublished doctoral dissertation). Retrieved from https://libres.uncg.edu/ir/asu/f/Willis,%20Jason_2014_%20Thesis.pdf

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Appendix A
Essay Assignment

The instructional approach in our class is different than in other college algebra classes since students are expected to watch videos and take notes *outside* of the classroom, and then solve problems *inside* the classroom. This approach to instruction is an example of a *flipped classroom*.

A study is being conducted of our class for mathematics education research. By completing this extra-credit assignment you will be participating in the study and providing data that may be used to improve mathematics education. Participation is voluntary and participants may withdraw from the study at any time without penalty. Your grade in the class will in no way be negatively affected by any aspect of the study. Students who choose to participate in the study by submitting an anonymous essay will receive 10 points extra credit on the final exam.

To receive extra credit the essay submitted must be at least one full page and no more than two pages in length, typed double spaced in a 12-point font on 8½ x 11 paper, and have one-inch margins on all four sides. The first line may be used for a title for the essay; all remaining lines must be used for the body of the essay. Each paragraph may be indented by ½ inch, and there should not be any extra spacing between paragraphs. This statement of the extra-credit assignment that you are reading conforms to these requirements.

Each student will be able to submit their essay anonymously by inserting it into a large envelope to be passed around during class. Students will sign a roll sheet taped to the front of the envelope so that extra credit can be awarded to those students who submit an essay. If any essay fails to meet any of the formatting requirements it will be rejected, and the essays will be returned and recollected. Rejected essays may not be resubmitted.

The study is primarily concerned with student perceptions of a flipped college algebra classroom. Besides the formatting requirements previously described, the only other requirement is that the essay describe what you think about the flipped college algebra classroom. In doing so you may answer all, some, or none the following questions.

- What do you think about learning college algebra by viewing videos and taking notes outside of class, and solving problems in class?
- What do you like or dislike about the flipped classroom?
- Which component(s) of the flipped classroom (video viewing, note taking, video problem solving, in-class problem solving, and/or quizzes) do you find the most or least beneficial in terms of learning?
- If you were to take the class again, would you prefer a flipped format or the traditional lecture format?
- Do you believe that you are learning better in the flipped classroom than if the class were being been taught using traditional lecture?
- Does the flipped classroom require more or less work than a lecture-based class?
- Does learning in a flipped classroom result in a more efficient use of time, so that you can learn as much (or more) with less effort? Or is the opposite true?
- How can the flipped college algebra classroom be improved?

Only hard copies of the essay will be accepted. Essays may be submitted early, but no essays will be accepted late. **The essay is due at the beginning of class on Thursday, June 25, 2015.**

Appendix B
Questionnaire

For each item, except items 9, 18, and 20, the student indicated her or his level of agreement with the statement by choosing one of the following responses.

1 Strongly Disagree 2 Disagree Somewhat 3 Neutral 4 Agree Somewhat 5 Strongly Agree

For items 9, 18, and 20, the student chose one of the responses shown with the item below.

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1. I feel that viewing videos, and perhaps taking notes while doing so, contributes to my learning.
2. I feel that solving video problems contributes to my learning.
3. I feel that solving problems in class contributes to my learning.
4. I try to learn as much as possible while viewing the videos.
5. I find it helpful to view videos and solve video problems before coming to class, so that in class I can ask and get answers to non-basic questions.
6. Solving problems in class instead of outside class allows me to better focus on the assigned problems.
7. I prefer the flipped classroom format to the traditional lecture format.
8. I feel that I had sufficient knowledge of mathematics at the beginning of the semester for taking this course.
9. On average, I've watched about _____ of each assigned video at least once.
   1: 0%-19% 2: 20%-39% 3: 40%-59% 4: 60%-79% 5: 80%-100%
10. I believe that I am able to learn college algebra better with flipped classroom instruction than with traditional lecture-based instruction.
11. I like being able to speak with my instructor during class and receive individual help when solving problems.
12. I would like my future mathematics instructors to teach using a flipped classroom approach.
13. I have previously taken a College Algebra course within the last two years AND had already been exposed to most of the mathematics taught in the course prior to the first day of class.
14. I frequently pause or repeat segments of the videos in order to increase my understanding of the material.
15. I feel the flipped classroom offers me greater opportunity to learn college algebra than the traditional in-class lecture with outside-class problem solving.
16. Giving and receiving help with other students in my group increases my learning.
17. The flipped classroom, with content delivery outside class, and problem solving in class, is an instructional method especially appropriate for mathematics.
18. I've watched approximately _____ of the videos that have been assigned this semester.
   1: 0%-19% 2: 20%-39% 3: 40%-59% 4: 60%-79% 5: 80%-100%
19. I enjoy being able to work with other students in the classroom.
20. At the end of the semester, I expect to receive a grade of _____.
   1: A 2: B 3: C 4: D 5: F or W