

EFFECTS OF FLIPPING THE CLASSROOM
ON SUBURBAN MIDDLE SCHOOL MATH STUDENTS

by

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CERTIFICATION OF PROJECT WORK

We, the undersigned, certify that this project entitled EFFECTS OF FLIPPING THE CLASSROOM ON SUBURBAN MIDDLE SCHOOL MATH STUDENTS by Mohammad Alswat, Candidate for the Degree of Master of Science in Education, CURRICULUM AND INSTRUCTION, is acceptable in form and content and demonstrates a satisfactory knowledge of the field covered by this project.



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Abstract

The purpose of this research is to examine the effects of using the strategy “flipping the classroom” with students. One eighth grade math class was selected to be used from a school in Western New York. The teacher of this classroom taught seven math units using traditional homework and classwork, while four of the units were taught with a flipped classroom. Data was collected through a likert survey for the students, an interview with the teacher, and the analysis of the students’ grades. Results of the data show that the students generally like the strategy of flipping the classroom. The students also scored 3.11 points higher on average on their tests with a flipped classroom. The teacher also said mostly positive comments about this strategy. She and her students were more comfortable using it in the classroom because their class time was more productive for them. Some suggestions for future research and limitations are discussed in this paper to provide evidence that flipping the classroom can be an effective strategy in certain classes.

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Introduction

What is the problem?

Math teachers have many different strategies and techniques that they can use to help instruct students. There are lots of books that have the “best” strategies for teachers. The best way to find these practices is by looking through research. The problem for math teachers is that there are so many strategies from which to choose, how can they know what is really the best? By conducting research about a specific strategy like flipping the classroom, I hope to help math teachers to use only the best strategies.

If there is a strategy that can help students learn the subject much easier, then teachers would benefit from learning it. For instance, if a strategy may work very well with some students, then it should be researched, so people will understand more about it. For this reason, I think “flipping the classroom” is a strategy that might help teachers to teach subjects in less time. This is why I think this new strategy should be researched.

In a typical math class, the teacher spends class time teaching an aspect of math to the students. After the students learn it, then they try it with the teacher’s help. After class, the students complete homework, practicing what was introduced in class to help reinforce their knowledge of the topic. If a teacher uses the flipping the classroom strategy, then it looks different. The teacher will record a video of himself or herself teaching the strategy for the students and the students will watch this video at home during the night before class. This means that the students will be familiar with the unit before they even get to class the next day. When the students arrive to class, they can spend time very quickly practicing the content and no time

is wasted. The students can tell the teacher where they struggled and where they think they need additional help.

This research might provide evidence that this is a good technology strategy to use with students in middle school. Using strategies like this is new for the field because technology is becoming a big part of instruction in schools. If this strategy is helpful for students, then it means that this is another aspect of instruction that teachers can use in their curriculum. For these reasons, my research question is, “Does ‘flipping the classroom’ improve math achievement for 8th graders in a suburban middle school in Western New York?”

Importance to the field

This information is important to the field because it could give data as to whether the strategy is helpful or not. If the research shows that by using this technique, math achievement increases, then that is a good thing for the field. If a strategy proves effective after being empirically studied, then it is important that teachers and principals, as well as other educators, know it is a good strategy to use. That is why this is important to the field and why I think it is a good topic to use for my thesis.

This research is good for the field because it can help transfer experience from one teacher to another. If the research shows that this might be a helpful strategy in one middle school, then other teachers will want to try it. Research that helps to insure a strategy is good is helpful research for the field because good strategies are important to teachers. Also, if the teachers are using videos to record themselves, then the principals may watch the videos also to evaluate the teachers’ performance. This can also help with professional development for the

school. Lastly, this is important for the field because if this strategy is used as a way to teach students, it frees up more time for the students to practice the problems in class with the teacher acting as a math coach.

Why is this important for me?

I think this is an important strategy to research because my background is math. I am interested in all strategies that use math and I want to learn more about them. I have read that flipping the classroom helps some students, and I wanted to explore this idea more. In addition to this, this strategy uses technology, and I think that technology can help teachers save time for their lessons. If this strategy can save time for students, then they can spend more time practicing their math content and becoming more familiar with it. I also think that this gives the students more opportunities to learn because it helps prepare them for a math unit. If the students don't understand something from the video, they can watch the video again or ask for help from their parents or the teacher before they have class. From watching the videos, the students already know what they will need help with and they can ask the teacher right away. If the students cannot do the problems at home, the students can prepare their questions for the teacher, so they can learn for themselves what they need to work on.

I think that this strategy is great for students and teachers. It helps to get the students ready for the lesson. It gives students many opportunities to see the strategy if they have questions. Because students can save the video and watch it many times, it is helpful for them to keep it in their library and share it with others. This strategy uses technology, which is a very important skill for students and teachers to use. Personally, using this skill will help make sure I

know how to use technology better, and I can help spread this information to my colleagues.

This strategy of flipping the classroom could be very beneficial for all educators. It is important to look at the research that currently exists about this strategy to see data from real classrooms that use flipping the classroom. This study focuses on middle school students, and it is helpful to also look at the human development of middle school students to determine if this strategy may be effective for them and why. The literature review for this thesis examines these topics to find trends in current research pertaining to flipping the classroom.

Literature Review

Technology is very effective for working with students in today's schools. It is important for teachers to know what types of technology are best and what strategies are good too. Flipping the classroom is a strategy that is very effective for some students and is becoming popular now. This is why it is important to ask, "Does 'flipping the classroom' improve math achievement for 8th graders in a suburban middle school in Western New York?"

Flipping the classroom

Definition

The strategy of "flipped learning" is becoming very popular in the business world (Bergmann & Sams, 2014). This is a strategy that uses face-to-face time very effectively, and it is spreading to the educational world. Flipping the classroom is a strategy that has the teacher making a video before class for the students to watch. This video is about the content that the students will work on the next day in school. The students prepare their knowledge about the classes before they come to school by watching the videos at home the night before. The last part of this strategy is that the students come to school and they already know what they will be

working on. The teacher does not have to spend face-to-face time teaching the students. The teacher can spend class time giving students “individualized assistance on hard problems” (Bergmann & Sams, 2014, p. 30), which is using time efficiently. This strategy is getting more popular now with teachers and educators. This strategy works for students who are on grade level, but the strategy also works well for students with disabilities. Finkel (2012) says that “flipped learning can greatly increase a teacher’s ability to provide differentiated instruction given that students work at their own pace in the classroom” (p. 31). This means that this strategy can be very effective but certain practices must be followed.

Theoretical Framework

There is some research that supports flipping the classroom because of theories from researchers such as Vygotsky and Piaget. Tudge and Winterhoff (1993) talk about theories and how they connect to student learning. The main points of these theories are that learning for the human brain is very complex and the process of remembering subjects and materials from a class is improved when in a social environment. Tudge and Winterhoff (1993) state “social and cultural institutions, technologies, and tools channel the nature and focus of interpersonal interactions, which in turn mediate the development of children’s higher mental functions” (p. 66). This quote talks about how popular theories of learning are most effective in a social situation with interpersonal interactions. This supports flipping the classroom because students get more time to interact with the teachers and each other. When they are able to watch the videos at home, then all of their classroom time is for social interactions, according to current learning theories; this is a good situation for the students.

A book with a theoretical framework that works with flipping the classroom has a focus on peer-assisted learning (Topping, 2001). Peer-assisted learning is a type of instruction that can occur between students who help teach each other subjects. This can happen in schools that are using the flipped classroom because students watch videos at home and can spend all of their class time interacting with each other at school. Peer-assisted learning has been shown to be a “highly effective way of using school time” (Topping, 2001, p. 159). This is important to note because the theories suggest classroom time that has students working together is more effective for students’ brains. This supports the strategy of flipping the classroom because it lets students work together more often, which is good according to research.

Best instructional practices include technological requirements

To make the best instructional practices for students, there are two aspects that a teacher needs to know for flipping the classroom. The videos that the teacher makes need to be made in a clear way, so that the students can understand them when they watch them. Best practice for this strategy is an easy to understand video. This means that it should not be too long of a video because that gets confusing. The video should have goals that the students know about so they know the lesson’s objectives. The video should also be sure to have visuals and oral explanations so that many different senses are being used. Lastly, the technology that a teacher uses must be able to work for all students. There are a few things that teachers should do when they are using technology to create the video. Strayer (2012) uses an audiotape instead of a video tape in his research of flipping the classroom. He says that this “audiotape medium” (p. 189) gave his study limitations because some students didn’t understand it very well. To make sure these limitations

don't happen to other teachers, it is important that videos be used if possible and that they are clear to students.

The video that the teachers create for the students needs to be clear so that the students understand it. If the students are not hearing a teacher well, then they will not be able to learn well. This means that the teacher should speak clearly and should make sure that they teach the content in a way that is easy to understand. If teachers are not very good at working with technology or videos, "Simple resources exist even for teachers who are not video-savvy" (Finkel, 2012, p. 34). Teachers should know about technology that they can use in the classroom. If they do not, then it would be good for them to take media classes and learn how to teach best to their students using technology. Increasing their knowledge about technology is good for teachers because technology is being used more and more in classrooms. This can include things such as computers, iPads, and smart boards. It is also important for teachers to know as much as they can about technology because some teachers might teach very well in face-to-face lessons but when they are in a video, it could be harder for them to teach.

The technology that a teacher uses to make the videos for the students is also important. It is a good idea to make sure the videos can be small or short so that the size of the videos is not too big for the students to use easily. When a video is larger than 25 megabytes, some email systems do not let it be used. That is why keeping a video less than 25mb would be best. The teacher also needs to make sure that the video can be opened by students at their home computers or at a place where the videos can be seen. Gaughan (2014) used this best practice and decided to put her videos on YouTube to make them easier for her students to access. This

process was “quite painless” (p. 224). She says that it was a good way for her Instructional Technology Department to help her with the video because she was not comfortable doing it by herself. It is also important for the teacher to use a good digital camera and a digital microphone so that the information will be clear for the students. If a teacher does not have this technology then the school’s technology department could be a source of help. A teacher can also make a checklist to see which students got the video, so the teacher could work with those who could not access it. If students are not able to have any access to it, then the teacher can work with the librarians to give the students an opportunity to watch the videos on the library computer. This is a good way for students to be able to use the technology even if they do not have access at their home. The teacher can also keep all of the videos for the students so there is an archive to look back at later (Strayer, 2012). The students can use this archive in the future when the teacher is giving them an assessment and they need to study. This strategy uses technology to teach students a topic and make effective use of time.

A study that uses something different than video is by Bolliger, Supanakom, and Boggs (2010). These researchers used podcasts instead. The researchers say that podcasts are “recorded audio files that can be integrated in educational and training settings in order to deliver personalized content to learners in a specific course during a given semester” (p. 714). Podcasts are another way that teachers can flip the classroom without having to use only videos. The researchers wanted to see if using podcasts, which is only audio, was effective for students. They found that “podcast users felt comfortable using the podcasts and believed they could learn the content provided by their instructors” (Bollinger et al, p. 720). The researchers also found that

giving students instruction on how to use podcasts very well is a good practice for the teachers. Their data indicates that students with more podcast experience had better scores and felt more comfortable. Another view on podcasts is from Chester, Buntine, Hammond, and Atkinson (2011). The professors in this study gave podcasts to students and students could also come to lectures in person at some class times. The findings from this study are that many students felt more confident and more independent. This is good for those students because in interviews they said that they did better in this class with technology than others. Some students did not want to use the technology but the researchers said that some students do not know how to use technology properly. They think the “newness of the technology” (Chester et al, p. 244) will soon not scare students. They also find that students with confidence use more materials than other students in many different subjects in school. This is important because teachers can make sure to help the students who are not confident. The podcasts in this study were not only for mathematics. There were podcasts for language arts as well as math, which means that the data may not be as accurate when applied only to math.

Two other studies look at effective ways teachers can use podcasts. This is important because if teachers can use podcasts very well, then they can use these strategies to flip their classroom. The study by McCombs and Liu (2007) uses data from the University of Houston. They identified results that are best practices for flipping the classroom. One finding is to “use the lowest format to achieve best results” (McCombs & Liu, p. 133). This means that teachers should use lower quality media and use audio only so students can access it easier. If a file is very big and long to download, then students might have problems. Another strategy is to try

“preparing material in different formats” (McCombs & Liu, p. 133). This means using different types of media like podcasts, with some text on paper, and a video so that many different users can learn from it. Technology used to teach is still new to education and trying new things is good. McGarr (2009) reviewed literature about podcasts and created a visual to show uses of technology in the classroom. What’s most important is that he has three types of instructional technology: substitutional, creative, and supplementary. Substitutional technology has the students being “passive receivers of information” (McGarr, p. 318). Creative technology has students being “active constructors of knowledge” (Mc Garr, p. 318). Supplementary technology is a good mix of both the others. The researcher says that for learning with podcasting, the teacher needs to be flexible and have students doing different things with the technology, as opposed to doing the same thing over and over again. The researcher says students creating podcasts is a good way to use their knowledge and use class time effectively. This is good because it can happen during the class time while flipping the classroom.

A type of media like podcasts but different are problem-based video podcasts. Kay and Kletskin (2012) say that problem-based video podcasts are “short, web-based, audio-visual explanations of how to solve specific procedural problems in subject areas such as mathematics or science” (p. 619). This study talks about using video podcasts in a situation like flipping the classroom to try and increase student interest and motivation in the subject. The class that was taught was a pre-calculus class. The podcasts are similar to other podcasts but these have videos and have problems that the students are supposed to solve with a group. This is a good use of technology because the students can work with others and use technology to meet their interests.

The researchers find that the biggest places that students were helped from the podcasts were solving equations, solving exponential and logarithmic functions, and trigonometric functions. There were two thirds of the students in the study who liked using the video podcasts because they liked having control “over when, where, and how they learned” (Kay and Kletskin, 2012, p. 623). One of the most important things that the students said is that they liked step-by-step explanations in the videos because it helped them the most.

One study by Lage, Platt, and Treglia (2000) explores flipping the classroom. This study uses data from Miami University about higher education students with college and high school participants. The students watched videos at home on the course content but also had activities to do that fit best with each student’s learning styles. These differences for activities are a good strategy for some teachers because it “implements a strategy of teaching that engages a wide spectrum of learners” (Lage, Platt, & Treglia, 2000, p. 41). Another study looked at how teachers change their instruction for students and how this is good for students. Kapusnick and Hauslein (2001) say that the classroom teacher is responsible for “adjusting the curriculum to accommodate individual learning styles and differences” (p. 156). They list many strategies that have been shown in research to be good working with students. Flipping the classroom is effective because teachers can use it to help give students choices to learn. The idea makes sense and comes with a lot of benefits.

Benefits

There are many benefits to using a flipped classroom. To begin, the strategy will save time for the students and for the teachers. Researchers are saying that the videos “led to greater

gains in conceptual understanding” (Berrett, 2012, p. 39). Also, the students can watch the videos and work at home, so that will save time for them and they can be more comfortable. This means that students can also work at their own pace. Researchers are saying that this is “one of the most powerful things about these videos: that students who process slower, can process slower” (Finkel, 2012, p. 33). The videos can also give students more opportunities to develop their understanding because they can watch the videos as many times as they want. When students can watch these instructional videos often, they can work slowly or quickly at their own speed. This means that they will have a good chance to understand what they see. If a student is watching the video and needs to ask some questions, then they can ask their family. Parents and siblings can view the video as well and help the student better understand the presentation. Students also can ask each other if they need help with anything because they are all learning from the same video and can all use each other as a resource. Also, since the students know what they will need help with, they can prepare questions for the teacher for the next day of school, so that the face-to-face time will be most effective for them. This means that all students will come to school and already know what they need help with.

In a study that worked with college students and their lecture class, the professor tried to change the way the class normally ran. The professor flipped the classroom and gave lectures to the students using a live recording program called eTEACH (Foertsch, Moses, Strikwerda, Litzkow, 2002). The professor used the students’ normal homework time to lecture to them using technology and encourage them to do better. The class time was used to do “small, team problem-solving sessions facilitated by the professors” (Foertsch et al., p. 267). The researchers

of this study collected data from the student evaluations of the class. They found that the students liked the online lecture and took notes better than in a typical class. In particular, the students liked being able to pause and replay parts of the lecture.

Teachers can also compare their work with that of other teachers, so that if some videos are better than others, they can potentially choose the best presentation. Teachers can share their information and strategies with each other. This means that all of the teachers will have the best knowledge to use. Also, the principal can evaluate teachers and their work because he or she can also access the videos. If the students are able to learn easily from the videos then they can let the teacher know they liked it. This means that it is “easier to get feedback from all of the students” (Gaughan, 2014, p. 232). If the principal is watching the videos, then a good observation can happen and the teacher will want to work harder. Also, parents will be able to watch the videos with their children so that the teacher will make sure the videos are the best quality, so that the parents can also help their children. In addition, if a teacher can consistently make good videos for the students, then the videos will be proof of what works well for students. Since the videos are proof, the employees of the school can honor the teacher who can connect with the students, and he or she can receive praise for it. The state could even make a library of these good videos so that teachers from all around who want to flip their classroom can watch them and learn what works best for them. As with all strategies, there are still some drawbacks or negative aspects to this strategy.

Drawbacks

There are some drawbacks with the flipping the classroom strategy because it is still new,

and some teachers are not used to it. First, a teacher might be hard for the students to understand in a video. Their teaching skills might not be as good through technology, and this means that the students will have a harder time understanding. If teachers spend time trying to fix this, then it might be improved. Also, some teachers might look online and find other teachers' videos that are posted and not put their own skills into making a video. If a teacher just uses other teachers' work without trying to put their own skills in it, then they will lose their teaching skills. Another thing that can happen is that some teachers might not be comfortable using technology (Bergmann & Sams, 2014). They might try to make videos and try to learn more, but it could be a very hard situation for them. This is another drawback for teachers who are flipping the classroom.

Some drawbacks are also for students. Since this strategy requires students to use technology, it will be hard for them to watch it if they do not have a computer in their house. Some students do not have enough money to buy computers and do not have other technology devices to use. This means that they will not be able to watch the videos. Despite this, "Schools with large lower-income populations have been experimenting with ways to deliver content before or after school in the library" (Finkel, 2012, p. 30). Also, some students might have computers at home but might be careless with their learning and school. These students might not watch the full videos or any part of the videos, and it will be hard for them to catch up with their peers. Finkel states that "we need to provide equitable access" to all students (Finkel, 2012, p. 3). Another drawback is that some parents might not be comfortable helping the students to find the videos and might not be able to assist their children. If parents can not help their

children find the videos or learn from them, then the videos will not be able to teach anything to the students.

If the learning environment from the flipping the classroom strategy is not used properly then some students may learn less than in the traditional classroom (Elen & Clarebout, 2001).

The strategy usually needs some work to be sure that it is very effective for students. If strategies are not made to work for students then sometimes they are not positive. This is a drawback for flipping the classroom because Elen and Clarebout (2001) find that flipping the classroom is “not always positive and sometimes is detrimental” (p. 100). This means teachers should pay attention to their students’ needs when using this strategy. Some students miss being able to ask questions during the lecture which is another drawback (Foertsch, et al, 2002). Even though there are some drawbacks, this strategy works well with students who can be independent, such as students at the grade eight level.

Development of 13 and 14 year olds

This next section is about the development of eighth graders. Their development that affects their math skills includes social, cognitive, and emotional aspects. The social part has to do with how their friends feel about math and how they get help from their families. The cognitive part has a lot to do with their math life before 8th grade. If they have had any disabilities in their life then this will also affect this part. The last part is the emotional part and this has to do with how students feel about their math work and how much they like it.

Social Development

The social aspect of 13 and 14 year olds’ development is very important at this stage.

Students' social aspects of their lives are most important to them because they want to be received positively by their peer group. Social aspects also are about how a student's family treats each other and how much help the student gets from home. This affects their lives in math because sometimes students who do not get a lot of help at home will not do very well in school. If a student has to try really hard for math every day and does not have anyone to help him, it will be very hard. If there are brothers or sisters, they can help him be more outgoing and confident, and he will feel better to try his hardest and do well in math. If his family also has a lot of money then he might be more confident and do better in school. If a student's family life appreciates school a lot and spends a lot of time working for education, then this will really help a student because school life will seem more normal to him (Leavy & Middleton, 2011). Also, if students' friends are interested in school and doing well in subjects, then this will help them in math as well. When students find something more "typical" (Leavy & Middleton, 2011, p. 250) then they can relate to it more and success is easier. In addition to this, if students have good areas to practice math and work harder to "train their ability to shield studying from leisure distractions" (Hofer, Kuhnle, Kilian, & Fries, 2012, p. 368) then success in math is easier. This might be useful for teachers who flip the classroom because students can work on their own at their homes.

Some studies look at self-efficacy of students and if this is helpful for their success. Lodewyk and Winne (2005) did a study about students who have a lot of choice and independence in their work and what this means for them. The researchers "assessed variation in self-efficacy and performance over the course of students' work on two extended, authentic

problem-solving tasks they undertook as part of regular classroom work” (Lodewyk & Winne, 2005, p. 4). The students in this study were a part of two different lessons, one was “well-structured” and another was “ill-structured” (Lodewyk & Winne, 2005, p. 3). The data from this study shows us that students who participated in well-structured lessons said they felt like they could achieve more. When students had some lessons that let them lead their learning, they could achieve more. Flipping the classroom is a strategy that can help make sure this happens for students. The video also allows the teacher to take more time in structuring the lesson. The teacher can review the video for clarity before posting it, something that cannot be done in a “live” instructional setting. This is important for educators to know because not many strategies allow teachers to do this. An important study by Moos (2003) looked at how social contexts work with students to have them learn as much as possible. Moos (2003) reviewed different lessons that were taught to students and analyzed the social context to see if it was good for them. One finding was the importance of looking at student perceptions, “so that a connection between context and outcome” can be analyzed to see if the success and perceptions of the students are similar to what the teachers’ are (Moos, 2003, p. 9). Another finding was that letting students work with others is helpful for good social development of students. Social development is not the only aspect that affects students. The cognitive aspect certainly affects how students learn about math.

Cognitive Development

There is a lot of research that talks about how students’ brains develop and affect their math skills. Many things affect math skills like how mature a student is and how they performed

in math before the 8th grade (Travis, 1998). The types of strengths in math that a student has before 8th grade is also important. There are some things that are important in students' brains for them to be good at math but "speed of processing appeared to be the most fundamental component underlying development" (Travis, 1998, p. 52). This means that students with faster processing will have an easier time doing math. If students do not have good speed in their brains then it means they will have more troubles. This means that working with students on speed and helping them to have a faster time to say problems or be more comfortable with math fluency is important for them. Another aspect of cognitive development that is important for math students is "maturation of executive functioning" (Travis, 1998, p. 52). This means that some students who have a more developed brain for doing hard things like algebra or geometry will be able to do it better and faster. Knowing this, teachers should strive to make students stronger because knowing students' weaknesses, teachers can work to turn these into strengths. Flipping the classroom is a strategy that can allow teachers to differentiate instruction to have students learn a certain topic or another. The videos that are made can focus on students' weaknesses if a teacher notices that there is an area that could be stronger. Another thing to take into account is the use of technology. If students are able to utilize technology more, it will be able to help stimulate their brains and let them work better to increase their knowledge. Also, the ability to watch the videos multiple times for students with slow processing abilities is an important benefit of flipping the classroom.

A study by Winne (1995) looks for aspects of self-regulated learning that are helpful for students. One finding from this study is that self-regulated learning is a "cognitively inherent

aspect of learning” (p. 186). This means that teachers should try to let students lead their learning. When students can do this, they remember a lot of what was taught and they can develop skills to help them handle difficult problems. This is important for flipping the classroom in that teachers can let their students lead their learning because much of the instruction happens online or through technology. If teachers can let students do this, then they can help them to remember knowledge better. The emotional development of 8th graders is important as well because it can affect the cognitive aspect.

Emotional Development

Another area of students’ development for 8th grade focuses on their emotions regarding math. Some students love math and some students hate math, and these feelings affect how they want to learn math and how they feel about math in their lives. With tests in school, but especially math tests, some students have a lot of anxiety (Yaratan & Kasapoğlu, 2012). This means that many people are uncomfortable with math and do not like taking math tests, in particular. They get nervous about them or nervous about doing math work, and it means they do not like it. Yaratan & Kasapoğlu (2012) found that “Without eliminating the negative attitudes and high anxiety, it is almost impossible to have success in mathematics” (p. 168). For this reason, it is the teacher’s job to make sure that students are comfortable in their class so that they can learn as much as possible. If a teacher uses the flipping the classroom technique, then the teacher can spend the entire class time helping students feel more comfortable and working on parts of math where they need help. Yaratan & Kasapoğlu also found that “students should concentrate on understanding the concepts rather than memorizing them” (p. 169). This is

important for teachers to know because if teachers can help students learn concepts better, then the students won't have to memorize things and will feel more comfortable working with math. It is also important for teachers to use different tools with students to make sure that all different students are reached. This means using different manipulatives and using technology to make sure everyone can learn. This process would be easy to do if the entire class time was spent strengthening students' work through coaching instead of using most of the time for direct instruction. This also relates to the curricular expectations of 8th graders because these expectations are made knowing the students' social, cognitive and emotional development.

Curricular expectations

Math expectations now are higher than before because of the new Common Core State Standards. Students are asked to do many new things that are very difficult for them. According to the EngageNY.org website, the standards and lessons have increased the difficulty for students (EngageNY, 2014). If students are asked to do more difficult work, they need to be taught in a way that makes more sense for them. Teaching by flipping the classroom is a good way to share with students what they need to know before the class starts. Also, students need to know what the expectations are for them at the beginning of the year, so that they know what they will be able to do at the end. Students who struggle with math will have a harder time doing what the others are doing because they are so far behind. If the expectations are so high for students, then we should use strategies that help students understand what they need to know and learn at a fast level. The Common Core has a shift in mathematics that means the students will learn fewer topics but with more detail. The new topics that will be covered in a lot of detail for

eighth grade are linear algebra and linear functions. This means that a teacher can use flipping the classroom to teach linear algebra and linear functions in a lot of detail instead of just skimming over it with many other topics.

Math Expectations with Flipping the Classroom

Flipping the classroom is an interesting strategy for students and teachers. It is helpful because it fits well with math expectations. These expectations are split up into groups in the Common Core. These groups are, “The number system, expressions and equations, functions, geometry, and statistics and probability” (Common Core, 2014). These are very complex and students need a lot of work to understand them. These expectations also mean that flipping the classroom has the potential to support the curriculum.

Since the Common Core standards have been adopted by 44 states, these rigorous expectations are being used for every student in almost the whole country. Learning to use “expressions and equations” is difficult, especially if students are not motivated (Cleary & Chen, 2009). Since students might not be motivated enough to be the leader of their own learning, it is important for teachers to help students with this. Research on flipping the classroom shows that motivation increases and students can figure out questions on their own to ask the teacher (Bergmann & Sams, 2014). Cleary and Chen also find that there is a big connection between “motivation beliefs and self-regulation” (2009, p. 309). This means that the more students get to lead their own learning, the more motivation they have for something. This is important to know because other studies state that lack of motivation is a big problem for math achievement of students (Yaratan & Kasapoğlu 2012). If flipping the classroom can increase motivation, and

that is a good thing, then it would seem like flipping the classroom will be helpful for teachers to use. These findings are more important, the harder that a subject gets. If a subject is very hard and complex for students, then motivation is even more important for them (Cleary & Chen, 2009).

Alignment with flipping.

Since flipping the classroom has a lot of technology used for it, this is a good thing for 8th grade students. Karal, Çebi, and Peksen (2010) did a study that tried to see if problem solving of 8th grade students was helped at all by technology. They found that students were able to solve problems better when they were using technology than without it. The researchers say, “the simulation environment that is created will help students at the stage of making sense of the problem” (Karal et al, 2010, p. 4544). This quote means that students who use technology to explore math concepts help engage more of their brains than those just using pencil and paper. This shows that teachers who use technology to help teach math students can make their students’ problem solving skills better. Other studies say that when students do not put off their math homework, then they can increase their math grades a lot. This is important because if there is a way that teachers can help increase students’ grades, then they should do it. Kofer et al. (2012) say that “academic procrastination contributed significantly to the prediction of grades and grade changes” (p. 373). Since flipping the classroom is a strategy that helps make sure students stay on task, it would be good for teachers to use. When students have homework that involves technology, they generally work harder and more diligently (Cleary & Chen, 2009). This is good because it also lowers anxiety and makes students feel more motivated to work on

their math. This means that with all of the expectations of math for students in the Common Core and for students' development as 8th graders, flipping the classroom seems like a good strategy.

Hough and Gough (2007) talk about research that happened in the Netherlands at the Freudenthal Institute. This research is about a type of math called *Realistic Mathematics Education* (p. 34). This type of math is used in the United States also. The math program has students using real objects and easy to understand math that leads to harder math. The learning process for the students is to start with a "mental image of the situation, and during the course of the text the pupils will be offered various models" (p. 34). Students start with "informal pictorial approaches" (p. 35) and the program connects that with formal math equations and strategies. This program has had great success with schools in the United States and other countries. These strategies of "process-led rather than content-led objectives" (p. 37) are shown to work with students and they can be applied to strategies at home during flipping the classroom.

Different kinds of research also talk about strategies for using technology with math. Some research shows that using media "for building virtual environments" is successful (Okamoto, Cristea, & Kayama, 2001, p. 8). One reason virtual environments, like what is used during flipping the classroom, is effective is because time in a classroom is limited, but time at home is much greater. Also, learning environments for each student are easier to use through media than through the classroom. Students with different preferences can choose different options more easily online than in a classroom. Another thing about learning environments from flipping the classroom is that they should show the ideas very clearly to the students. Research says that "the use of particular modes of representations leads to improvement of students'

mathematical abilities” (Pape & Tchoshanov, 2001, p. 120). This is important for teachers who flip the classroom because when they show information online to students, they should make sure they represent it well so that students of different backgrounds can understand it.

Through all of the information that is available about math expectations, eighth grade development, and flipping the classroom support, it makes sense that this strategy could be very beneficial for students. Each category is an important aspect to look at for a strategy to be effective. Since all of these categories are effective for flipping the classroom, it warrants additional research to determine the effectiveness of the strategy.

Methodology

Setting

The setting for my study was in a suburban school in Western New York. I studied one math classroom at this school. In this classroom, seven units used a flipping the classroom format and the other units used traditional homework and class work. This school serves grades five through eight. The school is 85% white, 10% Hispanic or Latino, 1% African American, and 4% other. The school has a total of 481 students with 32% of those students with a low income.

Participants

The student participants are eighth grade math students. The age of the students is between 13 and 15. The whole class was used and every student’s data was collected for analyzing. The teacher of this classroom was also a participant. I interviewed the teacher about the program to see if she perceived it to be effective for the students.

Design

For this study, I used a quantitative methodology. I collected data on test scores to indicate the effectiveness of the flipped classroom approach. The design of my research is an ABAB design. First, I spoke with the teacher and interviewed her. After that, I analyzed the data from the students when they used the strategy and when they did not. They used the strategy, then had a traditional class, then used the strategy again. I looked at data from the students and compared it to when they had a flipped classroom and when they did not. The students watched these videos on some type of technology device on the internet and completed some introduction activities. The next day, the students knew exactly what they would learn and could spend all of class asking questions from the teacher and doing guided practice.

Data Collection

To collect data for my study, I used three different techniques. First, the teacher shared with me results from a likert scale survey that the students completed (See Appendix A) to indicate how comfortable they were with the flipped classroom. The scale was from 1 to 5 and the categories for the scale changed for some questions. The students circled 1 if they strongly disagreed with the statement and 5 if they strongly agreed with the statement. The survey also asked students if they thought they liked this instructional method more than the traditional approach. I also conducted a face-to-face individual interview with the teacher (See Appendix B) who used flipping the classroom. The reason I conducted an interview is to understand the experience of an educator and “symbolize their experience through language” (Siedman, 1998, p. 8). This interview was based off of research from Strayer (2007) on flipping the classroom. The teacher interview indicated what she viewed as the benefits and drawbacks of this approach

(Seidman, 1998). I also asked other things such as if she thought that the students learned more with this approach and the how class time was used. I conducted the interview for approximately 30 minutes with the teacher. This interview was in her classroom and happened at the end of the day after the students went home. The last method for collecting data was the test scores from the students on the tests they took. I analyzed this data to see if there was a pattern in tests from the different formats.

Data Analysis

To analyze the data, I looked at the survey responses, the interview with the teacher and the students' test scores. The survey scores were analyzed to find their opinions and to see if the students thought it was a helpful strategy or not. I analyzed the teacher's interview results to see her views on the strategy. I also compared the students' scores to see how they compared to each other and if flipping the classroom works well or if it the students' scores were the same or worse than the control unit scores. Possible trends in the data were identified to determine if there were any patterns of success in the units.

Findings

The grade eight teacher who worked with the students and flipped the classroom taught 11 units with 11 tests. Four of the units used the flipping the classroom strategy, but the other seven units used traditional teaching strategies. I collected test results so they could be analyzed to see if some students did better with flipping the classroom than regular strategies. The test scores are all shown in table 1. The test scores were slightly higher with a flipped classroom than with the traditional structure of class instruction and homework. This is similarly shown in the

student response on the likert survey. Most students indicated that they liked flipping the classroom more than they liked the traditional structure. Students also generally found it easier to learn using this model. This idea is also consistent with the teacher's ideas of flipping the classroom. The teacher feels "more connected" (Personal Communication, 2014) with the students using the flipped classroom than with the traditional method. She feels that it has been an effective strategy but might not be right for teachers who are not comfortable with technology.

Test Analysis

The data from the study is shown in Table 1. The average mean for the traditional tests is 67.98. The average mean for flipped classroom tests is 71.09. This means that there was a 3.11 point increase in the average scores for students when the subject was taught using a flipped classroom. The average median score for traditional-unit tests was 73.19, but flipped classroom-unit tests had an average median score of 78.21. The average median score difference is even more significant with a 5.02 point difference. The data shows that some of the tests had different scores because perhaps the quality of the test was not the same, but for all tests, scores for units with a flipped classroom had higher scores.

Also represented in table 1 are the titles for the units that were taught. There is a trend in the data that shows that students struggled more with the units in the beginning of the year than at the end of the year. Units four, six, nine, and eleven are the targeted units for flipping the classroom, which are generally towards the second half of the year. It is unclear whether the trend of lower scores in the beginning of the year is related to the flipped classroom or other factors.

Test one through test six occurred during the first half of the year, between September

and December. Test seven through test eleven took place from January to June. The average score of tests from units one through six is 66.07. Compared to the average of 72.76 for tests seven through eleven, that’s a 6.69 point difference. In terms of average median scores, the first six tests have a score of 72.71, which is less than the second five tests’ score of 77.78.

Table 1
Student Test Scores

Test	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10	Test 11
Unit Titles	Real numbers	Real numbers and exponents	Equations with one variable	Equations with two variables	More systems	Functions	Pythagorean theorem	Transformations	Congruence and Similarity	Statistics and Probability	Volume and Surface Area
Type	Traditional	Traditional	Traditional	Flipped	Traditional	Flipped	Traditional	Traditional	Flipped	Traditional	Flipped
Mean	69.01	62.53	62.75	64.79	66.35	71	73.39	68.28	74.83	73.56	73.76
Median	72.22	69.48	70	71.58	74.5	78.5	77.23	72.78	80.56	76.12	82.22
Student Scores	67	69	77	57	59	73	65	56	57	58	65
	84	79	83	80	79	85	75	73	71	63	67
	77	59	53	59	84	84	69	71	77	72	78
	78	75	76	59	81	85	69	58	63	77	80
	9	11	12	26	24	27	15	9	12	22	22
	65	72	68	68	65	76	72	65	53	68	72
	68	74	73	66	84	85	78	71	80	75	78
	63	85	76	72	86	97	83	84	80	78	80
		6	81	66	94	43	80	68	77	70	79
	81	82	84	68	81	81	83	87	80	78	19
	55	51	54	55	66	45	59	49	60	55	85
	39	52	60	44	39	69	51	68	64	63	61
	66	72	81	84	80	91	80	68	76	75	76
	72	63	56	68	70	81	71	66	78	55	82
	82	85	74	91	95	88	70	79	80	86	74
	61	53	28	36	34	60	54	50	67	89	86
	59	60	57	69	58	59	54	38	60	60	59
	62	61	69	75	92	85	78	62	78	72	62
	62	71	71	52	33	71	67	48	60	65	81
	30	8	22	16	23	35	48	59	74	63	68

Table 1 Student Test Scores

One reason this may be is because many of the math units that involve memorizing formulas and using a lot of numbers occur at the beginning of the year. During the second part of the year, the students learn about geometry and Pythagorean theorems which have a heavy visual aspect of learning. There are seven units that focus on memorizing formulas, using large amounts of numbers, and complex concepts to understand. These seven units have an average score of 67.14.

There are four other units that have a large visual aspect with shapes and less difficult concepts to understand. These four tests had an average score of 72.57. The two tests with highest mean scores and median scores were test nine on congruence and similarity and test eleven on volume and surface area. Both of these tests had a high visual aspect and were taught using the flipped classroom.

Interview Analysis

The teacher answered the ten questions in the interview and there are some main ideas from the responses. The teacher felt that she was more connected with her students because it is easier for her to answer questions her students ask during class time and now she “has a better understanding of where her students are at” (Personal communication, 2014). She also explained that the students like the flipped classroom a lot better. She likes this strategy better also because she has fun with it since her students have fun with it. Another main idea is that if students are absent, they can still watch the video and not miss the content. She thinks that this is a good point for why flipping the classroom is a strong strategy. Also, she noted that struggling learners like being able to watch the videos repeatedly, so they can watch it until they learn it. One issue with this strategy is when students try to cheat and fast forward videos. The teacher said that she cannot see for sure how much the students watch at home. So, if the students are struggling because they didn’t watch a full video, then they will not “have that knowledge that they should have had” (Personal communication, 2014). However, when it comes time to do the work, the teacher said she can always tell when a student has not really watched the full video.

The teacher talked a lot about being comfortable with technology because there are sometimes technological problems with the videos. She thinks that if a teacher is not comfortable

with technology then they might not be comfortable using this strategy. If a teacher has this type of comfort, she thinks that “any type of content can be flipped”. This is good because all teachers with technology comfort may use this strategy. In addition to this, teaching the students math and technology skills is helpful for our current world. Students have to have technology skills for new tests and jobs. This teacher believes that teaching them these skills is important because they can learn the content of the class and also develop their technology skills.

Student Survey Responses

The students completed a survey to determine their comfort level with flipping the classroom. For questions two and three, some students picked more than one answer. The results show that most students are comfortable learning with a flipped classroom. The data are shown in table 2. The question and answers are displayed on the left column and the number of students who selected each choice is shown by the numbers in each row.

Table 2 <i>Student Likert Responses</i>					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Question 1 Student affinity		2	3	3	8
Question 2 Flipping makes math easier		1	5	7	3
	School	Home	Library	Friend's	Other
Question 3 Where videos are watched	7	13	1	0	0
Minutes	10	20	30	60	120
Question 4 How long it takes	12	4	1		

Some more data from this survey is that most students watch the videos at home. Those who do not, generally watch them at school. Lastly, the students indicate that it takes them on average 10 minutes to watch all of the videos to get prepared the night before class. This is a short amount of time compared to the amount of time that traditional homework takes. This might contribute to the feeling that students have about liking flipping the classroom. Only two students indicated that they dislike flipping the classroom. All of the other students indicated that they either liked the strategy or were neutral about it. It is not clear as to why the students feel this way about the strategy, but based on the data from the survey, it might be because of the reduced time that it takes to finish watching the videos or because many students indicated that they feel that this strategy makes learning math easier.

Discussion

The data show us that overall, there is a happiness and comfort with using the flipped classroom strategy of teaching. The test scores are a little higher with the flipped classroom and the two highest scored units in this study are visual units with a flipped classroom form. The students indicated that they spent less time working on homework possibly because they only have to watch a short video and complete a worksheet with it. In addition to this, the teacher's comments from the interview indicate that she feels comfortable with the strategy as long as the technology works well.

Implications of Results

The results of the data show that there is not a very large difference between the two methods of teaching. There is a very small increase on student test scores for flipping the classroom. This is still important to see because it shows that the traditional way has about the same effectiveness as flipping the classroom. The same amount of success is important because

teachers may be able to use this strategy if they are more comfortable with technology and would prefer to use this approach.

The teacher in this study also said that she liked the time she spent in class with the students more. She thinks that her time is more efficient with the students and she works with them in a better way. Focusing on what they need help with, she has a better connection with her students. This is important because for some students, this face-to-face time with the teacher might be what they need to do better on their work. They can take more benefits from working with this style instead of using the traditional style. However, if some students like this way better, some other students might prefer the traditional strategies.

Some students' test scores decreased during flipped classroom tests. This might be that they liked to learn the strategy from the teacher or might like to practice the content independently. The teacher said that all students had many opportunities to use a computer to watch the videos. Also, the teacher made libraries of the content for the students to help them be organized. This means that the teacher tried many different methods of making sure students would benefit from the flipped classroom.

Some teachers might not prefer to teach using technology. The teacher in this study did not have too many technological problems with making the videos, but this is something that teachers less familiar with technology could experience. The students were very good at figuring out how to use the videos online and finding times when they could watch them. The teacher also said that she was able to tell easily which students did not watch the videos. She asked them questions in the beginning of class to help start the lesson. Some students answered the questions

poorly, and she could tell that they were not being truthful about watching the videos. Students might try to lie about watching the videos and the teacher has to be comfortable with the students to have this trust. Strayer (2012) also provides evidence that having trust between the students and the teacher is a good practice for flipping the classroom.

The strategy of flipping the classroom seems to work more effectively with math units that have a visual aspect to them. It might be easier to show visual parts of math by using a video to teach to the students. Further research with a larger group of participants would help to further develop this strategy.

Correlations with other literature

This study has similar data to some other studies in the literature review. Berrett (2012) found that students made similar gains. Berrett's reasoning for this result is that the videos helped connect to students to reach many different types of learners. The videos that the teacher makes can sometimes help some learners and the guided practice the next day in school can help build off the video and help other types of learners.

One of the drawbacks of the flipped classroom according to Finkel (2012) is that students need "equitable access" (p. 3) to technology to help make this strategy effective and to help schools teach students good skills they need for using technology. All of the students in this study were able to use the technology of the videos at a good spot after school. Most students watched the videos at home, but some others watched the video at school. The success of the strategy at this school could be because there were no students who did not have access to watching the videos.

Another practice that the teacher in this study followed was collecting all of the videos and creating an archive for students to watch past videos and re-watch new videos. This practice

has been supported by some research because the videos are always there as a resource for the students (Strayer, 2012). This might be a reason that the teacher in this study had positive results with using a flipped classroom.

Implications for practice

The students in this study showed a small increase in their test scores when they were a part of the flipped classroom. This gives some evidence that this strategy might be effective for some classrooms. The teacher of the classroom said in an interview that some of the subjects in their curriculum worked better with flipping the classroom than others. Some of the subjects had students learn better in the classroom with the teacher than at home through a video. This was determined by how complicated the subjects were for the students to learn. The more complex a subject was, the harder it was for them to use flipping the classroom. The teacher was able to fix this problem by using the beginning class meetings to introduce the topic. After the students understood the main ideas of the subject, flipping the classroom worked better.

Another point about the videos is that when the videos are longer than ten minutes, the students get bored with the video. This means that students will pay less attention to the content and might need to be taught more things. This happened sometimes when the teacher used videos that were too long. In the end, according to the results of this class, it is up to the teacher to figure out if this would be a helpful strategy to use with their class. Based on the findings from this class, videos longer than ten minutes do not work as well as shorter, more specific videos.

One other problem that occurred in this study is that in the beginning of the year, a lot of

time was spent helping students to understand how to use the technology and teaching procedures. If a teacher would like to use this strategy, then it would be helpful to plan that teaching how to use videos takes a significant amount of time. The first three or four class sessions should be used to teach procedures and answer any technology questions that the students might have.

Certain units might be more effective with flipping the classroom. Based on the data from this study, it seemed that more visual units had better results with a flipped classroom. It is up to individual teachers to find out what works best for them, but it seems that building on the visual aspects of the math lessons might be a good practice for teachers that want to use this strategy.

Future Research

Flipping the classroom is a new strategy. It would be a benefit to the education world to conduct more research on this topic. According to this study, there was some success with the students in this classroom. Future research for the next steps of flipping the classroom could include more classes of students and with different types of diversity. Students with disabilities might be able to learn very well from this strategy, as well as English language learners. Research could be conducted with students in this group to determine its effectiveness.

Another area of future research would be to conduct studies that find out what subjects work best with flipping the classroom. The data in this study shows that when a concept is very visual for the learners, the videos in this strategy can help to make that concept easier to learn. The visual parts of a video might be a key part to this strategy. That means that maybe using visuals in a very important way in the videos could lead to even bigger areas for students to make improvements. This means that more research on the types of visuals used in videos with a

flipped classroom and more research on different subjects or lessons that would work well with this strategy could be good to conduct.

Limitations of this Study

One of the limitations of this study was the demographics of the classroom that was used in this study. It was not a very diverse class. There were no students with disabilities in this class and there were no English language learners. These two groups of students require differentiation of the content, so that they can understand it more clearly. If there was a more diverse classroom, more data and information could be collected about how flipping the classroom works with many groups of students. In addition to this, the study was only conducted with one classroom of students. If possible, using more classes to collect data would have given more accurate results. This classroom will be my data source for this study but it is only approximately 20 students and this could be a limitation.

Unfortunately, only one class was using this strategy at this school, so another class could not be observed. If this strategy becomes more popular in the future, more data can be collected on different types of classrooms and how they respond to flipping the classroom.

This strategy is a very new strategy. Most of the research that was published about this strategy is from the last two or three years. This means that there will eventually be a much larger amount of research on this topic. Since this is so new, I was not able to find as many articles about the strategy. This is another limitation to this research.

Conclusions

The data from this study shows that the practice of flipping the classroom increases the mean score of students' tests. The teacher was happy with how her students were learning and was also happy about using the strategy. The students indicated that they were mostly happy and comfortable with the way flipping the classroom works. This can provide support that flipping the classroom is an effective strategy consistent with Strayer's (2012) findings. It is important to establish procedures with flipping the classroom particularly in helping students to watch the videos. Based on these findings, from this study, flipping the classroom raised mathematics test scores. More specifically, some units seem to be more effective with flipping the classroom than others. Math units that have a lot of visual parts to learning such as geometry and calculating volume and area might be more effective with flipping the classroom and teaching through videos because videos may be able to show visual concepts more effectively than a teacher can teach on a board. Future research could be conducted with different topics of mathematics or other subjects to determine its effectiveness in different areas.

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Appendices

Appendix A: Student Survey:

1. I like flipping the classroom.

1 2 3 4
 Strongly 5 No Agree Strongly
 Disagree

2. I think flipping the classroom makes math easier to learn and improves my skills.

1 2 3 4
 Strongly 5 No Agree Strongly
 Disagree

3. I access the video at:

1 2 3 4
 School 5 Home Library Friend's Other

4. Watching the videos outside of school takes:

1 2 3 4
 10 minutes 5 20 minutes 30 minutes 1 hour 2 hours

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Question 1 Student affinity		2	3	3	8
Question 2 Flipping makes math easier		1	5	7	3
	School	Home	Library	Friend's	Other
Question 3 Where videos are watched	7	13	1	0	0
Minutes	10	20	30	60	120
Question 4 How long it takes	12	4	1		

Appendix B: Teacher interview questions:

1. Does the use of technology in this class (compared to a more traditional approach) cause you to feel more or less connected with the students?
2. Were you hesitant or enthusiastic about using the flipped classroom strategy?
3. Do you feel that flipping the classroom helps you be more in control of student learning than in more traditional approaches?
4. Are your grades on exams higher, lower, or about the same compared to other math classes you've taught?
5. Do you feel that the flipping the classroom in this class gives students a better opportunity to master the skills?
6. When something goes wrong with the technology, do you first try to play around with it to get it to work, or do you immediately have someone else work on helping you fix the problem?
7. Do problems with technology happen often?
8. Are there any issues that you have noticed with flipping the classroom?
9. Would you recommend this strategy to other teachers?
10. How does using technology help or hurt students' progress in this class?