The Effects of Flipping the Classroom on Classroom Environment and Student Achievement

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Abstract

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Acknowledgements

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Chapter One

Introduction

The classroom environment is ever-changing, and teachers must adapt in order to best meet student needs. During my first six years of teaching I experienced two big changes - the further integration of new technologies into the classroom, and a movement toward a national set of math standards, known as Common Core State Standards for Mathematics (CCSSM). Many teachers hope CCSSM will provide solutions to the inch-deep and mile-wide content conundrum. In some respects, CCSSM are more focused than previous math standards. However, I find myself devoting additional instructional time to lecturing in order to cover these rigorous standards. As a result, I sacrifice question and answer time, as well as peer-to-peer collaboration opportunities.

The CCSSM has changed the learning environment and challenged me to do more with the same amount of classroom minutes. I struggle to cover every standard while still providing sufficient time for interactions with and amongst students. I also struggle to keep students engaged while devoting more time to direct instruction. The novel concept of the flipped classroom has recently been implemented by educators to address these very issues. In the flipped classroom, teachers record lecture material students watch outside of class. By video recording part of classroom lectures, more class time should be available for activities and homework questions. Less class time should be spent on delivery of new concepts, so students can instead actively engage in processing content and collaborating with peers. Demands of increased lecture time, as well as access to technology, have pointed educators toward the flipped classroom.
Motivation for the Project

Good teachers constantly reflect on their teaching practices and look for ways to improve their delivery of content. This year at Fargo South High School, sophomores, juniors, and seniors received personal learning devices. These tablets extend the possibilities of classroom instruction. Therefore, the idea of flipping the classroom is a common topic of discussion in my district. The interactive whiteboard in my room provides me with a platform to record videos. After six years of teaching, I want to update my instruction and keep students engaged. Flipping the classroom will force me out of my comfort zone.

This past year, I made a concerted effort to encourage collaboration in my classroom. I often had students share ideas or brainstorm with a partner. In the future, I would like to incorporate more collaboration into my classroom. Higher order thinking requires students to formulate and deliver an explanation, and they are often the best interpreters of a problem. Perhaps the flipped classroom model can increase time for students to become more active participants in the learning process.

Background on the Problem

The mathematics classroom has undergone many changes in the past two decades, including increased accountability. Students are expected to meet rigorous mathematical standards to prepare for college. In the past few years, the CCSSM was developed as a way to move toward a set of unified national standards. At the high school level, implementation of these standards requires teachers to know and teach more challenging mathematics. In the fall of 2011, my school adopted textbooks that meet the CCSSM. When this happened, my lectures increased approximately 10 minutes, or 20%, in each 50-minute class. As I attempted to cover all CCSSM concepts, I scrambled to interact with students and address their questions.
Access to technology also continues to transform education. For example, graphing calculators are now on school supply lists. Fargo South High School first mounted interactive whiteboards during fall of 2007 when I started my teaching career there. Now, the district is distributing personal learning devices to students. Many teachers wonder how they can effectively incorporate these technologies into everyday routines in the mathematics classroom. Perhaps the answer lies within the flipped classroom.

While some educators have used video podcasts for years, the notion of the flipped classroom is relatively new. Limited research has been conducted on the flipped classroom, which does not simply involve linking lectures online. The newest wave of personal learning devices provides a great opportunity to incorporate technology into instruction through the flipped classroom model. This flipped classroom model in turn does not limit lecture time to the 50 minutes available in class. By providing access to lectures outside the classroom, more time should be available to address student questions, increase teacher and student interactions, and augment student understanding of content.

**Statement of the Problem**

Due to implementation of the CCSSM, more material needs to be taught. As a result, less time exists for student questions, interaction with and amongst students, and activities which encourage discussion and emphasize applications of mathematical concepts. In addition, students at Fargo South High School received personal learning devices this year, which has prompted some teachers to consider the flipped classroom. By utilizing technology outside of class to deliver a portion of lecture material typically taught in class, perhaps more time will be available for students to engage with the mathematics and interact with each other and the teacher.
Statement of Purpose

The purpose of this study is to investigate effects of the flipped classroom model on classroom environment and student achievement. I will collect data on in-class lecture time, interaction time with and amongst students, student engagement, and overall grade trends for homework and assessments. Ultimately, utilizing technology should reduce class time traditionally spent on lectures. As a byproduct, I hope the flipped classroom will provide students with more time to interact with each other and with me, thus increasing student engagement and achievement in my classroom.

Research Questions

The main research question is as follows: How does flipping the classroom change the classroom environment? Related sub-questions include:

- Does flipping the classroom reduce lecture time in class, and as a result, allow for more interactions with and among students?
- Does flipping the classroom increase student engagement and achievement?

Definitions

*Flipped classroom* – According to Strayer (2012), the flipped classroom “uses technology to move lectures outside the classroom and uses learning activities to move practice with concepts inside the classroom” (p. 171).

*Personal learning devices* – “smart phones, iPod Touches, tablets, laptops, netbooks, or any other Internet enabled device” (Hegna, 2011, para. 1).

*Video podcasts* – audio or visual files which are distributed in digital format and can be downloaded from the internet or directly distributed to an audience (McGarr, 2009).
Summary

Teaching is a dynamic profession. Due to the rigor of CCSSM, topics once taught in fourth course advanced math classes are now being taught in first course algebra one classes. Increased pressure and accountability to cover these standards caused me to elongate classroom lecture time. Longer lectures potentially compromise student engagement levels and interaction time with and amongst students. As tablets are placed in the hands of my students, new opportunities arise to change the learning environment. While flipping is a relatively new idea, it shows promise as a way to alleviate pressures associated with limited classroom minutes through tapping into the availability of technology. The flipped classroom could allow for more contact time with students, as well as increase opportunities for peer collaboration. This study aims to analyze the effects of the flipped classroom on the learning environment and student achievement.
Chapter Two

Review of Literature

The flipped classroom recently developed in response to a variety of changes in the classroom environment, including learning preferences of students, limited classroom minutes, and increased access to technology. Thus, one flipped classroom may look different from the next. The following review of literature examines effects of flipping the classroom. Specifically, this chapter focuses on student and teacher collaboration, student engagement, student achievement, and reactions to flipping. This review of literature serves as a guide for further study and implementation of the flipped classroom model.

The Flipped Classroom

The “flipped classroom” is a new catch phrase in education, but is not a completely novel idea. Teachers often assign reading to be done at home, and then expect students to engage in conversation about the reading in class. This design could be classified as an inverted classroom (Strayer, 2012). However, a few key characteristics distinguish the flipped classroom from an inverted classroom. In the flipped classroom, students watch video-recorded lectures outside of class, thus increasing time for active learning and practice to occur in class (Strayer, 2012). While implementation of this method may look slightly different for each teacher, essentially “the ‘flipped’ part of the flipped classroom means students watch or listen to lessons at home and do their ‘homework’ in class” (Fulton, 2012, p. 13).

Online learning has various definitions. Historically, video lectures were created to provide curriculum access to individuals who lived far from school. Teachers began realizing videos not only helped off-site students, but also students who were present during lectures (Cascaval, Fogler, Abrams, & Durham, 2008). Online classes gained popularity in the past
decade, especially at the college level. However, students commonly complained about limited interaction and communication in purely online classes (Gecer & Dag, 2012). Flipping the classroom involves online learning through a series of video lectures, but is supported by face-to-face classroom discussions and individual help. Thus, the flipped classroom is different from traditional online learning environments.

Traditional classroom lectures often follow a one-pace-fits-all philosophy. Teachers may adjust their lectures based on student feedback, but some students will undoubtedly find the pace swift, while others find it slow. Video lectures provided through the flipped classroom model allow students to fast forward through examples they already understand, or pause and rewind to revisit topics which may require more processing time (Goodwin & Miller, 2013). Videos allow lectures to be broken into pieces, as opposed to traditional instruction which often contains a large volume of content delivered at one time (Brecht & Ogilby, 2008).

Salman Khan, a widely recognized online educator, popularized the flipped classroom through his website, Khan Academy. This website contains over 4,120 short educational videos, most detailing a specific math concept (Thomas, 2013). Khan works problems step by step on each video. “Khan’s idea was that youngsters would watch the videos at home and work on problems in class, essentially ‘flipping’ the classroom” (Kronholz, 2012, p. 25). Students also frequent the website to get homework help when they are stuck on a problem. Khan seeks to change the way people think about education, noting “the old classroom model simply doesn’t fit our changing needs” (Khan, 2012, p. 1).

Many schools have used Khan’s videos to flip the classroom. Greg Green, principal at Clintondale Community Schools in Michigan, commended the flipped classroom for its ability to assist students who do not get homework help at home (Finkel, 2012). Students now receive
guidance at home in the form of video lectures, and can directly interact with teachers and peers during class time to get answers to their questions. Teachers utilizing Khan Academy to flip their classrooms realize they often work harder during the school day as they are always moving around and interacting with students. It must be noted Khan Academy is not meant as a fix-all. Math teacher Courtney Cadwell commented Khan “is not great at helping kids conceptualize math” (Kronholz, 2012, p. 26). Video lectures need to be supplemented with activities which encourage discussion and emphasize the application side of mathematics. When flipping the classroom, teachers must constantly interact with students, adjust instruction on the fly, and design activities which complement the videos.

**Changing the Classroom Environment**

*Student collaboration.* Technology allows for various classroom environments and methods of instruction (Gecer & Dag, 2012). In recent years, differentiated instruction gained attention in education. Tomlinson (2005) pointed out differentiation should involve individual, small group, and whole class time. The flipped classroom allows for all of these recommended elements of instruction. In fact, Strayer (2012) found students receiving instruction in a flipped classroom environment were more willing to work together as compared to those receiving instruction in a traditional setting. Through interviews conducted during his research on the flipped classroom, Strayer noticed many students in the flipped classroom appreciated learning with a partner, whereas group learning was minimally mentioned as correlated with success in traditional instruction settings. Herreid and Schiller (2013) observed a similar theme when examining case study teaching with the flipped classroom model: “Active learning works best. Telling doesn’t work very well. Doing is the secret” (p. 65).
A study involving 476 fourth and fifth grade Texan students found differentiated instruction was more prominent in classrooms utilizing computer instruction, versus control classrooms which relied primarily on teacher modeling. Half of the control classrooms made time for students to learn on their own, while this aspect was always present in the experimental classrooms using computers. Also, about twice as many one-on-one teacher and student conversations occurred in the experimental classrooms (Rosen & Beck-Hill, 2012). While large group instruction certainly has its benefits, the flipped classroom allows for this type of instruction to not dominate classroom minutes. Watching part of the lecture on the computer promotes active learning and provides more opportunities to interact with students and differentiate instruction.

Learning in a small group setting is not always intuitive for students. In his experience with peer collaboration in the flipped classroom, Strayer (2007) observed students who shied away from group work. Some of his students began doubting themselves after arriving at a different answer than the rest of the group. Instead of discussing these differences with the group and using them as a learning experience, individuals began isolating themselves. It appeared some students would rather work alone with an incorrect answer than work with a group and discover the correct solution (Strayer, 2007). According to veteran math teacher Rob Warneke, “Kids need to be trained and guided to stay on task, work collaboratively, solve their own problems, be disciplined. This is harder than making everyone be quiet during a lecture” (Fulton, 2012, p. 14). Clearly, student collaboration can be a key component of the flipped classroom. However, collaboration is not always intuitive to students. Teachers must foster positive collaboration within the classroom, and allow students time to become comfortable with this process.
Strayer (2007) reviewed multiple studies on learning styles associated with the flipped classroom in his dissertation. A 2004 study conducted by Broad, Matthews, and McDonald revealed when online learning was integrated into a college accounting course, students were more focused on the process of learning rather than the end result. “This suggests students have adjusted their approach to learning and as a result of the change in the learning environment” (Strayer, 2007, p. 66). Instead of concentrating on the answer, classroom discussion can shift to why a solution works, or the cognitive processes involved. Adjustments in learning styles may not happen overnight, but the flipped model allows for such active learning and classroom discussions.

**Student engagement.** Audas and Willms (2001) defined student engagement as “the extent to which students participate in academic and non-academic school activities, and identify with and value schooling outcomes” (p. 12). Creating a classroom environment which keeps all students engaged in the learning process constantly challenges teachers. This is especially difficult when a classroom contains learners with wide ranges of mathematical abilities. Teachers need to cover a large amount of material while holding high expectations for all students, including those who are not fundamentally sound (Brecht & Ogilby, 2008). If students are unable to comprehend classroom content, they may shut down. Similarly, students may disengage if the material is delivered too slowly or is not stimulating. The flipped classroom aims to engage students from both ends of the spectrum. Video lectures can provide basic examples and review of background knowledge, thus allowing more time in class for higher level thinking and active learning (Brecht & Ogilby). Advanced students can skim through the videos, yet actively engage with more difficult concepts in class; while struggling students can watch the videos at their own pace, then practice the skills in class.
Today’s students, who have always been surrounded by technology, learn differently than students from previous generations (Skiba & Barton, 2006). Students are accustomed to accessing information quickly and efficiently. Technology is an inherent part of their lives. According to Havana, Illinois Superintendent Mark Twomey (as cited in Finkel, 2012), “‘All you have to do is watch kids in their free time. They always have some sort of electronic device in front of them’” (p. 30). The “Net Generation,” or “Millennials,” refers to people born in the 1990s and early 2000s (Howe & Strauss, 2000). “Net Generation characteristics include digital literacy, experiential and engaging learning, interactivity and collaboration, and immediacy and connectivity” (Skiba & Barton, 2006, para. 10). Students expect information to be at their fingertips and want to actively engage with technology and one another. Expecting students to take notes during a 30-40 minute mathematics lesson may not be the best platform for delivering instruction. Teachers must adapt to new learning styles to keep students engaged.

Technology can be used to engage students. Media-saturated students should find video lectures attractive (Brecht & Ogilby, 2008). In a study involving 136 middle school students from Ontario, 80% reported they liked watching video podcasts in class. Although 41% of students found the videos boring, 90% still thought they were better than using the textbook (Kay & Edwards, 2012). These findings are consistent with the learning preferences of the Net Generation.

The flipped classroom is in tune with attention spans of today’s students. Research shows once someone’s attention has been grabbed, there is only about a 10 minute window to keep it (Medina, 2008). In a study where 59 problem-based video podcasts were created to cover five units in a college pre-calculus course, researchers Kay and Kletskin (2012) analyzed data on video length. The mean video length was 7 minutes 40 seconds, with the longest video being 14
minutes 50 seconds. Each video included a problem the teacher explained, and a related problem the student had to solve. The mean time spent on the website was just under 6 minutes. Overall, 4,500 videos were watched by 195 students over a 3 week period, and 87% of the users found the videos to be useful. This study, paired with Medina’s research, indicates optimal video length is around 10 minutes. The videos on Khan Academy also seem to support these findings, with Khan’s average video length being about 10 minutes (Thomas, 2013). While this may not allow time for coverage of all concepts, follow-up lectures in class would ideally be the same length. Various classroom activities can then be done to regain attention and focus (Medina, 2008).

**Student Achievement and Perceptions**

When properly implemented, schools using the flipped classroom model have observed increases in student achievement. In a survey of 453 teachers who flipped their classrooms, 67% noted an improvement in test scores (Goodwin & Miller, 2013). When Clintondale Community Schools in Michigan flipped their math classrooms, freshmen math failures dropped from 44% to 13% in just one year (Finkel, 2012). Data from the Byron School District in Rochester, Minnesota showed flipping the classroom increased student achievement by a notable amount. The number of students scoring 80% or above on calculus tests rose by nearly 10%, while pre-calculus showed an average increase of 6.1%. Similar results were observed in their Algebra and Geometry courses (Fulton, 2012).

Documented successes can perhaps be attributed to increased student and teacher contact time. Providing more time for teachers to interact with students, versus standing in front of the classroom and delivering content, is one goal of the flipped classroom. This contact gives teachers more opportunities to provide students with feedback (Goodwin & Miller, 2013). Feedback allows students to immediately learn from their mistakes. Students can receive
feedback not only from the teacher, but through collaboration with one another. As a result of classroom collaboration, the teacher in turn receives feedback from students. Such feedback can be used by teachers as a formative assessment, which is necessary to direct instructional plans (Tomlinson, 2005).

Educational studies have been conducted to investigate the importance of feedback in the classroom. A meta-analysis involving 717 students across multiple grade-levels and subjects found feedback had an effect size of 0.76 (Beesley & Apthorp, 2010). The closer an effect size is to 1.0, the more significant the result. When reviewing Beesley and Apthorp’s study, Goodwin and Miller (2013) noted, “Feedback has one of the strongest effect sizes of any instructional practice” (p. 79). Specific opportunities provided in class for students to practice concepts with corrective feedback was found to be almost four times as effective as homework the students completed without guidance (Beesley & Apthorp, 2010). Increased opportunities to provide feedback is one of the attractive features of the flipped classroom.

Flipped classrooms look different from one another; thus, reactions to the flipped classroom are not all positive. Many students have difficulty making connections between online lectures and classroom instruction and activities (Strayer, 2012). Teachers must put in extra effort to ensure the two pieces align. Finkel (2012) noted students prefer videos made by their teachers, as these videos are customized to fit the curriculum. Fulton (2012) confirmed most students prefer watching videos made by their teacher, although she noted some students gain new perspectives by watching a different teacher’s video from the same school. Pre-made videos from the internet or book resources may be less work, but the results may not be as favorable.
The flipped classroom presents other obstacles. A limiting aspect of the flipped classroom is internet access (Gecer & Dag, 2012). Educational institutions wishing to promote the flipped classroom must ensure all stakeholders have access to appropriate technology. Also, according to Clark and Mayer (as cited in Kay & Kletskin, 2012), the ability to pause videos, rewind them, and watch them multiple times benefits many learners, but advanced students often find the videos tedious and too basic. Using videos to change the learning environment does not eliminate concerns involving the engagement all students.

Research shows the flipped classroom does not always positively influence the learning environment. Strayer (2007) conducted research involving two classroom models for delivering instruction in his college level statistics class. One class followed the traditional method of instruction; while his other class was flipped (students watched lecture videos from a tutoring system outside of class and did more projects and homework in the classroom). Strayer found students who received instruction through the flipped style were “less satisfied with how the structure of the classroom oriented them to the learning tasks in the course” (p. 4). Students in the flipped classroom seemed less comfortable with the style of learning, possibly because they were responsible for taking charge of the learning process. Their feelings could also be contributed to the fact Strayer, the instructor, did not make the videos for his students. Additionally, Strayer pointed out students need time to adjust to a radically different method of instruction.

Research reviewed in Strayer’s (2007) dissertation indicates participants in other studies preferred the flipped classroom. Students “felt they received more personal attention due to the structure of the class, had more control over their learning, and were able to engage in critical thinking that explored the implications of their learning” (Strayer, 2007, p. 62). Through his
research, Strayer found collaboration and participation were more present in flipped versus traditional classrooms. Decreased stress was reported among students watching the video lectures. A different study reviewed by Strayer found delivering content through traditional methods versus video lectures did not cause significant differences in pre-test and post-test results. While significant differences in student achievement were not evidenced by his research, the main distinction was an increased preference for collaboration among students in the flipped classroom (Strayer, 2007).

Research on the flipped classroom is new, but other studies have also shown no significant difference in student achievement. Finkel (2012) reported fifth-grade math teachers in Stillwater, Minnesota found flipping their classrooms had no effect on test scores, but did allow them to move at a faster pace. On average, the teachers covered two more weeks of material than in previous years. Teachers felt more freedom to differentiate instruction, and in turn, students developed a more positive outlook on math. Although scores did not rise, flipping produced other benefits.

Student commitment to watching video lectures outside of class affects the level of success experienced in the flipped classroom. Students who choose not to watch the videos are unprepared for in-class activities, as they do not have the necessary background knowledge. Many teachers who tried the flipped method gave a short quiz or assigned homework that covered information in the video (Herreid & Schiller, 2013). These activities increased student accountability to complete the “homework.” The level of success may also be attributed to quality of videos presented to students, as well as instructional preparation. Teachers must thoughtfully prepare for additional class time due to decreased lecture time. Clearly many
variables are involved, and different implementations of the flipped classroom produce varying results.

**Summary**

Today’s students have different learning preferences than students from previous generations, and teachers must adapt their instruction accordingly. Access to technology is more prevalent than ever before, and the flipped classroom taps into this resource. Assigning video lectures as homework can free-up class time, which in turn provides increased opportunities for teacher feedback and student collaboration.

The flipped classroom model addresses many learning styles of today’s students. The computer becomes an instructional medium; lessons are broken into manageable chunks; videos can be accessed at any time; and more chances are created for interaction with and amongst students. These features parallel the learning preferences of the Net Generation described by Skiba and Barton (2006). Research on the flipped classroom is relatively new, and its success appears to depend on its implementation. No single formula is proven to work, but the flipped classroom shows promise as a way to meet the changing needs of students.
Chapter Three

Research Design and Methods

There are different ways to flip the classroom. In this chapter, I describe my classroom setting and procedures for flipping. Also, I outline how data will be collected during this process to analyze changes in the learning environment and student achievement. Timelines for implementation and expected results are included.

Setting

This study will be carried out during my seventh year of teaching. All seven years have been spent at a large high school in North Dakota. This particular year, I am teaching three geometry classes and two algebra 2 classes. I chose to only flip my algebra 2 classes as I had no prior experience recording video lectures. Recording can be time consuming, and I wanted to create quality videos.

I will conduct research in my algebra 2 classes instead of my geometry classes for a variety of reasons. First, the mean age of my algebra 2 students is higher. Although they contain a few freshmen, my algebra 2 classes are primarily comprised of sophomores and juniors and a handful of seniors. Algebra 2 students typically complete more homework than younger geometry students. Second, about half of my geometry students have tablets from the school district this year, whereas all of my algebra 2 students received them. Last, the algebra 2 chapters I am flipping seem conducive to learning through video lectures. Some geometry chapters, such as those which rely heavily on proof, were not as intuitive for me to flip.

I will flip both of my algebra 2 classes to create a larger sample population. In the two classes, 40 students will participate in the study. Instead of using one class as the control group, I will use my two algebra 2 classes from the previous year as the control group. Therefore, I will
minimize any significant curriculum changes, including lecture and assessment materials. I will also attempt to maintain the prior year’s pacing. Last year, I had 22 students in my algebra 2 classes both semesters who were freshmen or sophomores, which would classify them as advanced students. I also had 23 juniors and seniors. This year, I have 23 students in my algebra 2 classes who are freshmen or sophomores, and 17 juniors or seniors. Thus, the ages of the students in the control and experimental groups are comparable.

**Intervention/Innovation**

During the **six/nine** weeks of this study, I will partially flip my classroom. Student attention spans must be considered when creating video lectures. Therefore, I will limit video lengths to 10-15 minutes, which is not enough time to cover the typical half hour I spend lecturing. Thus, I can only minimize, not eliminate classroom lecture material. Since a portion of all new lessons will be delivered through videos outside of class, and the rest will be delivered through lectures in class, my classroom will be partially flipped.

I will create a routine for my flipped classroom so students get in the habit of watching videos. Students will be assigned to watch a video outside of class before each new lesson. Videos will be linked through the district’s online assignment website at least 24 hours prior to class. Once students arrive in class, I will answer questions as usual. Then, they will be asked to attempt a few examples from the new lesson’s problem set, relying on their knowledge acquired from the video. Problem sets are daily problems I give my algebra 2 students to help them practice the material presented during the lecture. They are often worksheets I have pieced together, but occasionally are problems from a math textbook. I assign problem sets, traditionally referred to as homework, with each new lesson. Students will be encouraged to work with one another on problem sets, and I will use this time to address individual questions.
Some students will likely refer to notes they took during the video lecture to guide them. As a form of accountability, I will call a few students to the board to work out solutions to these problems. After the class feels comfortable enough to move on, I will lecture on any additional material not covered in the video. Then students will have time to work collaboratively or individually on the rest of the problem set. On a side note, my classroom is set-up so students sit next to a partner. All year I encourage each pair to share ideas when problem solving.

**Design**

Both qualitative and quantitative data will be collected to address the posed research questions. To better understand the effect flipping has on the classroom environment, a survey will be administered. This quantitative measure will give me feedback on engagement in class, collaboration opportunities, and overall perception of learning through the flipped classroom. Qualitatively, I will keep a journal to gather data on these same elements. As students may not elaborate on a survey, and I cannot observe everything as a teacher, I will attempt to triangulate data gathered on the learning environment by conducting student interviews. Interviewing a group of students will provide additional insight into student opinions. When analyzing the qualitative data, I will use inductive analysis to identify common themes in student responses and my journal entries.

Additional quantitative measures will be used to gather data. Throughout the year I will track how classroom minutes are spent. I will also track my algebra 2 students’ completion of problem sets throughout the year, as completion rates seem to be tied to success on quizzes and tests. To investigate student achievement, I will compare quiz and test scores of last year’s algebra 2 students to this year’s analogous scores using a $t$-test of independent samples.
Description of Methods and Analysis Strategy

Before beginning my research, I will receive approval from the principal at my high school (see Appendix A) as well as the associate superintendent of teaching and learning for the district (see Appendix B). I will also receive approval (see Appendix C) from Minot State University’s Institutional Review Board (IRB). Consent forms (see Appendix D) will be sent home with my algebra 2 students for their parents or guardians to sign prior to starting the study. Students will also be given an assent form (see Appendix E). These forms outline data collection techniques and my procedure for flipping the classroom, assure student confidentiality, and gain consent.

Throughout the school year, I will document the usage of classroom minutes on days when new material is administered in algebra 2 (see Appendix F). I will record approximately how many minutes I spend lecturing and answering questions over previous material, and how many minutes the students have to work on problem sets (see Appendix G for an example) to determine how classroom time is spent. Mean problem set completion rates for this year’s algebra 2 students will be tracked to reveal any trends from semester one to quarter three. Problem sets are not collected daily, but rather on quiz days which occur about once per week. I also will keep a detailed journal (see Appendix H) of my observations in class. During the flipped classroom intervention, I will record events I witness in the classroom as well as my perceptions about student achievement, engagement, and collaboration. After the six/nine weeks, I will review my journal and record the frequency of commonly appearing themes.

To assess student achievement, I will use mean percentages for quizzes (see Appendix I for an example) and tests (see Appendix J for an example) to compare students participating in the study (experimental group) to my previous year’s algebra 2 students (control group). First, I
will conduct a $t$-test of independent samples using first semester data to determine whether the two groups of students, control and experimental, are academically comparable. I will use four quizzes, and two tests which are extremely similar if not identical to the previous year’s assessments. The null hypothesis is no difference in mean achievement scores of the control and experimental groups; the alternative hypothesis is a difference in the means of the two groups. When analyzing results, I will use a 0.05 significance level. If the $p$-values of selected semester one assessments are greater than 0.05, I can conclude the academic performance of the control and experimental groups are not statistically different.

During the flipped classroom intervention, quiz and test grades will be recorded. These assessments will cover nearly identical material to previous year’s algebra 2 assessments. Independent $t$-tests will again be run using intervention period data to determine whether the students in the flipped classroom have significantly higher quiz or test scores than the control group. Results of these tests will be found in Chapter Four.

After six/nine weeks of flipping the classroom, a student survey (see Appendix K) will be administered in class. This survey contains 18 statements scored on a five-point Likert scale. For each statement, students indicate whether they strongly disagree, disagree, have no opinion or are neutral, agree, or strongly agree. Two free response questions at the end of the survey address positive and negative feelings associated with the flipped classroom. Students will be given at least 15 minutes to complete the survey. Survey questions were designed according to my research questions which address student engagement, collaboration with and amongst students, student achievement, and overall classroom environment. When reviewing survey results, I will take special note of questions in which data are skewed in one direction. For the free response questions, I will record the frequency of common themes.
Ten questions with similar themes were also created for student interviews (see Appendix L). The interview process will be semi-structured in format as some of the questions have optional sub-questions (Mertler, 2012, p. 124). The interview will include approximately six students gathered in my classroom simultaneously since the students and I have the same free period. I will choose students from varying ability and engagement levels as well as both genders and different ages to get an honest representation of student opinions. When analyzing interview questions, I will again identify common themes in responses.

By collecting qualitative and quantitative data through a variety of means, I will attempt to triangulate the data results. Although each method for gathering data is different, triangulation will allow me to be more confident with my results. Analysis of data collected along with interpretation of results can be found in Chapter Four.

**Expected Results**

Before conducting my research, I hypothesize flipping the classroom will cause lecture time in class to decrease. I predict students will be more engaged with problem sets due to increased work time. I strongly believe students will appreciate opportunities to collaborate with peers and ask me questions. These are themes I anticipate emerging from my journal notes, student surveys, and student interviews. Ultimately, I expect problem set completion scores to rise once the classroom if flipped. As a result, I anticipate quiz and test scores might also rise slightly compared to the previous year, but some research indicates I should not expect them to increase at a statistically significant level. It will be difficult to credit any positive results to one aspect of the flipped classroom as they could be attributed to video lectures, increased problem set completion rates, collaboration time, the content being studied, or other unknown reasons.
While I imagine students will appreciate more class time to complete problem sets, I anticipate mixed feelings toward learning through video lectures. Just as some students still prefer an actual textbook over an electronic textbook, some students probably prefer learning face-to-face versus through a video. I am certain not all students will watch every video every day; thus, I may spend more time answering questions than I would like. I do expect student engagement levels during class to increase, as shorter lecture time helps with student attention.

**Timeline for the Study**

The study itself will take six/nine weeks. During these six/nine weeks I will create 20 videos, one for each lesson. Classroom surveys will be completed shortly after the study is finished. Student interviews will also be conducted during the week following the study’s completion. Then, data will be analyzed and results of the study will be written up.

**Summary**

For six/nine weeks, I will flip my algebra 2 classrooms. During this time, students will be assigned to watch short videos covering part of the lecture material on their school-issued tablets as homework. One purpose of flipping is to allow more time for me to interact with students as they work on problem sets, and for the students to help each other. This change should influence student engagement levels, possibly increasing student achievement. To measure the effectiveness of the flipped classroom, data will be collected through a variety of qualitative and quantitative measures including student surveys, student interviews, teacher journals, a classroom minutes log, and assessment grades. Chapter Four contains results of the data collection process as well as an interpretation of those results.
Chapter Four

Results and Interpretations

Use an introductory paragraph to remind the reader of your purpose and to give them a brief description of what is included in this chapter.

Results of Data Analysis

Address each data collection method separately and provide its results (e.g., chapter test, survey, interview, etc.). Be sure to do the following:

- Summarize the results of surveys or other instruments.
- Display numerical or statistical results in tables or figures.
- Report the results of any statistical analyses you conducted.
- Theme and summarize narrative data, including representative quotes when appropriate.

Note: You may need to remind the reader of what you did to analyze the data while you are presenting the results.

Interpretation of Results

Revisit each research question and present the data that answer that question. Include the following:

- Did you successfully answer your question?
- Did you get the results you expected?
- Discuss significance and rigor (i.e., quality, validity, accuracy, credibility, trustworthiness) as needed.
- Discuss unusual circumstances as needed
Summary

Briefly summarize what you wrote in Chapter Four, highlighting the key findings, and transition the reader to the next chapter.
Chapter Five

Conclusions, Action Plan, Reflections, and Recommendations

Add an introduction here. Otherwise the two levels of headings, the one at the top that names Chapter Five and the Conclusions heading beneath it, are too close and look weird. You can reiterate your purpose and/or tell the reader what to expect in this chapter.

Conclusions

Draw conclusions about your research questions based on your results. Someone reading only this section should get a sense of your research purpose and findings.

Action Plan

Present a plan of action. What will you do now? Will you continue, modify, or throw out your innovation? Why? Speculate on your “next steps” in the action research cycle.

Reflections and Recommendations for Teachers

This section is all for you—your opinions, impressions, frustrations, and celebrations.

- What would you do differently?
- What were the highlights of your project?
- Advice to teachers about your intervention.
- Advice to teachers about action research.

Summary

This is the last paragraph of the paper. Briefly summarize what you wrote in Chapter Five and give any last comments that will help wrap up the paper.
References


doi: 10.3912/OJIN.Vol11No02Man04


doi: 10.1007/s10984-012-9108-4


Appendices
Appendix A

School Principal Consent Form

Dear Dr. Bertsch:

I am completing work towards the Master of Arts in Teaching: Mathematics degree through Minot State University. As a degree requirement, I am to conduct a research project in my classroom this year during third quarter. I am planning to analyze survey, interview, and assessment results to determine what effects flipping the classroom has on the learning environment. Specifically, I will be looking at collaboration with and amongst students, student engagement, and student achievement. To accomplish this, I would like to work with students in my sixth and seventh period algebra 2 classes. I chose my algebra 2 classes as they all have tablets.

During this time, I will tape 10-15 minute videos covering the same material I would normally teach during class. Watching these videos will be assigned as homework. The following day I will finish up the lecture in class, and students will have time to work on problem sets. At the conclusion of the study, students in my algebra 2 classes will complete a survey and some will be interviewed concerning the effectiveness of the flipped classroom. I will be keeping a daily journal, and will record how classroom minutes are spent. Also, quiz and test scores from this year’s algebra 2 students and last year’s algebra 2 students will be used for data analysis along with problem set completion rates. Classroom and student confidentiality will be observed regarding all data collected, and no individual will be identified by name.

Before the study begins, I will send home consent forms for parents/guardians to notify them of this project and request their permission, allowing their student to participate in the research study. Student consent forms will also be administered. A copy of these letters is attached for your inspection.

I am requesting you permit me to carry out this research in my classroom. Please contact me if you have any questions. Thank you for your consideration.

_______  I grant permission for Jessica Myxter to conduct the above mentioned research in her classroom.

_______  I do not grant permission for Jessica Myxter to conduct the above mentioned research in her classroom.

________________________________________________________
Signature of Dr. Todd Bertsch, Principal at Fargo South High School

_______________________________
Date
Appendix B

Associate Superintendent of Teaching and Learning Consent Form

Dear Dr. Grosz:

I am completing work towards the Master of Arts in Teaching: Mathematics degree through Minot State University. As a degree requirement, I am to conduct a research project in my classroom this year during third quarter. I am planning to analyze survey, interview, and assessment results to determine what effects flipping the classroom has on the learning environment. Specifically, I will be looking at collaboration with and amongst students, student engagement, and student achievement. To accomplish this, I would like to work with students in my sixth and seventh period algebra 2 classes. I chose my algebra 2 classes as they all have tablets.

During this time, I will tape 10-15 minute videos covering the same material I would normally teach during class. Watching these videos will be assigned as homework. The following day I will finish up the lecture in class, and students will have time to work on problem sets. At the conclusion of the study, students in my algebra 2 classes will complete a survey and some will be interviewed concerning the effectiveness of the flipped classroom. I will be keeping a daily journal, and will record how classroom minutes are spent. Also, quiz and test scores from this year’s algebra 2 students and last year’s algebra 2 students will be used for data analysis along with problem set completion rates. Classroom and student confidentiality will be observed regarding all data collected, and no individual will be identified by name.

Before the study begins, I will send home consent forms for parents/guardians to notify them of this project and request their permission, allowing their student to participate in the research study. Student consent forms will also be administered. A copy of these letters is attached for your inspection.

I am requesting you permit me to carry out this research in my classroom. Please contact me if you have any questions. Thank you for your consideration.

_____ I grant permission for Jessica Myxter to conduct the above mentioned research in her classroom.

_____ I do not grant permission for Jessica Myxter to conduct the above mentioned research in her classroom.

______________________________________________________________
Signature of Dr. Bob Grosz,  
Associate Superintendent of Teaching and Learning for Fargo Public Schools

______________________________
Date
Appendix C

IRB Approval Letter
Appendix D

Parent/Guardian Consent Form

The Effects of Flipping the Classroom on Classroom Environment and Student Achievement

A Research Project by Jessica Myxter

Invitation to Participate
Your child is invited to participate in a study involving the flipped classroom. Flipping the classroom centers on students watching video lectures for homework. In turn, this often allows more time to complete problem sets in class.

Purpose of the Research
I am currently completing work towards my Masters of Arts of Teaching: Mathematics degree through Minot State University. For my final degree requirement, I am conducting this action research project during quarter three to determine if flipping the classroom changes the classroom environment. Specifically, I will be focusing on student and teacher collaboration levels, as well as student engagement and achievement.

Basis for Subject Selection
Your child has been selected for my study because he/she is in algebra 2. As an algebra 2 student, your child has a school-issued tablet that can be used to watch video lectures. Many of the concepts studied during quarter three lend themselves nicely to the video lecture format.

Duration of Participation
This study will be conducted during the third quarter, which begins January 13th, 2014 and ends March 19th, 2014.

Specific Procedures
Due to the large amount of material covered in algebra 2, much of the class period is devoted to lecturing. After the lecture, students may have a few minutes to get started on the problem set as I circulate around the room. During third quarter, I will tape 10-15 minute videos which will replace part of the in-class lecture. In class I will lecture on any additional material not covered in the video. Then, students will have time to work on the problem set. Student homework will include watching the video prior to the next day’s lesson, and completing the problem set if they do not finish in class.
At the end of the quarter students will complete a survey on the environment of the flipped classroom. Some students may also be interviewed for their opinions. Survey responses, interviews, my observations, classroom minutes, homework completion rates, and assessment (quiz and test) results will be analyzed to determine whether the flipped classroom affects collaboration, student engagement and achievement levels, and the overall classroom environment. Results will be summarized and included in my research paper. No students will be identified in my results. This research study has been approved by the district office.

Benefits and Risks to the Individual
There are no direct benefits to participating in this study, but the data collected will be used to help improve the classroom environment. The risks to your student are no more than he/she would encounter in a regular classroom setting.

Confidentiality
The researcher (myself) will treat all data confidentially. All data including student assessments, problem sets, surveys, and interviews will be kept safe in a locked cabinet or on my password-protected computer. All data will be destroyed once the paper has been defended. The researcher agrees to maintain strict confidentiality, which means your name and your student's name will not be discussed or given to anyone. The researcher will also make sure confidential information will not be discussed in an area that can be overheard that would allow an unauthorized person to associate or identify the student with such information.

Voluntary Nature of Participation
During this study, survey responses and interviews do not have to be included. However, I hope you approve of your student being involved in this study because a large sample size improves the accuracy of the results of my study. If you decide to participate, you are free to withdraw your consent at any time during the study. If you do not consent or withdraw your consent, your student’s data will not be included in my results, your student will not complete the survey nor be interviewed, but your student will still participate in the flipped classroom as it is part of the course work.

Human Subject Statement
The Institutional Review Board of Minot State University has given me permission to conduct this research. If you have questions regarding the rights of research subjects please contact the Chairperson of the MSU Institutional Review Board (IRB), Dr. Bryan Schmidt, at 701-858-4250 or bryan.schmidt@minotstateu.edu.

Offer to Answer Questions
If you have any questions or concerns now or during the study, please contact me at myxterj@fargo.k12.nd.us.
Consent Statement
You are voluntarily making a decision whether or not to participate in this study. With your signature below, you are indicating that upon reading and understanding the above information, you agree to allow your student’s survey, interview, problem set, and assessment results to be used in this study. You will be given a copy of this consent form to keep. Thank you for your consideration.

_____________________________________
Participant (Please Print Student’s Name)

_____________________________________
Signature of Parent or Guardian Date

_____________________________________
Signature of Researcher Date
Appendix E

Student Assent Form

The Effects of Flipping the Classroom on Classroom Environment and Student Achievement

A Research Project by Jessica Myxter

Invitation to Participate
You are invited to participate in a study involving the flipped classroom. Flipping the classroom centers on students watching video lectures for homework. In turn, this often allows more time to complete problem sets in class.

Purpose of the Research
I am currently completing work towards my Masters of Arts of Teaching: Mathematics degree through Minot State University. For my final degree requirement, I am conducting this action research project during quarter three to determine if flipping the classroom changes the classroom environment. Specifically, I will be focusing on student and teacher collaboration levels, as well as student engagement and achievement.

Basis for Subject Selection
You have been selected for my study because you are in algebra 2. As an algebra 2 student, you have a school-issued tablet that can be used to watch video lectures. Many of the concepts studied during quarter three lend themselves nicely to the video lecture format.

Duration of Participation
This study will be conducted during the third quarter, which begins January 13th, 2014 and ends March 19th, 2014.

Specific Procedures
Due to the large amount of material covered in algebra 2, much of the class period is devoted to lecturing. After the lecture, you may have a few minutes to get started on the problem set as I circulate around the room. During third quarter, I will tape 10-15 minute videos which will replace part of the in-class lecture. In class I will lecture on any additional material not covered in the video. Then, you will have time to work on the problem set. Homework will include watching the video prior to the next day’s lesson, and completing the problem set if you do not finish in class.
At the end of the quarter you will complete a survey on the environment of the flipped classroom. Some of you may also be interviewed for your opinions. Survey responses, interviews, my observations, classroom minutes, homework completion rates, and assessment (quiz and test) results will be analyzed to determine whether the flipped classroom affects collaboration, student engagement and achievement levels, and the overall classroom environment. Results will be summarized and included in my research paper. No students will be identified in my results. This research study has been approved by the district office.

Benefits and Risks to the Individual
There are no direct benefits to participating in this study, but the data collected will be used to help improve the classroom environment. The risks to you are no more than you would encounter in a regular classroom setting.

Confidentiality
The researcher (myself) will treat all data confidentially. All data including student assessments, problem sets, surveys, and interviews will be kept safe in a locked cabinet or on my password-protected computer. All data will be destroyed once the paper has been defended. The researcher agrees to maintain strict confidentiality, which means your name will not be discussed or given to anyone. The researcher will also make sure confidential information will not be discussed in an area that can be overheard that would allow an unauthorized person to associate or identify you with such information.

Voluntary Nature of Participation
During this study, survey responses and interviews do not have to be included. However, I hope you approve of being involved in this study because a large sample size improves the accuracy of the results of my study. If you decide to participate, you are free to withdraw your consent at any time during the study. If you do not consent or withdraw your consent, your data will not be included in my results, you will not complete the survey nor be interviewed, but you will still participate in the flipped classroom as it is part of the course work.

Human Subject Statement
The Institutional Review Board of Minot State University has given me permission to conduct this research. If you have questions regarding the rights of research subjects please contact the Chairperson of the MSU Institutional Review Board (IRB), Dr. Bryan Schmidt, at 701-858-4250 or bryan.schmidt@minotstateu.edu.

Offer to Answer Questions
If you have any questions or concerns now or during the study, please contact me at myxterj@fargo.k12.nd.us.
Consent Statement
You are voluntarily making a decision whether or not to participate in this study. With your signature below, you are indicating that upon reading and understanding the above information, you agree to allow your survey, interview, problem set, and assessment results to be used in this study. You will be given a copy of this consent form to keep.
Thank you for your consideration.

_____________________________________
Participant (Please Print Student’s Name)

____________________________       ___________
Signature of Parent or Guardian   Date

____________________________       ___________
Signature of Researcher            Date
Appendix F

How Classroom Minutes Are Spent When a New Concept Is Taught

<table>
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<tr>
<th>Date</th>
<th>Concept</th>
<th>Lecture Minutes</th>
<th>Problem Set Completion Minutes</th>
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Appendix G

Sample Algebra 2 Problem Set

Name_____________________________

6.1 Roots and Radical Expressions

Find all the real square roots of each number. In other words, which real numbers squared produce the given number?

1. 400
2. -121
3. 0.0049

Find all the real cube roots of each number. In other words, which real numbers cubed produce the given number?

4. \( \frac{1}{216} \)
5. -125
6. -0.064

Evaluate the expressions if possible over the set of real numbers. Recall the radical sign indicates you are looking for the principle root, so you should only have one answer.

7. \( \sqrt[3]{144} \)
8. \( -\sqrt[4]{16} \)
9. \( \sqrt{-0.01} \)

10. \( \sqrt[5]{0.00001} \)
11. \( \sqrt[3]{-27} \)
12. \( \sqrt{0.09} \)

Simplify each radical expression, assuming all variables are nonnegative and nonzero.

13. \( \sqrt{81x^4} \)
14. \( \sqrt[4]{121y^{10}} \)
15. \( \sqrt[3]{8g^6} \)

16. \( \sqrt{125x^{18}} \)
17. \( \sqrt[3]{243x^5y^{15}} \)
18. \( \sqrt{(x-9)^3} \)
19. \( \sqrt[5]{\frac{32}{x^{10}}} \)  

20. \( \sqrt[4]{\frac{64x^9}{216}} \)  

21. \( \sqrt[3]{-0.008x^{12}} \)  

22. \( \sqrt[6]{\frac{x^4}{81}} \)  

23. \( \sqrt{36x^2y^{14}} \)  

24. \( \sqrt[5]{25(x+2)^4} \)  

25. The volume of a cube is 8,000 cubic centimeters. What is the length of each of the sides?  

26. The voltage \( V \) of an audio system’s speaker can be represented by \( V = 4\sqrt{P} \), where \( P \) is the power of the speaker. An engineer wants to design a speaker with 400 watts of power. What will the voltage be?  

Find the two real solutions of each equation.  

27. \( x^2 = \frac{0.16}{49} \)  

28. \( x^6 = 64 \)  

29. \( x^4 = \frac{16}{625} \)  

30. How many imaginary solutions does \#28 have? How about \#29?  

31. Simplify \( \frac{38x^2x^{-4} \cdot \frac{3}{16}}{2x^6 \cdot \frac{1}{8}} \)
### Appendix H

**Teacher Journal Entries**

<table>
<thead>
<tr>
<th>Date</th>
<th>Observations/Lesson Notes</th>
<th>Comment on Observations/Reflection on Lesson</th>
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Appendix I

Sample Algebra 2 Quiz

Name_________________________________

Quiz 6.0-6.2a
Algebra 2- Myxter
Show your work as partial credit will be given!    NO CALCULATOR

1. Simplify the expressions completely, writing all answers with positive exponents.

a) \((3x^5 y^4 x^2)^3 = \) \___________

b) \(\frac{x^2 z}{x^{-4} z^5} = \) \___________

c) \(\left(\frac{2x^0}{5x^{-2}}\right)^{-3} = \) \___________

d) \(16^\frac{-1}{2} = \) \___________

2. Find all real cube roots of each number if possible. In other words, what numbers cubed equal the given number?

a) \(-64 \) \___________

b) \(8 \) \___________

3. Simplify the following:

a) \(\sqrt{0.81} = \) \___________

b) \(\sqrt[3]{-125} = \) \___________

c) \(32^{\frac{1}{5}} = \) \___________

4. Cross out any of the equations below that are not true:

\(\sqrt[3]{3} \cdot \sqrt[3]{6} = 10\sqrt{18} \) \hspace{2cm} \(\sqrt[3]{7} \cdot 4\sqrt[3]{7} = 12\sqrt{7} \) \hspace{2cm} \(\sqrt{3} \cdot \sqrt{11} = \sqrt{33} \)
Simplify the radical expressions **completely**. Assume all variables are nonnegative and nonzero. Circle your answer so I can find it please! ☺

5. \(\sqrt[4]{16x^{24}y^8}\)

6. \(\sqrt[3]{32x^5y^{10}}\)

7. \(\frac{\sqrt[2]{20x^{16}}}{\sqrt[2]{5x^2}}\)

8. \(\sqrt[2]{6x^3y^2} \cdot \sqrt[2]{16x^4y}\)

*Bonus* Solve the equation \(x^3 = 8\)

\[x = \]
Appendix J
Sample Algebra 2 Test

Name__________________________________________

Test 6.0-6.5
Algebra 2- Myxter NO CALCULATOR
Read all directions and show your work as partial credit will be given!

Simplify the expression completely, leaving no negative exponents. Assume all variables are nonnegative and nonzero.

1. \((x^2)^{6}\) = __________

2. \(\frac{x^4x^{-3}}{x^{-8}}\) = __________

3. \(\frac{1}{y^3} \cdot y^5\) = __________

4. \(\left(\frac{-1}{x^3} \cdot y^4\right)^8\) = __________

5. \(\left(\frac{1}{16}\right)^{-\frac{1}{2}}\) = __________

6. \(27^{\frac{2}{3}}\) = __________

Evaluate the following:

7. \(\sqrt[3]{16}\) = __________

8. \(\sqrt[3]{-32}\) = __________

9. \(\sqrt[3]{625}\) = __________
10. Simplify the radical expression $\sqrt{75} + \sqrt{12}$

11. Cross out any equations below that are not true.

\[
\sqrt{8} \cdot \sqrt{8} = 15\sqrt{8} \\
4\sqrt{3} + 7\sqrt{2} = 11\sqrt{5} \\
\sqrt{6} \cdot \sqrt{7} = \sqrt{42}
\]

Simplify each expression completely. Assume all variables are nonnegative and nonzero.

12. $\sqrt[3]{64a^6b^{12}}$

13. $\sqrt[3]{50x^5y}$

14. $\sqrt[4]{4x^3} \cdot \sqrt[8]{8xy^{10}}$

15. $\sqrt[3]{40x^{14}y^2}$

16. $\frac{\sqrt[3]{10x^{12}}}{\sqrt{2x^2}}$
Simplify the expressions, making sure to rationalize the denominator. Assume all variables are nonnegative and nonzero.

17. \[ \frac{\sqrt{5x^4y}}{\sqrt{7x^7y}} \]

18. \[ \frac{10}{7 - 3\sqrt{2}} \]

Find all real solutions.

19. \[ \sqrt[3]{x-3} + 4 = 6 \]

20. \[ 2x^{-4} + 3 = 165 \]

\[ x = \boxed{} \quad x = \boxed{} \]
21. \(5(y+1)^{\frac{2}{3}} = 45\)

22. \(3x^3 = 96\)

\[y = \] \[x = \] 

23. \(\sqrt{x+7} = x+1\)

\[x = \]

*Bonus* (from the 2009-2010 ACT practice test)

In the real numbers, what is the solution of the equation \(8^{2x+1} = 4^{1-x}\) ?

\[x = \]
Appendix K

Flipped Classroom Student Survey

I have designed this survey to receive feedback on student perceptions of the flipped classroom model and its effects on the classroom environment. Please take your time and answer the questions truthfully. This is an anonymous survey so do not write your name on it. Thank you!

For each statement 1-18, indicate your level of agreement by checking one box that best aligns with your opinion and experience.

<table>
<thead>
<tr>
<th>Item</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
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</thead>
<tbody>
<tr>
<td>1. The video lectures helped me understand math concepts.</td>
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<tr>
<td>2. I would rather watch a video lecture for homework than do math problems for homework.</td>
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<td>3. I prefer the flipped classroom over the traditional classroom format.</td>
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<td>4. When the classroom was flipped, I spent more time working with classmates.</td>
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<td>5. I understand the problem sets (worksheets) better when I work with a classmate.</td>
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<tr>
<td>6. The flipped classroom allowed for more time to ask the teacher questions in class.</td>
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<tr>
<td>7. The flipped classroom allowed more time to complete problem sets (worksheets) in class.</td>
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<tr>
<td>8. When the classroom was flipped, I understood the problem sets (worksheets) better.</td>
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</table>
9. I was more engaged watching the videos than I was during in-class lectures.

10. I learned better through the videos than I did through in-class lectures.

11. I watched the video lectures prior to class.

12. I often paused the videos when watching them in order to process the content.

13. I rewound some videos or watched them more than once.

14. I fast forwarded the videos when watching them.

15. I pay better attention to the videos when they are made by my teacher versus using pre-made videos from another source.

16. When I watched the videos, I took notes.

17. I am able to focus better when the lecture is broken into smaller parts.

18. I want to continue learning math in the flipped classroom format.
19. What did you like about the flipped classroom? Describe any aspects of the flipped classroom that helped you learn better than the traditional classroom format.

20. What did you not like about the flipped classroom? Describe any aspects of the flipped classroom that hindered your learning compared to the traditional classroom format.
Appendix L

Student Interview Questions Guide

1. How often did you watch the videos?
   a) When did you usually watch them?
   b) Where did you usually watch them?
   c) Did you watch the whole video continuously from start to finish? Explain.

2. Did you pay closer attention during the lecture when the classroom was flipped, or did you pay closer attention during the lecture in the traditional setting? Explain.

3. Did you have more questions during the lecture when the classroom was flipped, or did you have more questions during the lecture in the traditional setting? Explain.

4. Did you interact with me (the teacher) more or less when the classroom was flipped?
   a) What did these interactions look like?
   b) Do you feel you learn better when there is more time to interact with me (the teacher)?

5. How often did you work with another student when completing problem sets (worksheets) in the flipped classroom versus the traditional classroom?
   a) If you work with a peer, does this help you learn better than if you work on your own? Explain.
6. Overall, did you spend more time thoughtfully completing the problem sets (worksheets) when the classroom was flipped? Elaborate.

7. How do you feel you performed on tests and quizzes while the classroom was flipped versus the traditional setting?
   a) If there was a noticeable difference in your performance, what would you attribute the change to?

8. What did you like about learning through the videos?
   a) How did your understanding of the material in the flipped classroom compare to the traditional setting?

9. What did you dislike about learning through the videos?
   a) Is there anything you would like to see me change about the flipped classroom in the future?

10. Do you think I should flip the classroom in the future? Why or why not?
    a) Should I flip the classroom the whole year, or only for certain chapters?