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The Effectiveness of the Flipped Classroom

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Exploring the Effectiveness of the Flipped Classroom

By Raymond Szparagowski

This research study explores the “flipped” or “inverted” classroom and its effects on student learning. The flipped classroom is a form of education in which students learn new content during out-of-class-time instead of the traditional review exercises that are normally given, which opens up class time for activities, problem solving, and other forms of instruction. During this study, a flipped classroom was implemented in a high school mathematics course. Data was collected from student grades, a pre and post survey, a class interview/discussion, and my personal notes from teaching. My results indicate that some potential benefits of the flipped classroom make it a form of education that teachers should not overlook.

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Introduction:

A current trend in the education community has teachers flipping out across the nation. This trend is known as the "flipped classroom" or "inverted classroom." A flipped classroom, as its name suggests, is a class where the lecture and homework have been reversed. In other words, the practice problems normally completed at home are worked on in the classroom, and the direct instruction normally given during class time is given as homework through video lectures, reading assignments, or some other direct instruction delivery method. However, this idea has evolved into a more nuanced form of education.

There are many misconceptions about what the flipped classroom actually is. Some misconceptions about the flipped classroom are that student spend the entire time in front of a computer screen, students work without structure, videos replace the teacher, students work in isolation, or that a flipped classroom is an online course. An effective flipped classroom is one that, the time normally spent lecturing, is used for in-class activities, discussions, problems, and group projects. The most meaningful learning in a flipped classroom occurs as a result of efficient use of the extra class time (Tucker 2012). The direct instruction given to students as homework can take the form of a video, an article, a book, a power point, a handout, or a combination of these among other. Any teacher who has had students read materials before class in order to prompt discussion or activities has, in a sense, utilized the flipped classroom.

Opinions in the education community regarding the flipped classroom are mixed. Some educators consider the flipped classroom to be the future standard of educational technique (Bergmann, Overmyer, & Wilie, 2012). Other educators consider the flipped

classroom to be a passing trend that will be found to be an ineffective and undesirable form of education (Bergmann, Overmyer, & Wilie, 2012).

For my research project, I utilized the flipped classroom method of education in a high school Algebra 2 course while simultaneously evaluating its effectiveness. The objective was to discover whether this form of education will be an effective instructional method for use in my future teaching.

Literature Review:

The use of the flipped classroom has the potential to be an effective and beneficial method of education. Replacing direct instruction (the explicit scripted presentation or delivery of information or a task) from the class time with video lectures observed outside of the classroom allows for more class-time to be used for active learning. Active learning can include activities, discussion, student-created content, independent problem solving, inquiry-based learning, and project-based learning (Bergmann, Overmyer, & Wilie, 2012). This use of class-time can create a classroom environment which uses collaborative and constructivist learning; blending with the direct instruction used outside the classroom (Tucker 2012). Constructivist learning takes place when students gain knowledge through direct personal experiences such as activities, projects, and discussions. (Ultanir, 2012). The frequency of these personal experiences can be increased in a flipped classroom through the use of activities, creating students who are active learners (learning by engaging in analysis, synthesis, and evaluation), rather than passive learners (learning by the absorption of information from hearing, seeing, and reading) (Minhas, Ghosh, & Swanzy, 2012; Sams, 2013). The passive learning of a flipped classroom happens during the video lectures outside of class, freeing up in class time for active learning (Tucker, 2012). Active learning has been found to produce better grades than passive learning (Minhas, Ghosh, & Swanzy, 2012). Collaborative learning takes place when two or more people learn something together, holding one another accountable for their learning (Roberts, 2004). Collaborative learning can create students who are more invested in their own learning, desiring to succeed in order to meet the expectations of one's peers (Roberts, 2004). Through group activities, discussions, and

group problem solving, a flipped classroom can achieve a high level of collaborative learning.

The flipped classroom also involves a transformation of the teacher's role. In a traditional class, the teacher can be described as the "sage on the stage" that presents information in engaging ways in hopes that students will pay attention and absorb the information (Bergmann, Overmyer, & Wilie, 2012). The flipped classroom moves away from this idea, placing the teacher in the role of the "guide on the side" who works with the students to guide them through their individual learning experiences (Bergmann, Overmyer, & Wilie, 2012). The "guide" role can be illustrated using Paulo Freire's idea that education "should not involve one person acting on another, but rather people working with each other," (Smith, 2012, p. 1).

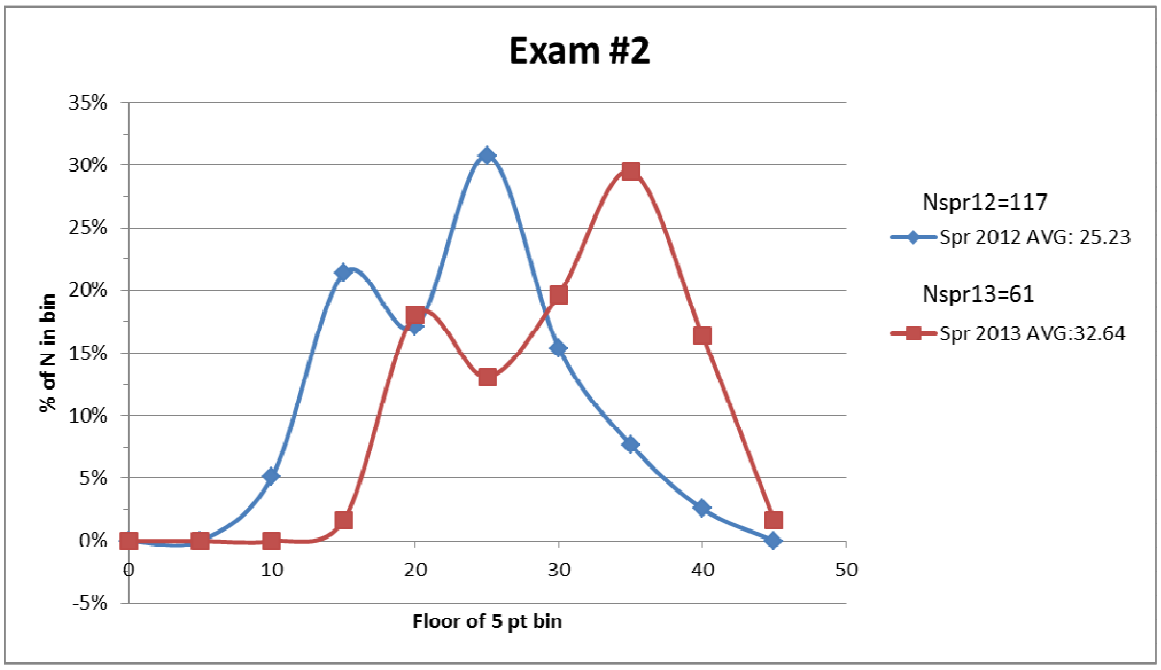
There is little research regarding the flipped classroom's effects on student learning and overall effectiveness. However, the majority of the research that I examined involved flipped classrooms at the college level. This differs from middle school or high school classrooms in difficulty, class size, days and times classes are held, and other factors. One such study by Strayer 2008, *The effects of the Classroom Flip on the Learning Environment,*showed that students in a flipped classroom environment preferred the method and displayed a higher level of innovation (being able to solve problems in creative and unique ways) and cooperation (familiarity with working with others to solve problems and discuss ideas), than students in a traditional classroom setting. His results also indicate that students in a flipped classroom experience a lower level of task orientation than students in a traditional classroom (Strayer, 2008). From the results of his study Strayer gives recommendations for the implementation of flipped classrooms.

One recommendation for implementing a flipped classroom in an introductory course is to provide step-by-step instructions for classroom activities to create more structure for the students (Strayer, 2008). To create more structure a teacher could also scaffold the activities. Scaffolding is instruction given when learning a new task where different levels of support are given, with student eventually having most or all support removed as the activity progresses (Hogan & Pressley, 1997). Another recommendation is to keep open activities short; spending no more than two lessons on any one activity (Strayer, 2008). According to Strayer, one effect of the flipped classroom is that students will become more aware of their own learning processes (Strayer, 2008). Because of this increased awareness, students will need more time to reflect upon their activities to make connections to the course material (Strayer, 2008).

Another study on the flipped classroom was conducted by Toto and Nguyen. In this flipped classroom, students watched a 30-minute video lecture prior to going to class. As a result, there was additional free time in class, which was spent using real-world tools and engaging in practical applications (Toto & Nguyen, 2009). This classroom was found to have increased student engagement (Toto & Nguyen, 2009). Furthermore, students had more opportunities to gain a sense of how the tools and ideas they were leaning are used in the real world (Toto & Nguyen, 2009). The positive results of this flipped classroom stem from the effective use of class time.

To gain a better understanding of the flipped classroom, I interviewed Dr. Miles Blanton, an instructor in the department of physics and astronomy at Bowling Green State University. Dr. Blanton has been implementing a flipped classroom for 2 semesters in his introductory astronomy class and is now my research advisor. I would describe Dr.

Blanton's flipped classroom as a "flipped-traditional classroom" since it still resembles the traditional college lecture style classroom in a way. In a flipped-traditional classroom students watch video lectures as homework and work individually on problems, exercises, and thought experiments during class time. Dr. Blanton, with the help of two teaching assistants, answers questions and discusses ideas with students one-on-one or in small groups. Dr. Blanton has collected data from both his flipped and traditional classrooms (Blanton, 2013).



The above graph compares test results of an exam from one class taught with a traditional lecture, and another taught with a flipped-traditional classroom. Both classes were taught the same material and given the same exam. The red line shows the distribution of scores from the flipped classroom and the blue line shows the distribution of scores from the traditional classroom in an exam out of a total of 50 possible points. As illustrated by the graph, the flipped classroom's distribution curve appears to be a full letter grade higher than the traditional classroom's (Blanton, 2013). These results seem

to imply that the flipped classroom could produce better grades, but since variables such as class size, students past knowledge, and other variables can have a large impact on grades, this data cannot be used to draw solid conclusions. Additionally these results have not been run through data analysis to show that they are in fact significantly different. Interestingly, there are other slight differences present between these distribution curves. The distribution curve for the flipped class appears to be steeper at its beginning and end, perhaps indicating that the flipped classroom produces a more tightly packed grading curve than the traditional classroom. These results are from only two classes and are insufficient for drawing generalizable conclusions about the flipped classes, but these results do suggest that the flipped-traditional classroom has the capacity to improve in-class performance of students compared to a traditional classroom. While these results are preliminary, Dr. Blanton's work is ongoing.

Methodology:

In order to analyze the effectiveness of the flipped classroom, I compared a flipped classroom with a non-flipped classroom. By comparing the two methods of teaching I was able to find some of the effects the flipped method had on my classroom.

The school that I was placed at for this research was Penta Career Center. The school is on a block schedule with four 88 minute blocks each day, A block, B block, C block, and D block. During my student teaching I was placed in three algebra II classes during B, C, and D block. I had A block off as a planning period. There were 23 students in B block, 22 students in C, and 21 students in D block. This research project happened towards the start of my student teaching. For this reason each block was taught slightly differently. B block being my first time teaching a lesson had a lot of timing problems and other issues to work out. Despite a lot of mistakes here and there B block students are were very respectful and were hard workers. During C block I am usually able to fix and adapt my lesson a little, but I had another issue of dealing with multiple students with behavior issues. During D block I was usually able to further improve my lessons and was a little more relaxed and confident while teaching. Because of this D block was probably my most energetic class, with students that were more comfortable sharing ideas and working together on problems.

To compare the flipped with non-flipped I first gathered data from a normal non-flipped classroom so that I would have somewhat of a baseline data with which to compare the flipped classroom. To gather this data I started by implementing a non-flipped normal classroom for about 4 days. These lessons were designed with normal classroom events such as lecture, activities, and other education techniques. For

homework each night students were given practice exercises about the material covered in class.

After implementing a non-flipped classroom for 4 days I surveyed my students. The survey asked how long students spent on homework each night, how helpful they found the homework to be to their learning, and how students rated the effectiveness, difficulty, and engagement of the classroom. In this survey students had 5 possible responses to the survey prompts: strongly agree, agree, neither, disagree, or strongly disagree. Additionally the survey had three open response questions that let students write any comments and put what they liked or what they would want changed about the class.

Following the implementation of the normal non-flipped classroom I implemented the flipped classroom for 4 days. In my flipped classroom, for homework, students were assigned to watch 5 to 15 minute video lectures followed by a 3 to 5 question video quiz. To find videos that would meet the needs for my lesson plans I searched on Google and YouTube. I found that many Khan Academy videos were excellent and used them for 2 of my flipped homework assignments. His videos show students how to solve problems and also asks questions and explains the reasoning and thought process behind the problems. The video quiz gave one to three problems on concepts or ideas that was solved, described, or shown in the video/handout. Handouts with the same information as the video were available for students without internet access at home or for students who wanted an additional resource.

During class time students engaged engage in discussions, activities, problem solving, and group work. During time spent working on problems students were placed

in strategic pairs or “math buddies” and pairs were combined to form larger groups of four students. While working students were instructed to work with their math buddy then check answers with their larger group of four.

On the first day students learned some of the basics of graphing in their video. In class I expanded upon what they learned in the video with some review notes, then I followed notes with a graphing battleship game that I found and adapted for the algebra II class. For homework students watched a video that demonstrated how to graph functions by factoring and finding the intercepts.

During the next day of class I started by giving students a mini-vocab quiz from the day before, and then had an ice breaker. I then gave students a short period of time to check and discuss the video quiz answers with their math groups before turning them in. Then I gave them an example similar to the one they watched in the video followed by a list of practice problems, each with a new aspect or twist to it. I then gave students time to work and I went around the classroom observing and helped students. Next I had students volunteer to go up to the board and show the class solutions to some of the problems. Next I had students write a notecard sized cheat sheet of tips that I later let them use on the next quiz. Next I showed students a group of problems that they would not be able to solve using intercept form. I then had the class discuss what they needed in a graph of a quadratic function and had them try to come up with ideas of how they could find the vertex and other points.

For homework before the third day students watched 2 short videos. One on graphing basic inequalities and linear inequalities and the other on graphing quadratics in vertex form. At the start of class students were again given time to check and discuss the

answers to the video quiz. During this time I was able to determine that the graphing vertex form graphing video ended up being a little complicated for most students and I had to adapt my lesson and spend a good part of the start of class showing students how to graph quadratic functions in vertex form. Then I let students work on a few practice problems. Next I reviewed graphing basic inequalities. Then had students try to graph a quadratic inequality function for the first time. Even though students had not been shown how to graph quadratic inequalities they were able to transfer over to quadratics with ease. At the end of class students were given another opportunity to make a small notecard sized cheat sheet for the quiz.

On the last day of the flipped classroom students had watched a video about basic transformations and their definitions for homework. At the start of class I shortly went over the definitions and descriptions of the transformations that they learned in the video. Then I had students get laptops and work on review problems while waiting for the laptops to load. After working for a bit I discussed the review problems with the students, then directed them to desmos online graphing calculator. Students were given an activity handout that had them change different aspects of the quadratic equations in both vertex and standard form then write a description of the transformation that was happening. Next I had the class come back together and share their results. Then I asked questions about the activity: asking what transformation would result from a certain value change and what value change would result from a certain transformation. Students were then given a short period of time to make a final cheat sheet to use on the quiz.

After implementing a flipped classroom for 4 days I gave my students the same survey that they took after the non-flipped classroom. In addition at the end of the survey

I added two questions asking students which method they preferred, flipped or non-flipped.

After I completed teaching both the flipped and non-flipped I documented my own personal reflections of what went well in the flipped and non-flipped classrooms. I documented what aspects of the flipped and non-flipped classroom that I liked and disliked and what I would keep the same or change for next time. I then compared the survey results from the flipped and non-flipped classes and assessed how students rated various aspects of the classroom differently. After evaluating the surveys I compared student grades from the non-flipped class and the flipped class.

Data analysis:

To analyze the survey results I assigned number values to each possible survey question response: 1 to strongly disagree, 2 to disagree, 3 to neither, 4 to agree, and 5 to strongly agree. Then I took the average (mean) results from each block for each survey question, along with a combined average of all three blocks. I chose to keep look at the survey data of each block separately for part of my survey analysis since each block was taught a little differently and developed a different classroom environment. I think a part of this can be attributed to me being a student teacher. After teaching a lesson for the first time to B block I usually make some changes to improve my lesson when I teach it to C block. After C block I make additional changes when I teach it to D block. To compare flipped with non-flipped I took the differences of the two average survey results. Taking the flipped survey average and subtracting the non-flipped survey average. In this paper I will refer to this value as the "delta score". When analyzing the delta score, a positive value indicates that student's agreement with a survey statement increased after being in the flipped classroom for 4 days and a negative value indicates that student's agreement with a survey statement decreased after being in the flipped classroom for 4 days.

Next I had to determine which delta scores levels were insignificant or significant. I set the criteria that a difference must be enough to possibly foster a change in response, in other words, since a delta score about a 0.5 could be enough to sway a result from one response to a different response. For example if someone agreed with a statement, then had a half or more increase in their agreement they might change their response from agree to strongly agree. Delta scores below a 0.5 were considered to have an

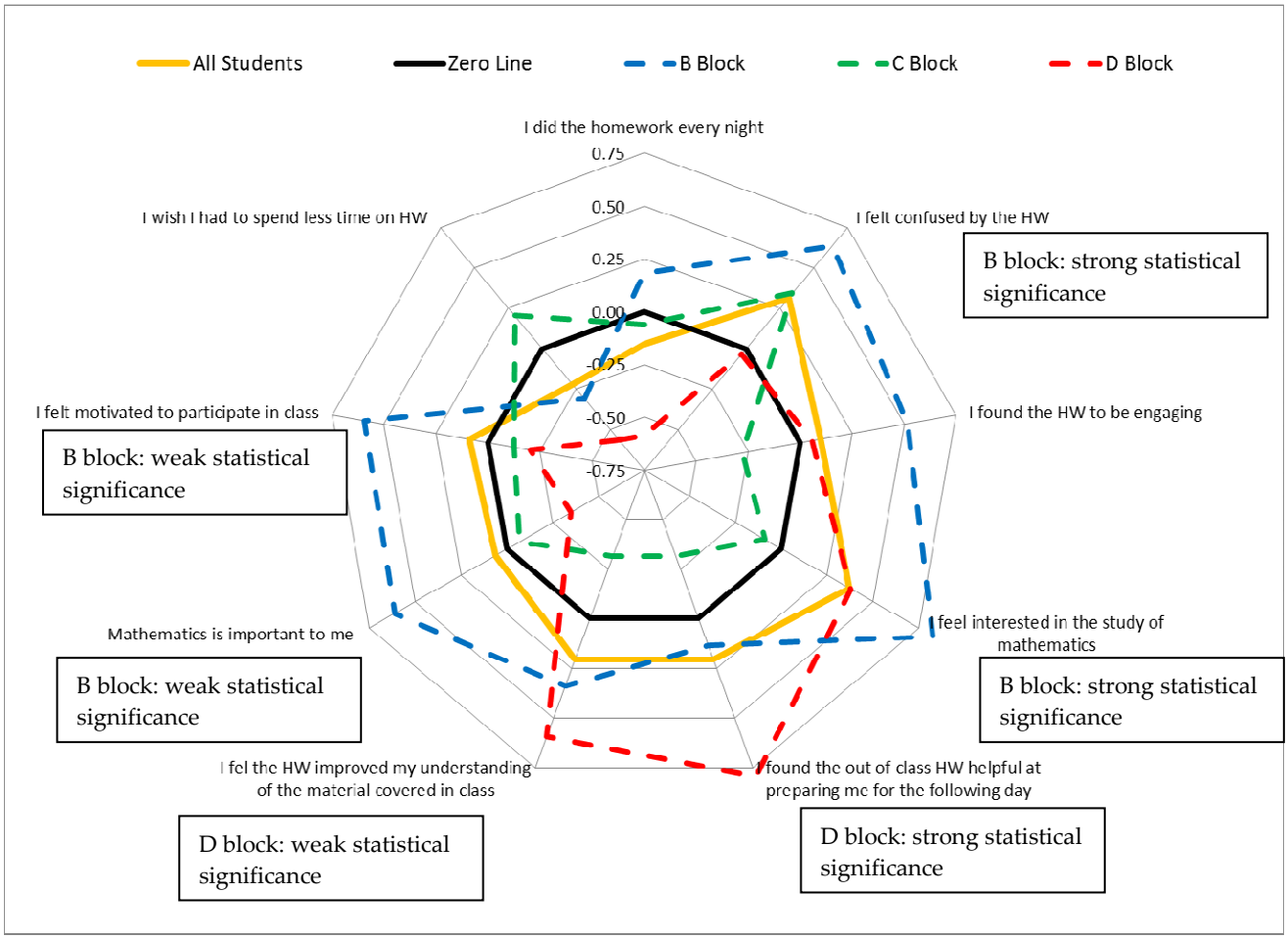
insignificant difference since this level of difference in agreement would not likely change student responses. This indicates that having a flipped compared to non-flipped would not foster different agreement levels in the statements on the survey.

Additionally to analyze the difference between the pre and post survey data I also ran two tailed, two sample equal variance T-Tests on all survey data responses to find p-values. A T-Test's p value is used to determine the statistical significance between sets of data. A set of data has a very strong statistical significance if it has a p value less than or equal to 0.001, a strong statistical significance if it has a p value between 0.001 and 0.05, and a weak statistical significance if it has a p value between 0.05 and 0.1. This test is also the measurement tool that I used to determine the significant difference when comparing student grades. Since grades were not anonymous I was able to change the T-Test from a two sample equal variance into a paired T-Test to find more accurate results.

Survey Data Results:

My survey results showed that most of the delta scores showed an insignificant difference between the flipped and non-flipped classroom. To get a visual representation of the delta scores I made a graph that contained all delta scores that had a significant increase or decrease from non-flipped to flipped. Three of these delta scores produced a strong statistical significance and 3 of these score produced a weak statistical significance.

Significant Survey Delta Scores:



The delta scores from the average of all students were insignificant on all survey prompts and T Tests also did not result is p values that showed statistical significance. This shows that overall the non-flipped and flipped classroom mostly produced the same student perceptions. The limitation of only 4 days of non-flipped and 4 days of flipped could have had not been enough time for agreement levels to change.

In B block there were two p values that indicated a strong statistical difference between the flipped and non-flipped. One prompt, "I found the homework to be confusing", had a p value of 0.043 and a delta score of +0.63. This result indicates that in B block on average students found the flipped homework to be slightly more confusing than the non-flipped homework. As a teacher this is not actually a negative aspect to have in homework assignments. If students are only given homework problems that are easy they will not be challenged and have the opportunity grow and learn more from their homework. Having increased confusion in the homework can have some negative consequences on the classroom. Too much confusion in the homework can decrease student's confidence and possibly influence students to not complete the homework.

Another significant survey result from B block was to the prompt "I feel interested in the study of mathematics", which had a p value of 0.047 and a delta score of +0.83. This result indicates that after the flipped classroom students in B block felt significantly more interested in the study of mathematics. This could be attributed to the subject change from solving to graphing. It also could be an indicator that aspects of the flipped classroom such as the graphing transformations activity or the time spent in class working on problems in class could have increased students interest in the study of mathematics.

In B block there were two results that had weak statistical significance. One result had p value of 0.09 and a delta score of +0.61 to the statement "mathematics is important to me". This result, though only a weak statistical significance supports the previous result of students feeling an increased interest in the study of mathematics. Much like before, this change in student view of the importance of mathematics might be caused by other factors and not necessarily the flipped classroom. Another result with weak statistical significance had a p value of 0.069 and a delta score of +0.60 on the prompt "I felt motivated to participate in class". Though this result only had a weak statistical significance it still demonstrates the potential of a flipped classrooms increased time to complete problems and activities and less time on direct instruction to increase student motivation. As a new teacher this result could also be stemming from my growing abilities to motivate my students as I got more experience teaching.

In C block students non-flipped and flipped classroom survey results produced no statistically significant p values. This indicates that, for the most part, the flipped classroom didn't make students perceptions of the homework, mathematics, or the classroom any better or worse.

There were 2 significant results from D blocks survey results. One result had strong statistical significance, a +0.80 delta score, and a p value of 0.040 on the survey prompt "I found the out-of-class homework to be helpful at preparing me for the following day". This result is one that I would expect from a flipped classroom since the idea of a flipped is to have students learn something new for homework. The importance of this result is that students found the flipped homework more helpful than the non-flipped homework. Like all results, this increased delta score could be caused by many

factors other than the flipped classroom. Interestingly the other significant result had a weak statistical significance with a p value of 0.075 and a delta score of 0.60 on the survey prompt "I felt that the homework improved my understanding of material covered in class". There are 2 ways that I envision students interpreting this prompts: some could have interpreted this prompt as improving their understanding of material that they then learned in class the next day or that it improved their understanding of material that they already learned the following day. Interpreting the results either way indicates that the flipped classroom might improve students understanding of mathematics.

Grade Results:

While analyzing grades it will be hard to justify a difference between flipped classroom and non-flipped as indicating that one will produce better grades that the other. During each method the students were taught different subjects. Also the summative assessment students were given were very different. For the non-flipped class students were given a larger test, half of this test was a SLO posttest that my cooperating teacher created and graded. For the flipped class students were given a smaller quiz. Before the quiz/test in each class students were given a study guide. These study guides were also a lot different between flipped and non-flipped. In the non-flipped the study guide was made by my cooperating teacher. In the flipped I created the study guide myself and added an extra credit question at the end of it.

In analysis of the homework grades I found that more students did the non-flipped homework than the flipped homework. In the non-flipped classroom about 9 to 10 students out of the 66 total students did not do the homework each night. This amount was also fairly consistent over the three days of homework grades that I analyzed. In the

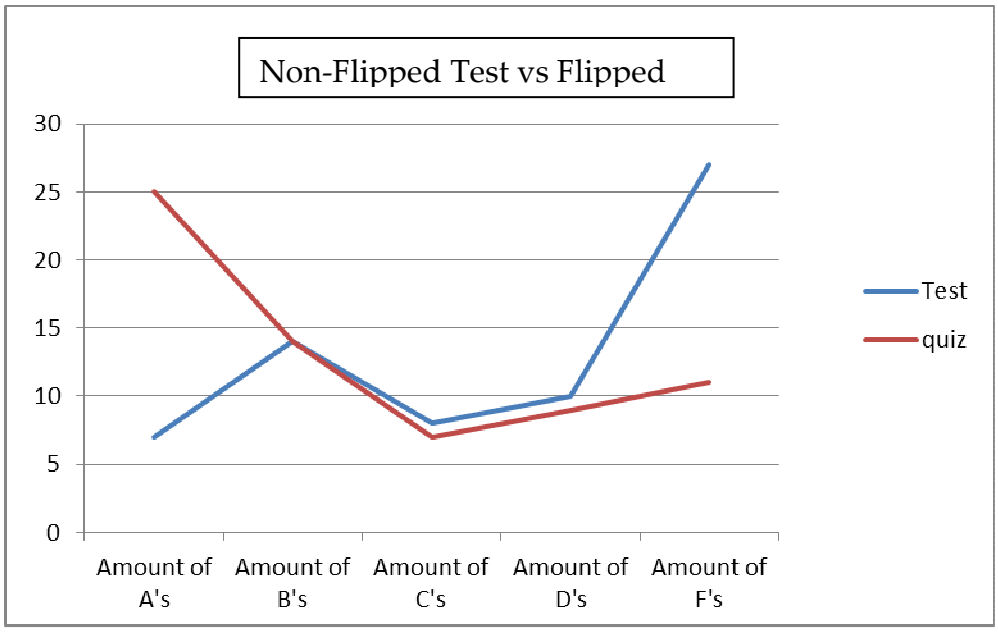
flipped classroom the homework grades showed that on the first day flipped homework as assigned 19 students out of 66 students did not do the homework. The next day 17 students did the homework and on the third day of flipped homework 12 students did not do the homework. On the first day of flipped a great deal of students did not do the homework, but each night more students did the homework as the flipped classroom went on. By the third day the flipped class had almost the same amount of homework completion as the non-flipped class. This could imply that when transitioning to a flipped classroom for the first time many students might not do the homework at first, but over time a teacher might see the same levels of homework completion as a non-flipped classroom.

Additionally the two tailed, paired T-Test had a p value of 0.022 indicating a strong statistical significant difference between the flipped homework grades and the non-flipped homework grades. In the non-flipped class students averaged 4.15 out of 5 possible points and in the flipped student's average 3.71 out of 5 on the homework. Since homework was graded on completion most students scored either a 5 or a 0 on the homework. Making the largest cause of the grade difference result from the amount of students that didn't do the homework each night. This lower grade might eventually level out grades followed the previously mentioned pattern of more students doing the flipped homework each night.

The T-Test of the study guide grades showed a very strong statistically significant p value of 0.0029. On the study guide for the non-flipped test students scored an average of 52% and on the study guide for the flipped quiz student scored an average of 72%. On both study guides each question was graded and students seem to either get a

score close to 100% or a score close to 0%. Meaning that this much higher average on the homework resulted mostly from their being 7 more students that completed the flipped study guide than the non-flipped study guide. Maybe since students were not given problems on the flipped homework they were more motivated to do the flipped study guide to get more practice. So maybe not having to do a bunch of practice problems every single night, but having homework intermittently or switching from nights of flipped homework to non-flipped homework might make students more inclined to do the practice exercises and problems since they will not be bogged down by having to do it every single night.

In the analysis of the non-flipped test and the flipped quiz the p value of 0.0000000023 indicating a very strong statistical significance. On the non-flipped test students average grade was 68% and on the flipped quiz students average grade was 82%. Like I mentioned before, this grade does not show that students will get significantly better grades on the flipped than in a non-flipped classroom. Much of this difference can be attributed to the larger size and greater difficulty of the test.



To further analyze the non-flipped test grade and the flipped quiz grades I made a histogram of the amount of A's, B's, C's, D's and F's in each class. These results showed that both the test and quiz had distribution curves with some interesting differences and similarities. Both distributions had somewhat of a U shape to them instead of the normal bell curve that I would expect in a distribution graph. The low point in the middle might suggest that I was an easy grader on the quiz, giving more credit than students deserve. Since my cooperating teacher graded half of the non-flipped test maybe his stricter grading can account for much more students with a failing grades. The main difference between these distribution curves is that the flipped quiz has a lot more A scoring students and a lot less F scoring students than the non-flipped test.

Personal Notes:

Here is a collection of personal notes I made during and after teaching the flipped classroom.

- When I used the flipped classroom I felt that on I did not give enough time for students to practice. I spent a lot of time having myself or students show how to solve problems, but should have given them more time to work on problems. I think one of the reasons for this might be that the graphing problems the students were working on take a lot of time. For example to graph in intercept form students need to simplify, then factor, then find the zeros, then find the x value of the vertex, then use this x value to find the y value, then plot all three points. When I think about what it might have been like to teach this without doing a flipped classroom I think I would have been in the same predicament. If I had assigned a lot of graphing for students many might have gotten overwhelmed and not finished and I still would have had to go over the homework for a lot of the class time. Even though I felt like I should have given more time to work on problems in class I still feel that in a flipped classroom I got to work more one on one with students than I got to when I was teaching the non-flipped classroom. Given another teacher to co-teach with the flipped classroom could be an effective means to have more time for one on one student teacher interactions.
- I think most of my videos were a little on the complex side. Some students complained about following along with many of the videos. The goal should be for the videos to teach the students the basics and get a lot of the simple direct instruction out of the classroom. I think if I repeated the flipped I would make my

videos less complex and more about the concepts and less about solving particular problems. The flipped home about concepts and vocabulary on the first and last day were the ones that seem to work the best.

- I made a mistake in one lesson and picked a video and made a handout that was too complex for students. Since both the video and the handout were both too complex for my students I had to spend a large portion of the first part of class reviewing the information that they were supposed to learn in the video. This type of mistake when planning a flipped lesson can be a costly one. One of the great advantages of the flipped classroom is that the learning and background knowledge students get while watching the video opens up a lot more class time for more meaningful learning experiences. If the students have trouble learning from the video then this advantage is lost.
- Comparing the time spent planning a flipped lesson to the time spent I feel that a flipped classroom could take as much as 2 to 3 times the time to plan in order to find the write video, video questions, supplementary handout, and then plan the lesson to build upon the video effectively.
- The transformations activity went really well. This was a perfect example of what I want the use of flipped to be like in my classroom. Students really used the information that they have learned for homework to take the lesson a lot further than they would have been able to do if I just gave them practice problems. At the start of class the students got to do a little bit of practice while their laptops were loading and during this practice I was there to help students who needed it.

- When I first started the flipped I got some resistance from students who were shocked that I was asking them to learn something new for homework. I think by the end though students had grown more familiar with this situation. They starting to not get as worried about understanding the flipped homework 100% because they were able to have more time to get help on problems during class. This carried over when I switched back to a non-flipped classroom and added the occasional homework problem that would start to introduce students to problems that they have not yet learned how to solve.

Student Comments and Notes:

Here are a collection of the statements that students made in the class discussion at the end of this research study.

Student comments on the benefits of the non-flipped classroom:

- More practice and confidence
- Students can check their own understanding of what they learned in class

Student comments on the benefits of flipped classroom;

- Visual. Easier for a visual person to understand
- See the whole problem worked out
- Learn for the homework not just practice
- Not as time consuming as normal homework
- Can slow things down and pause Click on other links and get help
- Introduce next topic before learning about it in class
- 2nd chance to understand things

Student comments on the weaknesses of non-flipped classroom:

- Nothing to fall back on if you don't know what to do
- Time consuming
- Repetitive
- Unmotivated to do the homework
- Not enough time

Student comments on the weaknesses of the flipped classroom:

- Unreliable internet. Sometimes videos don't load if internet is bad

- (learning something that wasn't taught in class bugged some of the students during the start of the flipped classroom)
- 2 different teachers explaining things. (some found this to be a weakness others described this a benefit of the flipped homework)

These comments give a student point of view of the flipped and non-flipped classroom. Some key comments to note are some of the benefits and weaknesses of the flipped classroom. Some of the benefits like being more visual for students, students being able to work at their own pace, and learning for homework not just practicing demonstrate that a flipped classroom can help create more differentiated homework that will help students get more out of the time they are spending working on mathematics outside of class

Conclusion:

Even though the survey data and the grades cannot be used to make any substantial conclusions about differences between the flipped and non-flipped classroom, I think the difference between grades, significant survey results, and student's comments on the benefits of the flipped classroom warrants further interest and research in its use in the high school classroom.

In my flipped classroom I found 2 days to be more effective and 2 days to be less effective than I would have hoped. I think one important aspect needed to make a successful flipped classroom is to choose videos and create handouts that are the right level of difficulty to build confidence, but also build groundwork of knowledge for the work they will be doing in class. Another important part of implementing a flipped classroom would be to use the class time to have student do something. What made the two more effective days were that students were working at something. On the other two days I felt that I spent too much time showing problems or having students show problems instead of having students work out problems for themselves.

I think for my classes at Penta it is not a type of education that I would not want to use every single night, but would want to use intermittently; especially when I want to build students background knowledge before a lesson in order to free up more time for an activity or discussion. Much like the first and last day of teaching the flipped classroom in which I was able to use a battleship activity and a transformations activity. I found that with the complex and time consuming graphing problems that students were solving, If I were to repeat these flipped lessons again I would add additional practice problems to go with the videos to give students more practice than just the video quiz. I think the

flipped classroom is a great tool for teachers to add to their teacher toolbox. A good teacher tires to use different methods of instruction in the classroom to meet the needs of diverse learners, why not also use different methods of instruction for work outside the classroom?

Some next steps for my research on the flipped classroom are to explore the effectiveness of using it intermittently with a non-flipped classroom. In using both I could pull the strengths of both flipped and non-flipped. Also it would be interesting to find how the flipped classroom would work in a shorter non-block classroom. Given the block schedule I had to cover multiple topics and problems each day. I think in with a shorter schedule I could focus the use of developing student background knowledge more effectively.

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