Practicality of the Flipped Classroom

A project completed in partial fulfillment of the requirements for the Honors Program

by

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Abstract

A recent development in pedagogy is the flipped classroom. This method uses digital technologies to shift direct instruction outside of the classroom, filling classroom time with maximal individual, face-to-face interactions and student collaboration which allows students to engage more deeply in content. While research shows positive gains from the flipped classroom model, students must have access to the technology needed and have the motivation to complete their homework in a non-traditional way in order for teachers to properly implement this pedagogy in their classrooms. The purpose of this study was to determine the practicality of the flipped classroom in the Columbus area, particularly in high school mathematics courses, by looking at students’ access to technology, study environments, and motivation to use technology for their school work. Students from various Columbus area high schools participated in a survey asking where they can access technology, in what environments they regularly complete math homework, and whether or not they would watch math videos if they had appropriate technology and access to view them. The scope of the participants was restricted to high school math students from select schools in the Columbus, Ohio area, and thus, generalizations for any subject, classroom, or school building cannot be made. However, this study can conclude the following about the students surveyed: all students had a way to access needed technology, at home, in a public library, or at school, the most popular study environment for students is at home, and those students who indicated they would watch videos are most likely to watch videos from five to ten minutes in length.
Because what we can know is changing dramatically, pedagogy, too, is changing dramatically. With new technological advances and increased understanding of cognitive development, educators have to be open to changes and improvements in their classroom instruction. One pedagogical response to the growing interest in technology in the classroom is the flipped classroom. This method involves interchanging typical classroom tasks with homework tasks. Instead of taking class time to demonstrate math processes, teachers record their lectures and assign students to watch the lecture videos as homework. The flipped model allows active learning to take place in the classroom during class time. This technique allows teachers to be present when students run into difficulties as they apply what they are learning to solving problems; instructors can hear and correct misunderstandings the moment they occur.

In the 21st century, it is logical to integrate technology into the classroom. However, questions arise regarding access. If all students do not have access to the technology needed to watch the lecture videos at home, is this type of instruction productive? Students must not only have access, but using technology also needs to be conducive in the environments in which students complete their math work. Furthermore, students must have the necessary motivation to benefit from this technique. Some studies have explored the benefits of the flipped classroom, the study environments of students, and student motivation for using technology, but no studies have been found that connect all three aspects in an attempt to determine if the flipped classroom is practical for high school students. The goal of this study was to determine if students have access to the necessary technology, and if they would use the technology to watch math instructional videos.
Literature Review

Access to Technology

The Flipped Learning Network, with the support of Pearson Education and researchers at George Mason University, undertook a comprehensive review of forty-one studies on different aspects of the flipped classroom (Hamdan, McKnight, McKnight, Arfstrom, 2013). This review notes the benefits of the flipped classroom model. One benefit of this model is allowing active learning and peer instruction to take place in the classroom. By reviewing direct instruction outside of the classroom before in-class instruction, students are primed for the active learning that takes place in class. Students are able to process information more efficiently as they have been pre-trained with the content with time to digest the material before applying the concepts. The flipped model also has the potential to benefit diverse learners as lectures can be paused and viewed more than once and students can receive immediate help on problems. Learners who prefer to hear or see new concepts multiple times can do so with a video lecture. Additionally, students can work on problems in class as opposed to outside of the classroom, where they have peers and their teacher available for assistance instead of waiting until the following class period for their questions to be addressed. Also, students can be challenged regularly as there is more time to work in the classroom with teacher and peer support. This allows students to explore concepts beyond general understanding as material can be covered in more depth with that scaffolding support present. However, as good as this method sounds, it cannot be implemented if teachers and students alike do not have the necessary technology to make it work or if they are unwilling to partake in this learning method.

Betty Collis, former faculty of Educational Science and Technology, and Jef Moonen, former professor of Educational Instrumentation Technology at University of Twente in the
Netherlands, now consultants and directors of Moonen & Collis Learning Technology Consultants, focus on the use of technology for strategy, learning, and change in corporate learning and higher education. In their study of flexible learning situations, Collis and Moonen (2001) stress the importance of the need for technology to use the flipped technique. In order for students to buy into digital learning, ease of use is important in the implementation phase. Up-to-date computers, reliable network connections, user friendly software, and home use are important aspects of overall ease of use (Collis and Moonen, 2001). Students must start with a successful experience to build confidence; that experience begins with having the resources readily available.

Aaron Sams and Jonathan Bergmann, the first teachers to spread the use of this student-centered pedagogy, suggest that files can be loaded onto flash drives and burnt to DVDs for those without home computers or Internet (Schaffhauser, 2009). But what if students still do not have access to the needed technology, computers or DVD players, in their homes? Karen Cator, director of the office of educational technology for the U.S. Department of Education, worries that the classroom flipping trend might leave behind students without computers, Internet access, and electronic devices in their homes (Baker, 2012). The Flipped Learning Network literature review expresses similar concerns (Hamdan et al., 2013). Students having unequal access to technology will likely create problems with the practicality of using this model for essential instruction outside of the classroom (Hamdan et al., 2013).

Studies have shown that the United States has yet to bridge the digital divide in homes (Vail 2003, Hinson 2005, DeBell and Chapman, 2003). According to Kathleen Vail, director of Editorial Services at National School Boards Association, the technology gap between poor and rich children is now not in school access, but in the bigger issues of home access (Vail, 2003).
Matthew DeBell and Chris Chapman found that socioeconomic differences continue to have a significant impact on computer and Internet use at home by children and adolescents ages 5 – 17 (DeBell and Chapman, 2003). In their report, a comparison by race reveals that 77% of white children and adolescents use computers at home while only 41% of black and Hispanic children and adolescents do so. When comparing income levels, 31% of children living in homes with yearly income levels of $20,000 or less use computers at home. In contrast, 89% of those living in families with annual incomes over $75,000 use computers at home (DeBell and Chapman, 2003). Their study also found that parental educational attainment levels relate to home computer use. Twenty-three percent of children living in homes where parents have less than a high school education use computers at home, compared to 69% of children living with parents with some college coursework and 89% of children whose parents have a college degree (DeBell and Chapman, 2003).

A second study conducted by DeBell and Chapman showed that 70% of Caucasian and Asian students have access to computers at home while less than 50% of Hispanic and African-American students have similar access (DeBell and Chapman, 2006). The U.S. National Telecommunications and Information Administration reported that computer and Internet access is distributed unequally by race, income, and education (Warschauer, Knobel, Stone, 2004). More recent studies on home computer and Internet access of students were not found, but from the studies discussed above, it is clear that home computer and Internet access is not universal. Home use varies among diverse groups of society. While there are several alternatives for digitally delivered instruction other than through an Internet enabled computer, students still must have access to those other essential devices. For students without a home computer, tablets or smartphones can be used to access videos. However, these devices still require reliable home
Internet access. Those students with a computer but no Internet access can watch videos from a flash drive while students with no computer, Internet-enabled device or Internet access can watch videos on a DVD. But these alternatives still require the use of other technological devices outside of a computer or Internet access. The studies previously discussed fail to explore availability of these other resources.

*Desire to Use Technology*

Access to technology is only one obstacle in successfully implementing the flipped model. Whether students do or do not have access, they must also have the desire to use technology at home as an educational resource. Daniel House researched the motivational effects of computers and classroom instruction for science learning by examining eighth grade students in the United States and Korea for the Trends in International Mathematics and Science Study (TIMSS) 2007 Assessment (House, 2012). A total of 10,813 students were given a questionnaire that measured several characteristics that were a part of the contextual framework for learning science. With regard to computer activities, this questionnaire asked students how frequently they used computers in their science lessons, whether or not they used computers in several specific locations, at home, at school, in a library, etc., and how frequently they used a computer for school work in science. Students were also asked the degree in which they enjoyed learning science (House, 2012). From this study, House concluded that “students in the United States and Korea who reported that they frequently used computers for schoolwork in science also showed higher levels of enjoyment for learning science” (House, 2012). In addition, students in this study reported “higher levels of enjoyment for learning science when they were given active learning assignments” (House, 2012).
Catherine Amelink, Glenda Scales, and Joseph Tront also conducted a study examining student use of learning technologies and its relationship to student motivation and self-regulated learning behaviors (2012). Their survey, distributed to students enrolled in the College of Engineering at Virginia Tech, examined student and faculty use of the Tablet PC, features associated with it, and learning behaviors such as rehearsal, organization, elaboration, critical thinking, meta-cognitive self-regulation, and peer collaboration. They found that students’ motivation to learn and engage with engineering course content increases in learning environments where students make use of Tablet PCs.

The studies performed by House and Amelink et al. highlight several interesting characteristics of the flipped classroom. First, both studies found that students who frequently used technology in a certain subject tended to engage with and enjoy learning that subject more. The flipped classroom implements instructional technology daily meaning this approach has the potential for increased student involvement in a particular subject area. This suggests that if learning opportunities were available through technology, students would be more likely to use and enjoy them. Secondly, House’s study showed that active learning increases student enjoyment of learning. The flipped classroom model allows for more in-class, active learning opportunities, as students can work together mastering concepts the entire class period as lecture has already been delivered outside of the classroom. Lastly, House and Amelink et al., both found that students who used computers to learn and took part in active learning tended to have higher enjoyment of learning, supporting the idea that the flipped classroom, which implements use of technology and active learning, can be a positive pedagogy for student learning and enjoyment.
Purpose of Study

Although studies have determined several learning benefits of the flipped classroom and research has found that the use of technology increases student engagement and motivation to learn the specific content, studies have also determined that diverse groups of students present in education have unequal access to technology within the last ten years (Vail 2003, Hinson 2005, DeBell and Chapman, 2003). However, it has yet to be recently determined how accessible technology is to all students in 2013, specifically those in the Columbus area. Also, if technology is available, would the students be willing to use those resources as a part of their school work? Using technology must be conducive in the environments in which students complete their math work.

As a future middle school or high school mathematics teacher from the Columbus area who would be interested in using the flipped classroom model to help students learn math, the goal of this study is: 1) to determine the accessibility of necessary technology needed by students in a flipped course in metro Columbus; 2) to determine the study habits of students, to decide if the technology is available, would a flipped classroom model be helpful based on the settings in which students complete their math homework; and 3) to determine if students have access, would they watch math instructional videos. Researching the accessibility of technology in students’ homes and their study environments will help determine the practicality of using the flipped classroom in a high school urban or suburban setting in the Columbus area.

Quantifiable success with this model is contingent upon all students having access to watch the assigned lecture videos before class time. If only half of students are able to watch videos outside of class, this model will not be beneficial. Students must also complete their work in environments where watching videos would be beneficial to their learning. For example, if
students tend to complete their math homework on the bus or in a car, watching videos would be much easier to complete in that setting, through a mobile network, DVD, or flash drive on a laptop. However, if students tend to complete their math homework at home and they have no Internet access, watching videos for homework may be more difficult to complete. Lastly, students must be willing to commit to watching math instructional videos outside of class time. If students will consistently view the videos as assigned, class time can be effectively used for deeper learning. But if students fail to view the videos, class time will be used to teach the material in the videos, making the recorded lectures useless. In order to obtain maximized positive effects from utilizing the flipped model, all three factors must align – all students must have a way to access the technology needed to view the videos, students must complete their homework in favorable environments, and students must willingly view the videos as assigned. This study will help schools and teachers in the Columbus area determine if the flipped model is a practical pedagogical tool for use with their students.

Methodology

The participants of this study were students in public and charter schools in Franklin County. Five school districts in Franklin County were contacted, asking if high schools in their district would allow their students to participate in this study. School districts contacted included Reynoldsburg City Schools, Groveport Madison Schools, Columbus City Schools, Southwestern City Schools, and The Charles School at Ohio Dominican University. The principals and certain math teachers of Reynoldsburg BELL Academy, Groveport Madison High School, and The Charles School were contacted directly. One teacher at each of these three schools agreed to administer the surveys to all of his/her students. The Director of Performance of Strategic Initiative in Columbus City Schools was contacted, but no response was received. The
Communications Department of Southwestern City Schools was contacted and given information about the study. An assistant principal at Westland High School, in Southwestern City Schools, sent a message agreeing to allow students in his school to participate in the study.

Detailed information about the study, including the purpose of the study, the survey document, and written instructions on administering the survey, were electronically distributed to participating teachers and principals in the four high schools. After each teacher and/or principal reviewed the materials and again agreed to participate, packets were distributed to each teacher/school. Packets included parental consent forms, student surveys, and a script for teachers to read to their students explaining the process and purpose of the study. For a complete review of the materials, see Appendixes A, B, C, and D.

The survey was only distributed in high school math classes. Parental consent forms were distributed to students and they were given five school days to return the signed form. On the day after the due date for parental consent forms, teachers read the script and distributed the surveys to only those students who returned a signed parental consent form. Those students completed a brief four question survey that asked students about their access to technology, study environments, and potential study habits.

Six sections of math classes, approximately 130 students, at Reynoldsburg BELL Academy were given the parental consent form. Of those 130 students, four parental consent forms were returned, and zero students completed the survey. At Groveport Madison High School, the parental consent form was given to six sections of math classes, approximately 117 students. Parental consent forms were returned from 63 students and 62 students completed the survey. Parental consent forms were distributed to approximately 140 students at The Charles School; 26 parental consent forms were returned and 26 students completed the surveys. At
Westland High School, ten sections of math classes, approximately 200 students, were given the parental consent form. Twenty-five parental consent forms were returned and 25 students completed the survey. A total of approximately 587 parental consent forms were distributed, 118 were returned, and 113 surveys were completed, for a parental consent return rate of 20% and a completion rate of 96%.

Of the 113 students who completed the survey, 15 students were freshmen, 22 students were sophomores, 49 students were juniors, and 27 students were seniors. Also, 65 students were female and 48 students were male.

Below, in Chart 3, are the demographics of the high schools who participated in the surveys, according to the 2012-2013 Ohio School Report Cards (for Groveport, Westland, and Reynoldsburg) and the 2011-2012 Ohio Charter School Report Cards (for the Charles School). I chose these schools as they have a high percentage of students who are economically disadvantaged. Therefore, technological resources may not be as readily available for these students as they may be for students at schools with a lower economic disadvantage rate.
The survey consisted of four questions with several items for participants to check if they applied. Questions one and two asked students what technological devices they had access to at home and where they could access technology outside of the home, like at a library or at school with the necessary transportation allowing them to do so. Question three asked students to check the environments in which they regularly work on math homework, and question four asked students what length of videos they would watch if they had access to the appropriate technology to view them. There was also space for students to share any other information related to access to technology or environments in which they work on math work. For the complete survey see Appendix D.

### Results

The results of this study are organized into four major sections, specifically the four questions asked in the survey. These include what technology is available at home for students, in what other ways students can access technology, the environment(s) in which they regularly work on math homework, and if they would utilize math instructional videos. In each section is a compilation of the data responses from students for that question. Then, when applicable, frequent and interesting comments students provided are listed.

<table>
<thead>
<tr>
<th>School</th>
<th>School Year</th>
<th>Performance Index</th>
<th>Economic Disadvantage</th>
<th>Graduation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groveport Madison High School</td>
<td>2012-2013</td>
<td>79.0%</td>
<td>53.1%</td>
<td>82.0%</td>
</tr>
<tr>
<td>Westland High School</td>
<td>2012-2013</td>
<td>77.5%</td>
<td>65.9%</td>
<td>81.9%</td>
</tr>
<tr>
<td>Reynoldsburg BELL Academy</td>
<td>2012-2013</td>
<td>83.9%</td>
<td>54.3%</td>
<td>N/A</td>
</tr>
<tr>
<td>The Charles School</td>
<td>2011-2012</td>
<td>99.8%</td>
<td>70%</td>
<td>N/A</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>85.05%</td>
<td>60.83%</td>
<td>81.95%</td>
</tr>
</tbody>
</table>
Question 1: Technology that can be accessed at home

The first question on the survey asked students to check all technology they had access to at home. Options included computer, Internet-enabled device (iPod, iPad, tablet, smartphone), Internet access, TV and DVD player, and flash drive. Out of 113 responses, 93 participants indicated they have a computer at home, 102 have an Internet-enabled device, 94 have home Internet access, 100 have a TV and DVD player, and 65 have a flash drive. Of the 113 participants, five did not have any of the listed technology available to view videos at home. Thirteen participants could view videos only in the form of a DVD. Three responded that they have a home computer, no Internet access, but they have their own flash drive to use. Additionally, four respondents that have a computer but no Internet access would need a flash drive to view videos. In total, 25 of 113 participants could not access videos via the Internet at home. Chart 4 below shows how students could view videos at home. If students indicated they had both a computer or Internet-enabled device and Internet, they were classified as using the Internet to view videos. Those who had a computer but no Internet were classified as flash drive users. Finally, those who did not have a computer, Internet-enabled device, or Internet were classified as DVD users.

Chart 4

![Chart showing How to View Videos at Home]

- Internet: 78%
- DVD: 11%
- Own flash drive: 3%
- Loaned flash drive: 4%
- None available: 4%
A number of students provided additional comments in regards to their home’s access to technology. Two students commented that while they have a computer at home, they are often too busy with work and extracurricular activities to utilize their home computer. Five students who indicated they have home computers commented that they have limited use as the computers are often occupied by other family members. Four of these students also have access to an Internet-enabled device and TV and DVD player at home. One student does not have any other home technology available, but has a library within walking distance.

Three students indicated possible complications with their home computer, such as unreliable Internet, slow processing computer, and broken sound. All three of these students had an alternate way to access videos at home through the use of an Internet-enabled device or TV and DVD player.

Of additional comments and concerns about home technology access from 13 respondents, only two did not have an alternate technology source to use. However, they both had another way to access technology outside of their home. A full list of additional student comments can be found in Appendix E.

**Question 2: Other available ways to access technology**

Question two asked students to check all ways they can access technology outside of their home. Options included a library within walking distance, before school with access to transportation to arrive at school early, and after school with access to transportation to return home. Out of 113 participants, 33 responded that they can access a library within walking distance. Forty-three responded that they can arrive at school early to use technology and 87 responded that they can stay after school to use technology with transportation to return home. Of the 113 respondents, nine indicated that they cannot access technology in any of the listed
three ways. However, those nine students who did not have other access to technology had the technology needed available at home. Furthermore, all five students who did not have any available technology to view videos at home indicated that they can access technology either before or after school with the necessary transportation to do so. Four students with no home Internet access commented that they can access the Internet at the houses of family or friends. All four students also had an alternate way to view videos at home through a computer and flash drive, Internet-enabled device, or TV and DVD player.

Question 3: Environments where math homework is regularly worked on

Question three of the survey asked students to check all places where they regularly work on math homework. Options listed were on the bus, while riding in a car, while traveling to and from sporting events, in a public library, in a coffee shop or other public business, and at home. Of 113 students, four indicated that they work on math homework on the bus and eight said they work while riding in a car. All twelve of these students have Internet-enabled devices which would allow them to complete their math homework in the form of watching videos on the bus if the Internet-enabled devices were smartphones with ample Internet. However, the type of Internet-enabled device was not specified. Eleven students responded that they work on their math homework in a public library. This setting would be suitable for students to watch videos for homework as library computers and/or Internet could be used. Nine students said they often work in a coffee shop or other public business. All nine of these students indicated they have an Internet-enabled device, so if these public businesses provide free Wi-Fi, this environment would be suitable to complete video homework. Finally, 110 indicated that they regularly work on math homework at home. Thus, home technology access is very important when implementing the flipped classroom model.
A very common additional comment was that they work on math homework at school. Fifty-two respondents commented that they regularly work on their math homework at school, whether that be during math class, lunch, study hall, tutoring, study tables, or free time in other classes.

Of the five students who did not have any home access to technology, two commented that they work on math homework at school, two commented that they only work on homework at home, and one only selected home, but did not provide any further comments. Based on data from this question, the flipped classroom would potentially only be a concern access wise for three of the 113 students surveyed.

Below is a breakdown of study environment responses by grade level and gender.

<table>
<thead>
<tr>
<th>Study Environments</th>
<th>Bus</th>
<th>Car</th>
<th>Traveling to Sporting Event</th>
<th>Library</th>
<th>Public Business</th>
<th>Home</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade 9</strong></td>
<td>7%</td>
<td>7%</td>
<td>0%</td>
<td>7%</td>
<td>13%</td>
<td>100%</td>
</tr>
<tr>
<td>(15 students)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grade 10</strong></td>
<td>9%</td>
<td>9%</td>
<td>0%</td>
<td>18%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>(22 students)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grade 11</strong></td>
<td>2%</td>
<td>8%</td>
<td>8%</td>
<td>6%</td>
<td>8%</td>
<td>98%</td>
</tr>
<tr>
<td>(49 students)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grade 12</strong></td>
<td>0%</td>
<td>4%</td>
<td>4%</td>
<td>11%</td>
<td>11%</td>
<td>93%</td>
</tr>
<tr>
<td>(27 students)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>4%</td>
<td>7%</td>
<td>4%</td>
<td>10%</td>
<td>8%</td>
<td>97%</td>
</tr>
<tr>
<td>(113 students)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study Environments</th>
<th>Bus</th>
<th>Car</th>
<th>Traveling to Sporting Event</th>
<th>Library</th>
<th>Public Business</th>
<th>Home</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Female</strong></td>
<td>3%</td>
<td>8%</td>
<td>2%</td>
<td>8%</td>
<td>9%</td>
<td>97%</td>
</tr>
<tr>
<td>(65 students)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>4%</td>
<td>6%</td>
<td>8%</td>
<td>13%</td>
<td>6%</td>
<td>98%</td>
</tr>
<tr>
<td>(48 students)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Question 4: Length of videos that would be watched

Question four asked students if they had access to math instructional videos and the appropriate technology to view them, what length of videos would they watch. Options included five minute videos, ten minute videos, fifteen minute videos, twenty minute videos, and I wouldn’t watch any videos. Of 113 respondents, 57 responded that they would watch five minute videos, 49 said they would watch ten minute videos, 26 would watch fifteen minute videos, 13 would watch twenty minute videos, and 26 would not watch any videos.

Below are the video length responses again broken down by grade level and gender.

<table>
<thead>
<tr>
<th>Grade 9 (15 students)</th>
<th>Video Lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 mins</td>
</tr>
<tr>
<td>Grade 10 (22 students)</td>
<td></td>
</tr>
<tr>
<td>Grade 11 (49 students)</td>
<td></td>
</tr>
<tr>
<td>Grade 12 (27 students)</td>
<td></td>
</tr>
<tr>
<td>Overall (113 students)</td>
<td></td>
</tr>
</tbody>
</table>
Chart 9

![Video Length by Grade Level](image)

Chart 10

<table>
<thead>
<tr>
<th>Video Lengths</th>
<th>5 mins</th>
<th>10 mins</th>
<th>15 mins</th>
<th>20 mins</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (65 students)</td>
<td>48%</td>
<td>49%</td>
<td>18%</td>
<td>9%</td>
<td>23%</td>
</tr>
<tr>
<td>Male (48 students)</td>
<td>54%</td>
<td>35%</td>
<td>29%</td>
<td>15%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Analysis

*Questions 1 and 2: Do all students have access to the necessary technology?*

**Discussion**

Of the 113 respondents, all 113 had a way to access technology to watch videos for homework, whether that be with the use of the Internet and Internet-enabled device, a DVD, flash drive, or using technology at an alternate location. One hundred and eight students had the necessary technology to access videos at home. Of those 108 respondents, 88 had access to the Internet and an Internet-enabled device, thus they would not need any additional materials from the school. Of the 25 participants that could not access videos via the Internet at home, 13 would need the video materials burnt onto DVDs, three would need the video materials transferred to their own flash drive, and four students would need to borrow a flash drive with the video materials. Five students did not have access to any of the listed technology at home. However,
all five respondents indicated they could access computers/the Internet at school either before
school or after school with transportation to arrive at school early and leave late.

Conclusion

All respondents in this sample had a way to access videos outside of class time, as long as
the school/teacher had funding to provide DVDs and flash drives to the students who needed
them. These limited results suggest that, for students who returned the parental consent form,
access is not a problem in implementing the flipped classroom model in the Columbus area.

Question 3: Is the flipped model easily completed in the typical student study environment?

Hypothesis proportion testing could not be conducted to compare study environments as
there must be ten successes for each environment. Because less than ten students surveyed
selected doing math homework in a bus, car, traveling to and from sporting events, and in a
public business, proportion tests could not be run. However, from the data collected, it is
obvious that most students complete their math homework at home as 97% of participants
selected at home. Therefore, students must have the necessary technology available at home in
order for the flipped model to be easily completed in their typical study environment. Because
96% of students have one or more forms of technology needed available at home, the results
suggest that the flipped model fits the study environments of the vast majority of the students
surveyed. With students having the technology available at home, the flipped model is easily
integrated in the typical student study environment.

Further studies could perform more complex statistical tests to compare the data for each
grade level in each study environment. For example, in the data collected in this study, there is a
twelve percent difference in tenth grade and eleventh grade students that work on math
homework in a public library. Additionally, there is a thirteen percent difference in ninth and
tenth grade students that complete math homework in a coffee shop or other public business. While significance of the data in this study cannot be determined without more complex statistical tests, these differences could be explored to determine if certain grade levels are more likely to complete math homework in certain settings.

Further studies could explore possible relationships among grade levels and study environments. Differences in grade level could arise due to juniors and seniors having the ability to drive themselves to school and other places. Are freshmen and sophomores more likely to complete work on the bus as they ride to and from school? Similarly, are eleventh and twelfth graders more likely to complete work in a public place as they may have the ability to drive themselves? These relationships among grade levels and study environments could be analyzed in future studies.

Likewise, each study environment could be compared by gender. The largest difference between male and female participants in this study was a six percent difference in working on math homework while traveling to and from sporting events. Again, it cannot be determined if this difference is significant, but further studies could consider male and female differences to determine if either is more likely to complete math homework in certain environments.

The survey results indicate that the majority of students work on their math homework at home. Very few regularly work in alternate locations. If they do work in alternate locations, they also work on math homework at home. Only three of 113 participants indicated they do not work at home. Because such a large number of students work on math homework at home, home access is extremely important in the implementation of the flipped classroom model. As indicated earlier, only five students did not have a source of technology to access videos at home. However, all five of these participants indicated they could access technology at school, before
or after the school day. Therefore, as long as these five students were willing to complete their math homework in an alternate location with technological access, the flipped classroom model could be executed in the Columbus area for these students.

**Question 4: If students have access, will they view math instructional videos?**

From the data collected, it is clear in Charts 7 and 8 that the percentage of students that would watch each video length declines as the video length increases. The largest number of students will watch five minute videos while the least number of students will watch twenty minute videos. Therefore, video length is an important factor to consider when using the flipped model. It is also important to note that 23% of participants indicated they would not watch any videos.

The number of participants who responded they would watch a minimum of five minute videos and those who responded they would not watch any videos were compared by grade level to determine if there was a relationship among grade level and watching videos. A breakdown of student responses by grade level is provided in Chart 11.

**Chart 11**

<table>
<thead>
<tr>
<th>Grade 9 (15 students)</th>
<th>Yes, would watch videos</th>
<th>No, would not watch videos</th>
</tr>
</thead>
<tbody>
<tr>
<td>60% 9 students</td>
<td>40% 6 students</td>
<td></td>
</tr>
<tr>
<td>Grade 10 (22 students)</td>
<td>86% 19 students</td>
<td>14% 3 students</td>
</tr>
<tr>
<td>Grade 11 (49 students)</td>
<td>73% 36 students</td>
<td>27% 13 students</td>
</tr>
<tr>
<td>Grade 12 (27 students)</td>
<td>85% 23 students</td>
<td>15% 4 students</td>
</tr>
<tr>
<td>Overall (113 students)</td>
<td>77% 87 students</td>
<td>23% 26 students</td>
</tr>
</tbody>
</table>
A chi-square test was performed with an alpha of 0.05; that is, if p < 0.05, the null hypothesis is rejected and the alternative hypothesis is accepted. This alpha represents the probability of mistakenly rejecting the null hypothesis. In this chi-square test, the null hypothesis was “there is no relationship among grade levels and likelihood to watch videos”, and the alternative hypothesis was “there is a relationship among grade levels and likelihood to watch videos.” With three degrees of freedom, the chi-square test returned a $\chi^2$ test statistic value of 4.902. This test statistic value corresponds with a p-value of 0.179. Therefore, because the p-value > 0.05, there is no reason to reject the null hypothesis, concluding there is no significant relationship among the grade levels of participants and their likelihood to watch math instructional videos.

Again, further studies could explore relationships between different grade levels and length of videos that would be watched. When looking at the results in Chart 8, this study indicates that there is a large difference in the percentage of tenth graders that would watch five minute videos and fifteen minute videos when compared to students in other grades, with the highest percentage of tenth grade students watching five minute videos. Additionally, there is a fifteen percent difference in the number of ninth and twelfth graders that would watch ten minute videos, with this data showing that the least number of ninth graders in this study would watch ten minute videos. Furthermore, there is a notable difference between tenth and twelfth grade students watching twenty minute videos, with more twelfth grade students in this study indicating they would watch twenty minute videos. This difference could possibly be explained by student experience by the time they are seniors. As seniors, students may be more apt to both complete homework and take advantage of a different type of homework format.
From the participants in this study, freshmen seem to be the least likely to watch videos, with forty percent selecting they would not watch any videos. Perhaps this is a result of the freshmen transitioning to high school courses and their demands. As students progress throughout high school, they may get into the routine of completing homework and knowing the advantages of resources.

Finally, tenth grade students in this study seem to be the most motivated to watch videos for math homework with eighty-six percent selecting they would watch math videos of some length. In tenth grade, students have adjusted to the high school setting and are not yet burnt out on school and anxious to graduate. This could explain the relationships found for tenth grade participants.

It is important to note the difference in sample sizes for each grade level in this study. The data is extremely limited, therefore, generalizations about grade levels and video lengths cannot be made. However, future studies could look at a more even distribution of student grade level and the relationship between grade level and likelihood to watch math videos as well as grade level and length of videos that would be watched.

Lastly, participants that responded they would watch a minimum of five minute videos and those who responded they would not watch any videos were compared by gender to determine if there was a relationship between gender and likelihood to watch videos. A breakdown of student responses by gender is provided below in Chart 12.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Yes, would watch videos</th>
<th>No, would not watch videos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (65 students)</td>
<td>77% 50 students</td>
<td>23% 15 students</td>
</tr>
<tr>
<td>Male (48 students)</td>
<td>77% 37 students</td>
<td>23% 11 students</td>
</tr>
</tbody>
</table>
As seen in Chart 1, there is no difference in the percentages of female and male participants in this study that indicated they would watch videos. This claim is supported by a two proportion hypothesis test. When tested at a 95% confidence level with a null hypothesis of “there is no difference between females and males”, \( t(113) = 0.020, p = 0.984 \), the null hypothesis cannot be rejected. Therefore, there is not a significant difference in the responses received between males and females’ likelihood to watch math instructional videos.

Conclusions

The object of this study was to determine the practicality of the flipped classroom in a high school setting throughout the Columbus area. This study began with the goal of answering three questions: do all students have access to the technology needed for a flipped model, do students complete their math work in environments where watching videos is conducive to learning, and if students have access, would they watch math instructional videos?

The first question of whether all students have access to the technology needed for a flipped classroom model was clearly answered for the 113 participating students. Of the 113 respondents, every single student had a way to access technology to watch videos outside of class. One-hundred and eight students had the appropriate combination of technology needed to watch videos at home, from computer and Internet, computer and flash drive, Internet-enabled device and Internet, or TV and DVD player. However, 13 students would need video materials burnt onto DVDs, three would need videos transferred to their personal flash drives, and four students would need to borrow a flash drive with video materials. All five students without the available technological resources at home indicated they had the ability to access a computer and Internet before or after school with transportation to arrive at school early and/or leave late.
Contingent upon school funds, participants in this study indicated they had the technology needed for a flipped model.

The second question of whether students complete their math work in environments where watching videos is conducive to learning was answered in regard to the options provided on the survey. This study found that the majority of students, 110 of 113, work on math homework at home. Because of this high percentage, home access to technology is key. In this study, 96% of respondents had appropriate home access, suggesting that students in this study do their math work in an environment where watching videos is conducive to learning. A total of 37 participants selected an environment in addition to home - on the bus, in a car, traveling to and from sporting events, in a library or in a public coffee shop/business. Many students commented that they work on their math homework at school - before, during or after math class, in study hall, or at lunch. Future studies could examine this additional study environment.

In regard to if students would watch math instructional videos, 51% of students in this study indicated they would watch five minute videos, 43% would watch ten minute videos, 23% would watch fifteen minute videos, and 12% would watch twenty minute videos. In addition, 23% of participants indicated they would not watch any videos at all. From these results, five to ten minutes is the ideal length for instructional videos. However, 23% of students still would not watch these videos outside of class. A further study could explore students’ tendency to complete homework outside of class time; would the 23% of students who said they would not watch any videos complete other assigned homework? Or, would the 23% not complete any type of work outside of math class? Future studies could also explore this aspect in more depth, investigating the reasons why students would or would not watch lecture videos.
A future study could also investigate if five minute videos are long enough to explain content. It is likely that more than one five minute video is needed to explain and teach the new content, so would students still be willing to watch a few five minute videos? While five minute videos are the ideal length, how many five minute videos would a student be willing to watch?

This study cannot make definitive statements or generalizations in regard to having the access and motivation to watch math instructional videos outside of the classroom as the number of participants was limited. Also, data was collected solely through surveys and not statistical, experimental or observational data. Students that took this survey did not necessarily have a full understanding of the flipped classroom model in order to accurately depict their opinions on watching math videos on a regular basis.

Additionally, the study was restricted to schools in the Columbus, Ohio area and was dependent on those school districts, principals, and teachers who responded to the initial contact. Because parental consent was required to survey students, the permission form return rate was extremely low. Those who completed the surveys had the initiative to get the parental consent form signed and returned. There is predictability between students who completed the form and who would watch the videos; those students are more likely to have the responsibility to complete school work and also the parental support and availability at home.

However, this study has provided several starting points on which to base further research. Further research could be done on the reasons why students would watch videos and why students would not watch videos as mentioned above. Studies could explore additional study environments, specifically the popular added response of working on math homework at school during the school day. A third aspect of this study to consider is the gender, grade level, and subject level of students surveyed. This study more equally represented gender than grade
level and subject level. Gender and subject level were analyzed, but grade levels were not equally represented in this study. The subject level of students surveyed was not collected. Researching grade level and subject level could greatly influence the practicality of the flipped classroom in different areas of high school mathematics.

This study has shown that, for the students surveyed, they have the access needed to watch videos at home, in their preferred environment, although this study cannot make broad claims about access and use of technology. Keeping math instructional videos to a maximum of ten minutes is essential to ensure views from those students who would watch them. However, there is still a significant number of students who would not watch any length of videos. These aspects of implementing the flipped classroom should be explored further in future studies so broad claims can be made about the practicality of using the flipped classroom at the high school level.
References


Appendix A: Letter to Principals

Mallory Kitts
Ohio Dominican University
1216 Sunbury Rd
Columbus, OH 43219
937-244-1433

[Principal]
[School]
[School Address]

Dear [Principal],

My name is Mallory Kitts and I am a senior integrated math education major at Ohio Dominican University. This semester I am working on my senior honors thesis and would like to conduct some simple research at [school name]. My thesis project will be researching the practicality of the flipped classroom model in Columbus high schools. In the flipped classroom model, teachers record their lectures and assign students to watch the lecture videos as homework. Class time is then used for students to collaboratively explore and engage in the content. While research shows positive gains from the flipped classroom model, students must have access to the technology needed to complete their homework in order for teachers to properly implement this plan in their classrooms.

My research would include conducting a survey with 100 students in your school. This survey would ask students questions about the accessibility of technology in their home and their study environments. Sample questions include: Do you have a computer at home? Do you have access to an iPod, iPad, other tablet or smartphone at home? Do you have Internet access at home? Do you have a DVD player at home? The survey consists of three main questions where students check situations that apply to them. The survey would take students no longer than 2 minutes to complete. A copy is attached.

The goal of my research is to determine how accessible the technology needed by students for a flipped course is in the Columbus area. Also, would the flipped classroom be helpful for students based on the settings in which students complete their math homework?

I would provide hard copies of the surveys to distribute to 4-6 different classes and would be willing to come into the school to administer the survey at the beginning of the designated classes.

I am hopeful that you will allow me to work with your school to aid me in my senior thesis project. I look forward to hearing from you soon.

Sincerely,

Mallory Kitts
Appendix B: Parental Consent Form

Dear Parent/Guardian,

My name is Mallory Kitts and I am a senior integrated math education major at Ohio Dominican University. I am currently working on a senior honors thesis under the supervision of Drs. Anna Davis and Marlissa Stauffer that addresses the practicality of the “flipped classroom” model in Columbus high schools. In the flipped classroom, teachers record their lectures and assign students to watch the lecture videos as homework. Class time is then used for students to collaboratively explore and engage in the content.

I am requesting permission for your student to complete a brief four-question survey on the availability of technology, preferred environments for completing math homework, and thoughts about watching math videos for homework. Your student’s teacher will administer the survey during a time that is minimally disruptive to the class, and I expect the process will take 5 to 10 minutes. While I do not anticipate any risks associated with participating, it is possible that your student will feel embarrassed reporting his or her thoughts. However, all responses will be given anonymously and all survey information will be kept confidential. Your student’s name will never appear on any survey, no identity will be made in the data analysis, and all written materials and consent forms will be stored in a locked file. Your student’s responses will only appear in statistical data summaries. This study has been approved by the Ohio Dominican University Institutional Review Board (Dr. Valerie Staton, Director, 614-251-4685).

Your student is under no obligation to participate in this study. He/she is free to withdraw consent to participate at any time. If you are willing to allow your student to participate in this research project, please sign below and have your student return the signed form to his/her teacher by Friday December 6. I greatly appreciate your consideration to allow me to survey your student to aid me in my senior thesis project.

Sincerely,

Mallory Kitts
kittsm@ohiodominican.edu

By signing below I agree that I have read the above statements and understand what is being asked of my student. I also understand that my student’s participation is voluntary and he/she is free to withdraw consent at any time, for any reason. On these terms, I certify that I give my student permission to participate in this research project.

Student’s Printed Name
______________________________

Parent/Guardian Signature
______________________________

Date
_______________
Appendix C: Letter to Teachers Administering the Survey

Dear [school name] teacher,

My name is Mallory Kitts and I am a senior integrated math education major at Ohio Dominican University. This semester I am working on my senior honors thesis project under the supervision of Drs. Anna Davis (mathematics) and Marlissa Stauffer (education). I am researching the practicality of the flipped classroom model in Columbus high schools. In the flipped classroom model, teachers record their lectures and assign students to watch the lecture videos as homework. Class time is then used for students to collaboratively explore and engage in the content. While research shows positive gains from the flipped classroom model, students must have access to the technology needed and motivation to complete their homework in order for teachers to properly implement this plan in their classrooms. The goal of my research is to determine how accessible the technology needed by students for a flipped course is in the Columbus area. Also, would the flipped classroom be helpful for students based on the settings in which students complete their math homework? And finally, if students had the access, would they utilize it?

My research includes conducting a short survey with your students. Because I am surveying minors, parental consent is needed. You will see that this envelope contains a set of letters to parents and a set of student surveys. First, I ask that you send home a copy of the parent letter with each of your students. Only students that have parental consent can participate in the survey. As noted in the parent letter, I asked for parental consent forms to be returned by Friday December 6. Once parent letters are returned, I ask that you distribute the survey to those students that returned a signed parental consent form. Administering the survey should take no longer than 5 to 10 minutes. Once all of your participating students have completed the survey process, please return both the consent forms and surveys to [principal]. I plan to pick up the materials from [principal] on Wednesday December 11.

Attached is a script to read to your students before distributing the surveys.

If you have any questions, please do not hesitate to contact me (kittsm@ohiodominican.edu; 937-244-1433), or my faculty advisors (Dr. Davis, 614-251-4657; Dr. Stauffer, 614-251-4621). Thank you for administering this survey to your students to help with my senior thesis project. Your assistance is greatly appreciated.

Sincerely,

Mallory Kitts
Ohio Dominican University
Please read the following to your students before distributing surveys:

“A student at Ohio Dominican University is researching the practicality of the flipped classroom model in Columbus high schools. In the flipped classroom model, teachers record their lectures and assign students to watch the lecture videos as homework. Class time is then used for students to collaboratively explore and engage in the content.

The goal of this student’s research is to determine how accessible the technology needed by students for a flipped course is in the Columbus area. Also, would the flipped classroom be helpful for students based on the settings in which students complete their math homework? And finally, if students had the access, would they utilize it?

The researcher has asked the students in our class to complete a short survey. You can only participate in this survey if you have returned the letter signed by your parent/guardian. If you choose to not participate in this survey, there is no penalty. If you begin the survey and later decide you do not want to complete it, you can withdraw at any time without penalty. Your responses will be anonymous and will not be shared with anyone other than those connected directly to the study.

When you are finished, raise your hand and I will collect the survey from you.

The researcher thanks you for helping her in her research project.”
Appendix D: Student Survey

Please check all items that apply to you.

1. I have access to the following technology at home:
   - [ ] Computer
   - [ ] Internet-enabled device (iPod, iPad, tablet, smartphone)
   - [ ] Internet access
   - [ ] TV & DVD player
   - [ ] Flash drive

2. I can access technology in the following ways:
   - [ ] Library within walking distance
   - [ ] Before school, with access to transportation to arrive at school early
   - [ ] After school, with access to transportation to return home

Please share any other information related to your access to technology. (Ex. I have a computer at home, but my parents or siblings are always using it.)
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

3. I regularly work on math homework:
   - [ ] On the bus
   - [ ] While riding in a car
   - [ ] While traveling to and from sporting events
   - [ ] In a public library
   - [ ] In a coffee shop or other public business
   - [ ] At home

Please share any other environments in which you work on math work.
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

4. If I had access to math instructional videos and the appropriate technology to view them, I would watch (please check all that apply):
   - [ ] 5 minute videos
   - [ ] 10 minute videos
   - [ ] 15 minute videos
   - [ ] 20 minute videos or longer
   - [ ] I wouldn’t watch any videos

Grade (please circle): 9 10 11 12
Gender (please circle): Male Female
Appendix E: Additional Comments Provided by Students in Response to Question 2

- “I have one laptop at home but mom/dad use it.”
  - This student also has access to an Internet-enabled device and TV and DVD player.
- “I have a computer at home, but I barely have time to use it because of homework and I work.”
- “I have a computer at home, but it is slow.”
  - This student also has access to an Internet-enabled device, flash drive, and TV and DVD player.
- “I have a computer at home, but I’m always busy with sports and work to get on it.”
- “I have a phone and Internet on it, but it uses my data.”
  - This student does not have access to any other technology at home, but can arrive at school early to use technology.
- “I have a computer at home, but my sister is always on it.”
  - This student has access to an Internet-enabled device and Internet at home along with a TV and DVD player.
- “I only have a laptop at my dad’s.”
  - This student has a TV and DVD player.
- “My dad has a computer, but I can’t use it.”
  - This student has access to an Internet-enabled device, Internet, and a TV and DVD player.
- “I have a computer, but the sound is broken.”
  - This student also has an Internet-enabled device, Internet, and a TV and DVD player.
- “I share my computer with my sisters.”
  - This student also has an Internet-enabled device, Internet access, and a TV and DVD player.
- “Wifi cuts in and out depending on weather conditions and is hindered by my brothers Xbox play.”
  - This student has a computer and flash drive and a TV and DVD player.
- “I have a computer at home, but my brother is always using it.”
  - This student does not have any other home technology available, but has a library within walking distance.