Curriculum Development of a Flipped Classroom in General Chemistry

by
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Abstract

This paper explores one possible solution to the best use of class time in a high school chemistry classroom. Many classrooms are taught through a lecture style where the content is taught in class and the student tries to apply the content by doing problems at home. Students most need a teacher's help while working through and applying the content though, not during a lecture of the content. This curriculum change intended to give students more time in class with the teacher to help understand the curriculum while watching a video of the lecture before coming to class. In class the next day, students would apply the content with the teacher there to help. This is called a flipped classroom. This style of teaching and learning showed a slight improvement in students' test scores after much trial and error. More time with this curriculum change however will help further determine its effectiveness.

Introduction

High school General Chemistry is a challenging class for many students. The topics that are required to be taught in Minnesota high schools are determined by the Minnesota Department of Education in the Minnesota Academic Standards in Science (2009). In the past, students that took General Chemistry were typically college bound and prepared for an academically rigorous course. Students mainly learned through a lecture instructional style; meaning they would listen to the content taught in class, then work on problems related to that content at home. The Minnesota Department of Education has changed their science requirements for graduation as stated in Minnesota's K-12 Standards and Graduation Requirements (2013). Students graduating in the year 2015 or later must successfully complete "3 credits of science, including at least one credit of biology, one credit of chemistry or physics, or one elective credit of science sufficient to satisfy all chemistry or physics standards, and all other science standards" (Minnesota's K-12 Standards and Graduation Requirements, 2013). This change in requirements means that all students in eleventh grade at South St. Paul Secondary, where I teach, will be taking General Chemistry. This change has made me rethink how I teach the content so that I can better use my class time to help students that struggle with the content. I decided to change my instructional style to a flipped class last year in preparation.

Literature Review

A flipped class is when the work that was typically done in class is now done at home, and the work that was typically done at home is now done in class (Bergmann & Sams, 2012). On a typical day in a traditional classroom, the students would have learned from a lecture on the material in class, and then been sent home with problems related to the lecture. Students would be at home working on problems and they would struggle, get

frustrated, and sometimes quit. In a flipped classroom, students watch a video of someone explaining the material outside of class, and then the next day in class work on the related problems. With this style, when students struggle with problems, they are in the classroom where the teacher and their peers are able to help them. It is a better use of class time and it also makes the class more student-centered (Bergmann & Sams, 2012). Students are responsible for watching the videos and asking questions, then in the classroom the teacher is there for "expert feedback" (Bergmann & Sams, 2012, p.16). According to Tucker, this can "best maximize the scarcest learning resource-time" (2012).

Jonathan Bergmann and Aaron Sams are chemistry teachers at Woodland Park High School in Woodland Park, Colorado and have been teaching there together since 2006 (Bergmann & Sams, 2012). They are considered some of the pioneers of the use of a flipped classroom. They started recording their lessons in 2007 due to many of their students missing school for sports and activities (Bergmann & Sams, 2012). When they realized that the videos were helpful to students that were not in class and also those that were, they discovered that they could use the videos for at home learning and be "physically present" when students needed their help the most (Bergmann & Sams, 2012).

In a flipped classroom, students become more active learners. After watching videos, students are able to participate in activities that help them think about what they are doing. The information from the videos helps the students think more deeply about the activities. This goes beyond pure inquiry learning. Students are able to have greater involvement with the class material due to their previous knowledge (Smith & Cardaciotto, 2011). This participation in learning has shown to help people remember information better than when they are just told it (Smith & Cardaciotto, 2011).

My flipped classroom has been modeled after Bergmann and Sams, because their results showed that their flipped classroom worked (Bergmann & Sams, 2012). They compared scores on seven different tests between the 2006-2007 school year and the 2007-2008 school year (Bergmann & Sams, 2012). The 2006-2007 year was taught through the traditional style, while the 2007-2008 year was taught flipped. The 2007-2008 students, with flipped curriculum, had lower incoming scores on the Colorado State Exam in all areas: reading, writing, math and science (Bergmann & Sams, 2012). This led them to believe that those students would not do as well on the tests, when they actually did just as well as the students from the previous year (Bergmann & Sams, 2012). Based on this data, Bergmann and Sams decided to continue with the flipped classroom (2012).

Bergmann and Sams started using the flipped classroom because students were missing school (2012). Byron High School in rural, southern Minnesota started using it because they had no money to buy new textbooks (Fulton, 2013). They needed new math textbooks, because their old ones did not meet the new standards from the state (Fulton, 2013). The math teachers decided to design their own math curriculum without any textbooks (Fulton, 2012). They thought they would be able to get material online for their students to use, but they quickly realized that the material they found was not best suited for their students' needs (Fulton, 2012, 2013). This led the teachers to create their own video lessons, store them on YouTube, and use Moodle as their online management system (Fulton, 2012, 2013). It took some work to have YouTube unblocked in their district, but once it was, they were able to store videos for free and embed them in Moodle, so there were no distractions from advertisements and other videos while working (Fulton, 2012).

Students at Byron High School have adapted to the change and now like it (Fulton, 2012). It is proving to be a good change according to test scores. In 2006, only 29.9 percent of Byron students reached mastery on the math Minnesota Comprehensive Assessment (Fulton, 2012). After flipping all of the math classes, 73.8 percent of students reached mastery in 2011 (Fulton, 2012). Their average ACT scores have also risen, from 21.2 (out of 36) in 2006 to 24.5 in 2011 (Fulton, 2012). The teachers have noticed an improvement in their ability to learn from each other to improve their teaching as well. If they feel that their presentation of a topic is not being understood, they watch other teachers' videos of them teaching the same topic (Fulton, 2013). In the past it was difficult to observe other teachers due to time constraints during the day (Fulton, 2013).

Flipped lessons have also been shown to work in physics classes. Dave Kawecki, a physics teacher in Wisconsin, started by flipping his magnetic fields unit (Brunsell & Horejsi, 2013). He used videos that he found both online and made himself (Brunsell & Horejsi, 2013). He did this because one third of his students said that they did not have enough time in class to get help (Brunsell & Horejsi, 2013). With his increased amount of time in class to work with students, Kawecki was able to do more hands-on learning and group work (Brunsell & Horejsi, 2013).

His physics students responded well to the change (Brunsell & Horejsi, 2013). They liked being able to re-watch videos, have more time in class to get help, and do more activities (Brunsell & Horejsi, 2013). After flipping his classroom, 96 percent of students were able to get the help they needed, which in turn increased students' performance on the unit test (Brunsell & Horejsi, 2013).

Kawecki found, however, that there were some problems. About one fourth of the students were not watching the videos, which made them ill prepared for class and their peers that were prepared became frustrated with them. Kawecki decided to give quizzes, online and in class, related to the material, brief reading assignments, requested by the students, and previews the day before to introduce the upcoming videos (Brunsell & Horejsi, 2013). All of these changes, along with a formative assessment at the beginning of class, added more accountability to the lessons (Brunsell & Horejsi, 2013).

According to the literature, flipped classrooms seem to work well in math and science classes. The research shows that trying a flipped classroom is worthwhile in an attempt to help all students be more successful in a General Chemistry classroom. This approach was modeled after the literature. It was originally designed following the Bergmann and Sams model and adapted to include aspects of what the math teachers do at Byron High School and what Dave Kawecki does in his physics classes. The intent with this curriculum change was to give eleventh grade chemistry students more time in the classroom with me to help them understand the content.

Justification for the Development of the Project

This project was created out of a need to help more students be successful in chemistry. Now that all students at South St. Paul Secondary would be taking the course, I needed to determine a way to help everyone learn chemistry. Advantages of a flipped classroom are: more time working with struggling students, more differentiation, more hands-on activities, and students working at their own pace (Bergmann & Sams, 2012).

The amount of time available to interact with students was one of the biggest reasons for this change. In the tradition classroom, there was not enough time with each student to help

them. This was due to very little time in class after a lecture to get to every student. Bergmann agrees stating that in flipping his classroom he now has time to "work individually with students" and "talk to every student in every classroom every day" (Tucker, 2012, p. 82). Many times the students that need the most individual help are the special education students. According to the new Minnesota State Standards, these students would be taking chemistry. Many of them have a paraprofessional in the room, but they are not the "expert", so it benefits them to have more time with the teacher.

All students do not learn the same way. In a flipped classroom, more time should allow for more differentiation of instruction (Bergmann & Sams, 2012). For every lesson, students would have the option to watch a video lesson, read the textbook, or even watch different videos with different explanations of a topic. This allows students to learn the way that makes the most sense to them.

Hands-on and laboratory activities are very important in science education. They help students learn by doing. According the American Chemical Society, hands-on laboratory activities are "essential for learning chemistry" (American Chemical Society, 2011). Labs do take time though. Flipping lessons allows for more time in class to do these activities. If more laboratory activities are included in the curriculum, students will have more access to learning that way.

The technology behind flipping lessons does not phase or impress students like it does adults (Bergmann & Sams, 2012). They speak the digital language, because technology has always been a part of their lives (Bergmann & Sams, 2012). They are able to adapt quickly to using the videos for their learning. Students can do things with the videos that they cannot do during a lecture in class, such as pause, rewind, work at their own pace, and re-watch the lesson

(Bergmann & Sams, 2012). In a traditional classroom, students can ask questions and have things repeated, but many students are shy about asking in front of the whole class. The video allows them to do this on their own.

All of this leads to a culture of learning. Students have more interactions with their peers and the teacher making the activities more meaningful. This should help students come to class more prepared to learn, because they already have a base of knowledge from the videos.

Design of the Project

A flipped classroom is a possibility in helping all students become more successful in chemistry, especially those that would not normally take it. Sophia.org is a resource to help teachers get started with this curriculum change. Sophia.org is a website that has videos on nearly every topic. They are uploaded and rated as to their accuracy by other teachers that view them (Lee, 2011). Sophia.org offers a Flipped Classroom Certificate by watching videos to educate people on the flipped classroom. There are short quizzes after each section to show your mastery of the concepts.

After learning the basics behind flipped classrooms, it was important to learn how to implement it. Most of this knowledge for me came from two sources: a TIES (Technology and Information Education Services) workshop and *Flip Your Classroom* by Jonathan Bergmann and Aaron Sams. TIES is a Minnesota software development and training company. The flipped learning workshop I attended was two days and covered many of the details of flipping your classroom. The Bergmann and Sams book aligned with everything in the workshop.

Before learning to make videos, it was important to determine which videos to make. The workshop demonstrated a technique to help plan out a unit. Each topic in the unit is written out on a note card. These topics are small enough that they can be taught in 5-10 minute

videos. According to Bergmann and Sams, each video should be one topic and they should preferably be less than 10 minutes long (2012). Student attention spans tend to lapse after 10-18 minutes into a lecture (Bunce, Flens, & Neiles, 2010). Keeping the videos short helps students think about one thing at a time while learning, review specific things later in the unit, and not lose focus.

Once the video topics are laid out, the activities are written out on different note cards. These include labs, inquiry activities, models, and worksheets. The goal is to have one activity per topic. The note cards are then arranged in order of how they should be taught. This helps plan each day in the unit.

After planning out the unit, videos had to be made to go with the activities. Each video was planned out with a script before they were made in order to be as concise as possible. Three different types of scripts were used: notes to talk about and write during the video, SMART Notebook presentations with notes and pictures, and PowerPoint presentations. These all help the videos stay on track and keep them as short as possible.

I chose to make my own videos instead of using ones made by others, because it was easier to control how my students learned the material. Having planned the lessons by specific topics, the videos should be only those topics so as not to confuse students. I was also able to address common misconceptions from my teaching experience in my videos as well.

There are a lot of different ways that videos can be recorded. All of my videos were produced using the SMART recorder that comes with the SMART notebook software and Screencast-o-matic. The SMART recorder is very easy to use. It records everything that is done on the screen regardless of if it was in Notebook or not. The screen can be written on using the SMART board. This worked well for doing problems. Screencast-o-matic is a free web

recording tool that also records everything on the screen. This is useful when recording a lesson that does not need to have writing done in it.

Choosing the correct type of microphone is very important. Most laptops have a built in microphone, which works well with Screencast-o-matic. A separate microphone is necessary when using a SMART board.

Once the videos are made, they need to be made available to the students. The easiest way is to upload them to YouTube. This is an easy, free way to store videos, since many schools do not want to store them on site due to server space issues. Students can go directly to YouTube to watch them or they can be on a course management system like Moodle. Moodle was used in this situation, because the videos can be embedded, allowing students to only see the video and not other videos or advertisements. Directions can also be written on the page with the video.

When students first watched the videos, the next day in class they had a lot of questions. Many of these would have been answered if the students had been listening to what was being said in the videos. After talking to them about this, it became clear that many of them were so busy writing down what was on the screen that they were not listening to what was also being said. This tends to be the same in a traditional classroom. The students needed to be taught how to watch a video lesson. This is something Bergmann and Sams say is “similar to teaching students how to read and use a textbook” (2012, p. 79). It also helped when the students had a notes outline. They still had to follow along and write some of the information down, but they did not have to write everything.

In order to ensure that students are gaining the knowledge they need to gain from the videos, there needs to be some accountability for watching them. This can be done by checking

students' notes from the video, though there is no way to tell if they understood the material this way. Formative assessments can check for understanding. A quick question or problem done in Moodle helped assess this. These were called Learning Checks and they were worth five points each.

At first, students earned five points for getting the question correct, and none for a getting the question wrong. When discussed in class however, students thought this was unfair, because they had not been allowed to ask questions on the material yet. The grading system was then changed to five points for a correct answer and four points for an incorrect answer, and they were only given one attempt.

After a while, it became evident that some students were concerned enough with their learning to try the question again, even though they were not getting the additional point. It was determined that they should be rewarded for this. The grading system changed one more time with the same points awarded, but students could try the question multiple times and their highest score would be recorded. Many more students are now mastering the content due to this change.

The last piece to this was accessibility of the videos in terms of a device to watch them on. Students fill out a survey in Moodle on their internet access. Most had a computer with internet at home to use. The few that did not have a computer had a phone that they could watch it on at school or a friend's house or would use someone else's computer, like the school's. This was not ideal for these students, but talking to them individually, a plan was made for each of them. They made do with what was available.

Now all of my students have a Chromebook issued to them by the school. This has made a big difference. Only a few students do not have internet access at home, and they are able to

watch their videos at school either during the day or after school or somewhere with free Wi-Fi during the evening. All students bring headphones with them to class every day, so that if they finish their in-class activity, they are able to watch the next video.

The time in class was spent very differently once students started watching videos. Instead of listening to a lecture, students did hands-on activities, group work, or practice problems. Planning was very different. A lot of time was spent trying to find activities to apply what the students had learned from the videos. In the past, there had been very little time for these types of activities.

Once students were proficient at watching videos and learning from them, more could be done to differentiate. In the gas laws unit, two videos were made for each gas law: one explained how to solve for the variable using the equation and the other explained how to solve for the variable using the mathematical relationship. Both ways helped students get to the same answer, but some understood one way better than the other. Students were able to choose which video they wanted to watch for each gas law and use that way to solve the problems.

Results

Some topics were flipped during the second trimester of the 2012-2013 school, but whole units were not flipped until the third trimester. At first the students were very skeptical of it. It was so different from anything they had done before. It took a lot of communicating and working together to improve it to make it successful. After each unit that was flipped, students filled out a survey (see Appendices A and B for copies of the surveys). They really started to get into it and like it after the first chapter. Not only did they like it better, but they were also more successful. Now all General Chemistry classes at South St. Paul Secondary are taught this way

The first complete unit that was flipped tended to be one that students had struggled with in the past. Throughout the chapter students were informally asked for feedback. Changes were made from that feedback, such as the grading system for the learning checks, but some students seemed intimidated speaking out in front of the class. At the end of the unit, students filled out an anonymous survey (see Appendix A for a copy of the survey).

Question six in the Chapter 10 Survey (Appendix A) asked students what they thought the negatives were in learning this way. The students seemed to give very honest answers, and there were a lot of similar answers. Students were asked for their honest feedback in order to help them learn better. Many responses were that they had questions during the videos, but could not ask them at that time. This was addressed in two ways. First, it was suggested that they write down any questions that they had during the videos to ask in class the next day. Class was always started by asking what questions there were on the video. Second a Google Voice number was created so that students could text their questions, at a reasonable time, if they wanted an answer more quickly. Related to this, many students said that they wanted to see more examples of the problems. This was discussed as something that should be brought up during the question time at the beginning of the hour.

Another common negative comment was that it took too long for students to pause the video to write down all the material. They commented that they were pausing a lot, and it was difficult to follow along. Students were then given notes outlines for the videos in the next unit. Students still had to follow along and take notes, but they did not have nearly as much to write down. They also had the learning checks written out, so that when they were reviewed in class the next day, they could see where their mistakes were made. Another suggestion was

made by one of the students. The student suggested watching the video writing all of the information down, then watching it a second time to listen more carefully.

Many students also said that it was hard to change how they have learned for so many years and also to stay on task while watching. A discussion about this proved to be helpful. Students were validated in their feelings about change being difficult. It was discussed that change can be good and necessary though. Students were asked if they knew of someone taking an online college course. Most students knew at least one person doing this and said that they had heard they were difficult. It was discussed that many colleges had online classes, and that this would help prepare them for that. In terms of staying on task, students were advised to put their phones and other distractions away. Headphones were brought up also as a way to help stay focused and block out other things instead of using speakers.

Students were also asked in the Chapter 10 Survey (Appendix A) what they thought were the positives to learning this way. There were a lot of comments repeated by many students. They really liked being able to work at their own pace. The ability to pause, rewind, and watch full videos again to review was a big plus for many. They found that it helped them review for the test much more easily and on their own time, not just when the teacher was available outside of class. They liked having time in class to work on problems in small groups and having me there to help when they got stuck instead of being at home alone. They thought it made them more accountable for their learning and that their homework took less time than it used to.

Students were also asked in the survey how many of them watched each video, took notes, asked questions when they had them, and tried their hardest on the learning checks. The results were compared from a survey after chapter 10 and chapter 11 (see Appendix B for a copy

of the survey). The same amount of students, about 90%, watched all or most of the videos in both chapters. Also the same amount of students, about 81%, took notes during all the videos. The changes were in the students asking questions and the learning checks. The percentage of students that said they asked questions if they had them increased from 20% in chapter ten to 36% in chapter eleven. This is still very low, but as this is done more and the students become more accustomed to it, they will hopefully be more comfortable asking questions. The percentage of students that tried their hardest on the learning checks also increased from 56% in chapter ten to 68% in chapter eleven, even though they were getting the same number of points for correct responses.

From the first to second unit, students' opinions of this style of learning improved. 95% of students thought that flipped learning in the most recent unit was better than the previous unit (Appendix E). Reasons given for this were: that they tried harder and paid more attention, they were able to ask questions right when they had them, more time was spent on their questions in class the next day, and notes were more efficient with an outline. After the second unit, 73.75% of students said they would choose to learn this way in the future (Appendix F).

There were things that made flipping the classroom difficult. One of them was the upfront time commitment of making videos, learning checks, and notes outlines. Videos were hard to make, because of interruptions. Putting a sign on the door saying that recording was in progress helped. Now that many of the videos are made though, there will be more time to analyze data from the learning checks to determine the level of understanding.

Another thing that was challenging was students not watching the videos before coming to class. Bergmann and Sams have their students watch the video during class before they can do the activity if they come to class unprepared (2012). They found this to be a good motivator,

since students would miss out on valuable help during class time (Bergmann & Sams, 2012). Some students were more of a challenge, but most finally saw the benefit of coming to class prepared. There were still some kids that did not watch the videos, but they were the same kids that were not doing their homework in the lecture style class. It is a constant struggle to try to motivate these students.

There were many positives to doing this according to the students. One very important one was helping students keep up with class when they were absent. One student had mononucleosis and was absent for two weeks. He was able to watch the videos while he was at home and do most of the work. He emailed when he had questions, and when he came back to school, he only had to make up a laboratory and take a test. He thoroughly understood the material too, as he did well on the test.

There were also the improved test scores overall for the students. Test scores were compared for two different tests. The chapter ten test results from 2012 (traditional learning) were compared with the same test in 2013 (flipped learning). It was the same test, but taken by different students. Overall the students in 2013 did worse on the test after learning by flipping (see Appendix E). After chapter ten quite a few changes were made according to what the students had said in their survey. The chapter eleven test results were then compared from the two years. Again it was the same test, but different students. This time the students that learned through flipping did significantly better (see Appendix F). With the flipped learning, 72.5% of the students earned an A, B, or C. With the traditional learning, only 65.4% of students earned an A, B, or C.

These results directly compared with the results of Bergmann and Sams. When they compared students that had learned with each method, they found that the test scores were very

similar (Bergmann & Sams, 2012). They saw this as an improvement, because the students that had done the flipped lessons had lower incoming scores on the Colorado State Exams in reading, writing, math, and science (Bergmann & Sams, 2012).

The increase in test scores on the chapter eleven test could be due to many things, such as more time in class for students to get help understanding the material, more time for laboratory and hands-on activities, and more differentiated instruction. There are however limitations to this study; one being that the test results that were compared were from different students. To try to minimize this limitation, it is important to look at how the students had been doing comparatively on previous tests when both groups had been learning through a traditional method. The students in 2013 (flipped) tended to score the same or slightly lower on average on most unit tests than the students in 2012 (traditional). Two tests do not necessarily make the data reliable or valid either. More data needs to be collected. As this curriculum style continues, it will periodically be evaluated for its effectiveness.

Reflection

There was a major learning curve in this process. My three main resources, Sophia.org, the TIES workshop and the Bergmann and Sams book, really helped me through this process. I have by no means perfected it, but communicating with my students on what does and does not work has significantly improved my flipped curriculum.

In addition to the flipped resources, many of the courses that I took while pursuing my Masters of Science degree in education have helped me prepare for this project. I learned from some excellent professors at the University of Wisconsin-River Falls. The chemistry classes that I took related and helped me the most.

I took Forensic Chemistry and Life in Extreme Environments as two of my course electives. Both classes were taught by Dr. Lisa Kroutil. She did a really good job in both courses of showing her students ideas of how to teach different topics. She had many great examples for us to try and practice. In each class after learning about the content through her methods, we were given an assignment of teaching a topic to the class. I found this beneficial in both classes, because it pushed me to go beyond what I had always done and try to be creative in my activities. Flipping my classroom has been a totally new experience. I have had to be very creative in how to best use it to teach my students.

Dr. Kroutil also introduced me to POGIL activities. POGIL stands for Process Oriented Guided Inquiry Learning (POGIL, 2012). POGIL activities are designed for the students to work in small groups to learn by doing (POGIL, 2012). After doing many of these in Dr. Kroutil's class, I have since implemented them in my own classes. Now that I have a flipped classroom, I have time to do more of them. Through guided questions, they really help my students discover the answers for themselves.

Another graduate chemistry course that I took was Polymer Chemistry with Dr. Kevin McLaughlin. His class was mainly taught through inquiry activities. This class was not only interesting, but challenging. It helped me bring more inquiry activities into my classroom. I used to struggle with finding the time to do inquiry activities. Now that I have flipped my classroom though, I have more time with my students, so I am able to do more inquiry activities.

My most influential graduate class relating to this project though, was when I was a teaching assistant for Dr. Kroutil's online general chemistry course. We worked with D2L to organize the class and videos of the lessons. This is when I first learned to manage online teaching materials, make videos for students, and embed them into a website. I learned to use a

website for posting and grading homework. I do this now every day with my students. The first video that I made was for this class. I recorded a demonstration lab for the students to do. I now record many of my demonstrations for students that are absent or need to see something again.

All of these courses helped me with my final project. I have been making improvements as I proceed with this new style of teaching, so I don't plan on making major changes in the future, though I am sure that I will still make changes. I do not feel that it is perfect by any means, but it is already much improved since I first started. I began teaching this way in only a couple classes and now teach all my classes this way. Other teachers in my building have also been interested in this, and I have helped them get started doing it in their own classroom.

This project has reminded me of some of my undergraduate work. Going through the process of changing my teaching style has made me think about how Bloom's Taxonomy is related to my flipped lessons. Bloom's Taxonomy is a hierarchy of thinking that increases in complexity (Churches, 2008). In order from lowest to highest they are: remembering, understanding, applying, analyzing, evaluating, and creating. My students now typically watch video lessons that help them to remember and understand the content. In my former traditional classroom, I did this in class. Now that students do it outside of class, I am able to work with them doing the higher level thinking skills like analyzing, evaluating and creating. This is when they need me the most, because the high level thinking skills really challenge them.

I believe that I have very much improved my teaching by changing my instructional style to a flipped classroom. This project has made me more proficient in my content area by analyzing how to teach topics in videos and differentiate them. I feel that this project has really helped me improve as a communicator with my students. Getting their thoughts on how to improve class has increased their respect for me and mine for them. It was great to hear their

viewpoints and know that they care about their learning as much as I do. My intent with this change was to give students more time in the classroom with me to help them, not to talk at them. I believe I accomplished this and will not be going back to a traditional classroom. I have found that this helps students of all abilities learn chemistry better, so I will continue to teach using the flipped method.

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Appendix A
Chapter 10 Anonymous Student Survey

1. How many Ch. 10 videos did you watch?
    A. All of them
    B. Most of them, but I missed a few
    C. A few of them, but I missed most
    D. None of them

2. Did you take notes during the videos and pay attention?
    A. Always
    B. Sometimes
    C. Never

3. Did you ask questions in class about material that was confusing?
    A. Always (if I had a question)
    B. Sometimes
    C. Never

4. Did you try your hardest on the learning checks?
    A. Always
    B. Sometimes
    C. Never

5. What do you think were the positives to learning this way? Please be specific.

6. What do you think were the negatives to learning this way? Please be specific.

7. What are your suggestions for doing this in the future?

Appendix B
Chapter 11 Anonymous Student Survey

1. How many Ch. 11 videos did you watch?
    A. All of them
    B. Most of them, but I missed a few
    C. A few of them, but I missed most
    D. None of them

2. Did you take notes during the videos and pay attention?
    A. Always
    B. Sometimes
    C. Never

3. Did you ask questions in class about material that was confusing?
    A. Always (if I had a question)
    B. Sometimes
    C. Never

4. Did you try your hardest on the learning checks?
    A. Always
    B. Sometimes
    C. Never

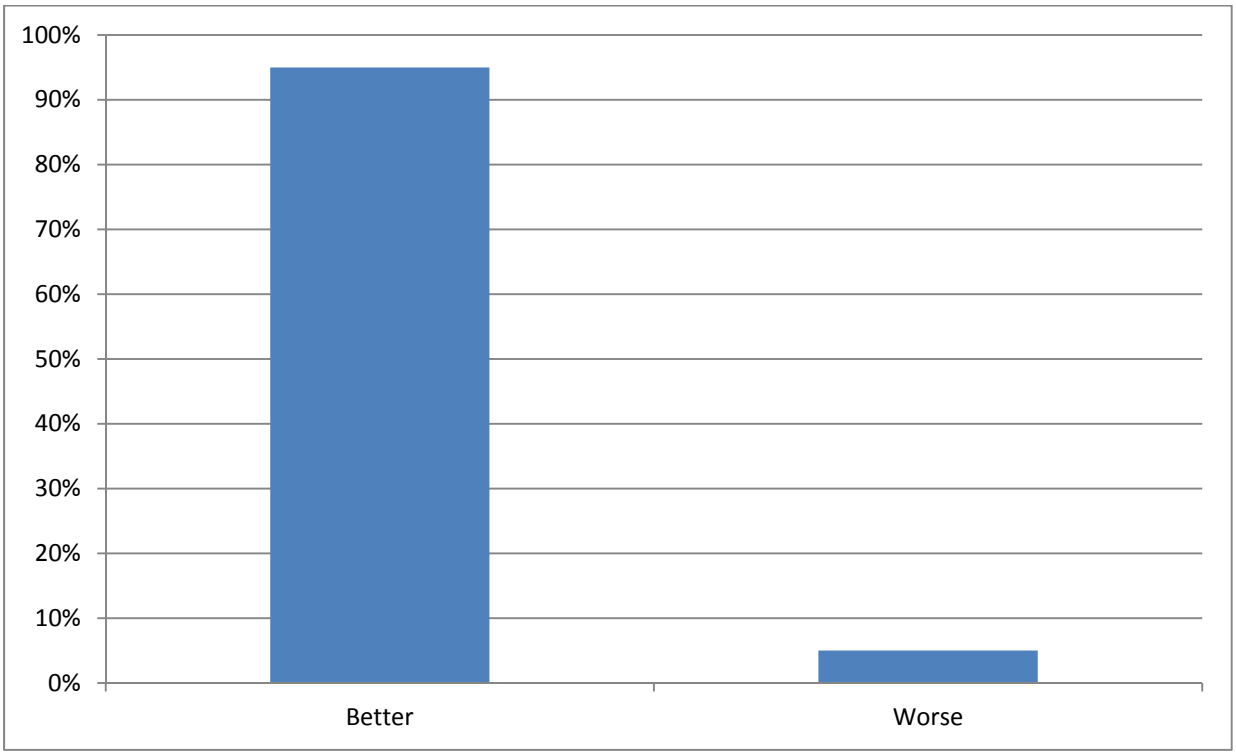
5. Do you think this learning way was better or worse than last chapter?
    A. Better
    B. Worse

6. Why do you think it was better or worse?

7. Would you choose to learn this way in the future?
    A. Yes
    B. No

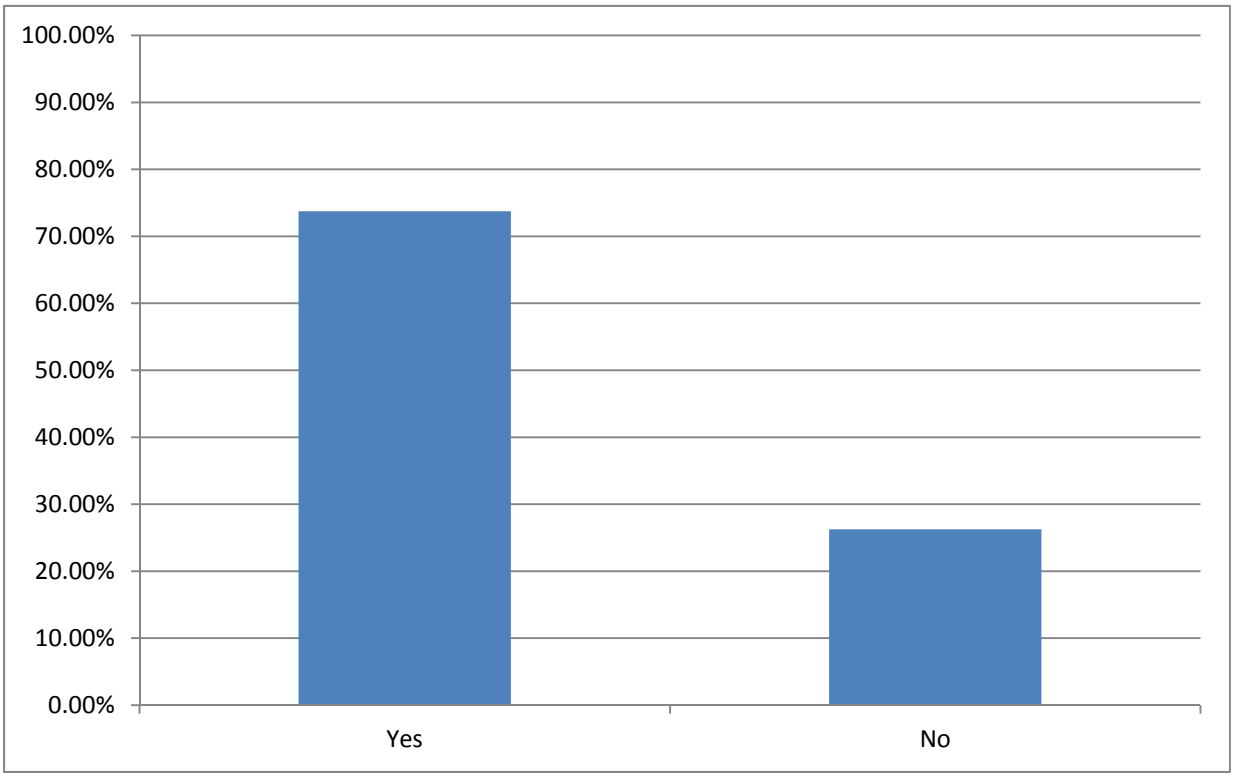
Appendix C

Ch. 11 Survey results of question five: Do you think learning this way was BETTER or WORSE than last chapter?



Appendix D

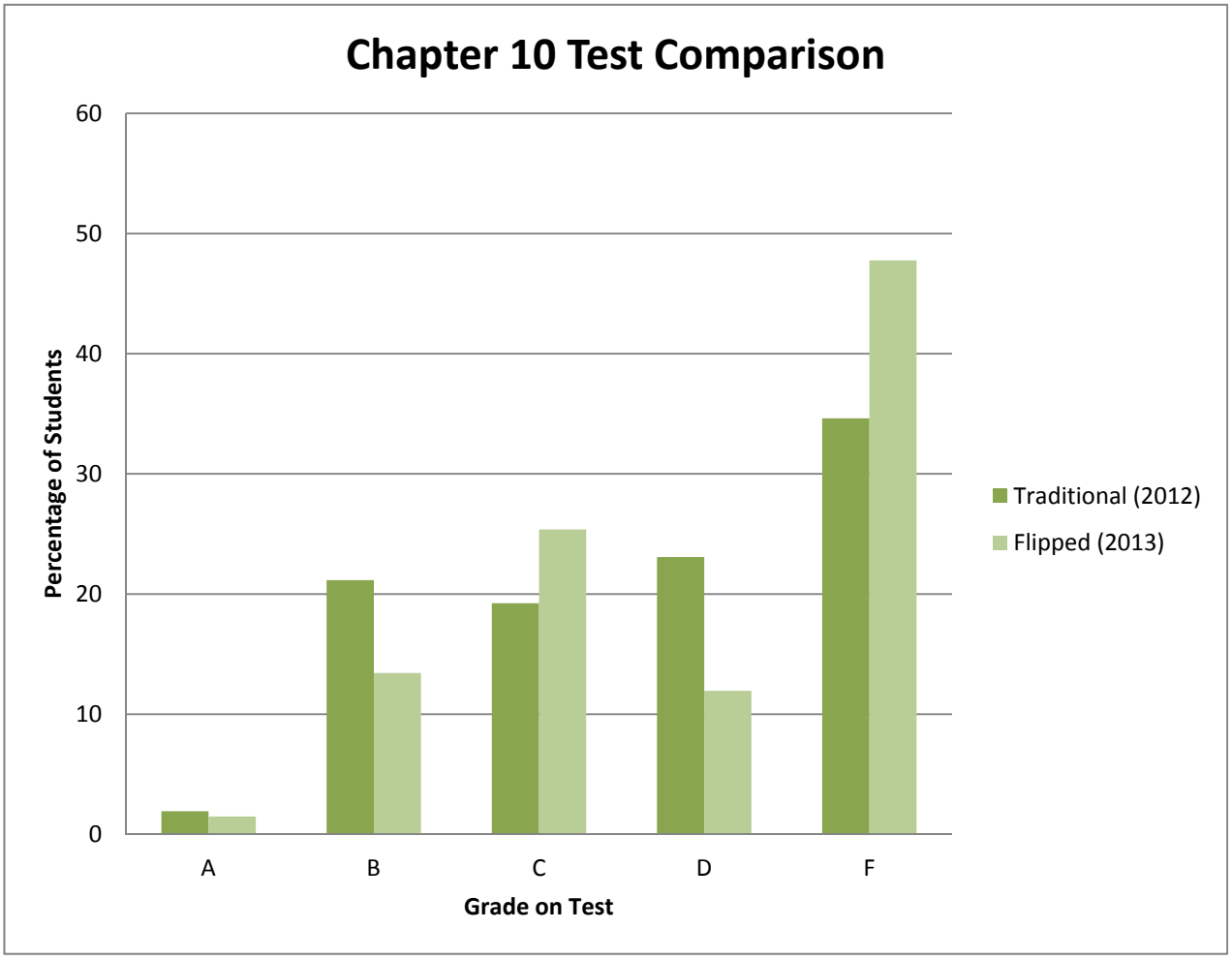
Ch. 11 Survey results of questions seven: Would you choose to learn this way in the future?



Appendix E

This is the chapter 10 test comparison of traditional versus flipped learning.

The test was the same in the two years, but the students and learning style were different.



Appendix F

This is the chapter 11 test comparison of traditional versus flipped learning.

The test was the same in the two years, but the students and learning style were different.