# THE EFFECTS OF THE FLIPPED LEARNING MODEL ON STUDENT ATTITUDE AND PERFORMANCE IN HIGH SCHOOL BIOLOGY

by

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# ABSTRACT

Flipped instruction using video recordings for students to watch at home to replace in-class lectures is becoming more common in high school and undergraduate education. This can free up instructional time to incorporate more discussions, labs, and other inquiry activities while still covering the content. This study looked at the impact of flipped instruction on student performance and attitudes towards class over the course of four units in biology; one with in-class lectures; two flipped units with lectures moved to video format outside of class; and one mixed methods unit with a combination of in class lectures and video lectures. Student performance on unit exams and homework completion were compared for each unit. Surveys and interviews were used to measure student attitudes towards class and the teaching style. Student attitudes towards class and performance on unit tests were not impacted by the teaching method, however homework completion decreased during the flipped units. Despite enjoyment and engagement for activities in class, students also showed a strong preference for in-class lectures compared to the video lectures.

# INTRODUCTION AND BACKGROUND

River Valley High School is a rural public school in the River Valley School District located in Spring Green, Wisconsin. There are around 440 students enrolled in the school and 93% are white. Additionally, there are 14.4% students with disabilities and 30.8% of students are economically disadvantaged. For this project, I focused on my two classes of biology that consisted of 44 students nearly all are sophomores. Five students had Individualized Education Plans that include testing accommodations and one student was from Latin America and has developing English language skills. Seventeen of the students were male and twenty-seven of the students were female. As seen in the results of the pre-treatment survey given (Appendix A) in Figure 1, 31.8% of students responded with agree/strongly agree regarding their interest with biology for their future. Nearly 92% of students responded with agree/strongly agree that they see value and importance of school. This shows the students involved in the research see value in school and are partially interested in the biology subject matter.

I chose these classes because biology is a course that I have consistently taught each of my four years in the district. Nearly all students take the class to graduate at our school so the results of the classroom research could impact most students at the school. Our district has adopted the Next Generation Science Standards (NGSS) and is beginning the process of transitioning to 1:1 by providing Chromebooks to students. This is the first-year students have had Chromebooks daily. I figured that if I had to incorporate an increase in technology and begin to align to the NGSS, I might as well dive in and make it a reflective process for my classroom research.

In my first few years of teaching I noticed that students were often disengaged during class. Science is supposed to be this great opportunity to do labs and hands on activities just like scientists, but getting through all the biology content resulted in very little time to do the labs and other science practices. I often rely on PowerPoint presentations and note taking to cover the content, but I want my class to be more than just taking notes and memorizing the definitions of terms. With a goal to move toward implementing the Next Generation Science Standards and utilize the new 1:1 Chromebooks at our school, I decided to try 'flipping' my classroom and provide lecture content through videos to watch at home. I hoped this would allow more time for labs, activities, and in class discussions during the class period, while still getting through the content. I measured student performance and attitudes during a traditionally taught unit, two flipped units, and a unit with a mixture of both to determine the impact of the flipped model on the students and myself.

Many other teachers are trying to figure out how to adjust their teaching methods to incorporate NGSS. In addition, there is a big push for increased technology across the nation. Between students having access to the internet with their own or school owned devices, there are many opportunities for content to be delivered in new ways. The results of this classroom research could benefit my colleagues or other science teachers who are also in a similar situation.

My focus was considering the performance of my students. I wanted to make sure that student performance on assessments was considered, so that regardless of other measurements I knew how students were performing in class. In addition, the attitudes of

my students were an important consideration. Students are more likely to learn if they have a positive attitude towards the subject they are learning. If students enjoyed the class more because of the flipped structure, perhaps it would lead to a better attitude towards biology and perhaps science overall. The research questions I asked were: What are the effects of implementing flipped units on students' performance in the biology classroom? What are the effects of implementing flipped units on student attitude? What are the effects of implementing flipped units on student's assignment completion? What are the effects of implementing flipped units on me as a teacher?

## CONCEPTUAL FRAMEWORK

Many educators have tried to determine the most effective ways of teaching as well as what the most important content is that should be taught. Currently, NGSS is shaping most of science education in the United States. In "A Framework for K-12 Science Education," it states that "Science is not just a body of knowledge that reflects current understanding of the world: it is also a set of practices" (National Research Council, 2012, p. 26). In my classroom, there has become a focus on the content, which leaves students disconnected from the work which research scientists do. Students struggle to understand why science is important and what the point of learning much of the content is in biology. The framework and NGSS standards encourage more science and engineering practices (SEPs) and providing opportunities for inquiry-based lessons. Implementing changes suggested through the framework will require a shift from time that has been spent focusing on content to more time spent on the other two dimensions.

A common concern I have heard from colleagues is *How will I get through the whole curriculum, if time for lecture is taken away?*

A dilemma in my classroom that was shared by Jonathon Bergmann and Aaron Sams is the feeling that we need to continuously move forward with the curriculum to stay on track with the school schedule (Bergmann & Sams, 2014a). Regardless of the student's understanding of the material, teachers feel pressure to move on to the next unit at a designated time. An alternative model is to move on when students have demonstrated mastery of the content. Benjamin Bloom has proposed that the Mastery Learning approach can help between 80% and 90% of students master the content compared with 15% under normal teaching methods (Bloom, 1968). A key to the success of this model is that it is not just one strategy. Instead it involves "determining what procedures will prove effective in helping particular students learn the content" (Bloom, 1968, p. 10). This individualized attention to the students improves their chances of success. Bergmann and Sams have shown that the Flipped Model of education can be a great way to differentiate and help enable more students to master the material. A critical component of this model is to "rethink and reimagine what class time should look like" (Bergmann & Sams, 2014b, p. 30). I was struck by this quote as I have been reflecting on the changes I want to make in my classroom. While I did not fully embrace Mastery Learning in this classroom research project, I did focus on the flipped classroom to see if students became more engaged and "develop[ed] an understanding of the practices of science and engineering" as well as improved their performance in class (National Research Council, 2012, p. 10). Moving towards the Flipped Mastery model as

Bergmann and Sams propose is a possible endeavor for the future.

Lecture is heavily relied upon as a method to deliver content in high school and post-secondary science classes. A concern of mine throughout the project is if the 'flipped method' would prepare students for college. I find myself frequently relying on lecturing to teach my students, which is what I recall from high school science classes I took and especially the college classes that I took. I have experienced this type of class and it is familiar to me, so I often utilize this familiarity in my own teaching. In a number of conversations I have had with colleagues, preparing students for the college lecture is a common way to justify the lecture format. A common idea a colleague might say is, *Well, that is how teaching is done at the college level, so we need to prepare students to learn via lecture*. However, research shows this is not necessarily the case. There are numerous instances of instruction at the college level that is alternative to the tradition lecture style.

A review of sixty-two studies on flipped education in engineering classrooms was published in 2017 (Karabulut-Ilgu, Cherrez, & Jahren, 2017). All but seven of these studies were published since 2011. In addition, a survey was conducted of higher education faculty, 29% were already utilizing flipped instruction and 27% planned to incorporate flipped instruction into their classes soon (Bart, 2013). While the research is still in the early stages, there is a trend that flipped learning is becoming more common at the college level so exposure in high school could potentially help prepare students for this style of instruction.

Research on flipped instruction at the college level is being performed across many content areas including biology. Heyborne and Perrett researched the effectiveness

of flipped instruction in a college level biology course (2016). They compared two sections of biology taught by the same instructor. The first section was taught in a traditional format, relying on in class lectures from slide-based presentations. The second section received these same lectures in a video format they were expected to watch before class. The extra time in class allowed for more activities to supplement the learning from the content. The same assessments were used in both sections and showed the flipped section performed higher in five out of six assessments. Although only one of these differences was of statistical significance, the authors state "a larger study is warranted," as the lack of statistical significance may "be due to small sample size" (Heyborne & Perrett, 2016, p. 36). These studies suggest using flipped education in high school will expose students to teaching methods they may encounter higher education.

In addition, for the potential success in a college level science course, Bergman and Sams demonstrate the flipped model can lead to improved student performance in their high school Chemistry classes. They started making videos of their chemistry lectures in 2007 to help students who missed class stay caught up with the material. This developed into all students watching the videos at home in the same timeframe, and eventually evolved into a “self-paced system” (Bergmann & Sams, 2013, p. 18) where students moved on as they demonstrated mastery of the content. This allowed for much more one-on-one instruction and more engaging activities during class time. If done well, this extra class time can help provide the opportunity to implement activities based on the ideas proposed in “A Framework for K-12 Education.”

## Flipped Teaching Methods

There is no one-size fits all model for implementing flipped learning, as a variety of techniques have been used. A common theme is having the lecture viewed in video format outside of class time. A method I adopted ideas from is from the 2016 research of Jonathan Leo and Kelly Puzio where they looked at the effectiveness of flipped instruction in high school biology classes over the course of a semester (Leo & Puzio, 2016). There were four sections of biology that were broken into a treatment group receiving the flipped instruction and the control group. For the treatment group, videos were produced and upload to YouTube for students to watch. In addition, the students completed a quick assessment with questions pertaining to the video content. During class time, the treatment group participated "in more active learning, such as projects, laboratories, and interactive forms of learning" (p. 778). The traditional group had typical lectures during class time that covered the same material as the video. In addition to the lectures, students in the traditional group completed worksheets that went with the class textbook. The traditional group performed some of the same activities as the treatment group. Four assessments were used to compare the differences between the two groups they found that students in the flipped grouped performed better on assessments.

Numerous capstone papers from graduates of the Montana State University Master of Science in Science Education (MSSE) have considered flipped methods. Instead of having different treatment groups, Donna Tully alternated between treatment and non-treatment units (Tully, 2014). She compared the results from five different units, two non-treatment and three treatment. She assessed effectiveness based on performance

on unit tests, student surveys, student interviews, and teacher observations. While she compared the results from tests, there were only minimal differences between the units and she did not discuss these much. There was no correlation between test scores and the instructional methods. It would have been interesting to look at the difficulty of the tests to see if that was playing a role. She relied heavily on student surveys to inform her of their opinions on technology and flipped learning methods and provided a basis for surveys to use.

Another MSSE capstone paper that validated my choice in Action Research topic was Maryellen O'Malley's capstone on the effectiveness of flipped teaching in the AP Biology classroom (O'Malley, 2015). While she was able to compare student performance from past years, my curriculum changed enough that comparing tests from previous years was not possible. Her results suggest the flipped method can be helpful for some students, however not all students responded positively to the treatment. It was clear from these examples that more research on the flipped method was warranted.

## METHODOLOGY

The purpose of this study was to determine the effectiveness of teaching using the flipped method. An exemption by Montana State University's Institutional Review Board was received for the research methodology of this project received and compliance for working with human subjects was maintained (Appendix B).

Starting at the end of the first quarter, I implemented the flipped teaching method with my biology classes to compare student performance and attitudes with my traditional in-class lecture-based teaching. The treatment units consisted of 'flipping the

classroom' or using a mixed methods approach where I combined teaching methods. For the flipped classroom, instead of lecturing in class, I made a five to ten-minute screencast recording of myself lecturing with my slides presentation for students ($N$=44) to watch as homework twice per week. These slides contained the same information that I would have used had I lectured in the classroom. To encourage students to complete the video, I required an assignment; they either completed notes on their own, answered questions embedded in the video through Edpuzzle, or answered a question posed in Google Classroom. For each of these types of assignments, I graded them based on completion.

The first unit (Cells) of the classroom research project was taught in my traditional method, comparable to previous years with the content delivered primarily through in class lectures. In addition to the lectures, there were a couple labs using microscopes and other activities as done in the past. This unit lasted 13 class periods. A unit exam was used at the end of the unit to determine student performance.

For the second unit (Microbes) I used a mixed methods approach where students were assigned two video lectures in addition to a few class periods with lectures to be introduced to the content. Students participated in an online lab and group activities to learn the material in more depth. Near the end of the unit, students responded to a questionnaire to assess the difficulty of this unit compared to the cells unit. The twelve-day unit ended with a unit exam to determine student performance.

Both the Protists and Fungi unit and the Plants unit were taught with all lecture content delivered through video, using the flipped method. The Protists and Fungi unit lasted eleven days and the Plants unit lasted fifteen days. Due to winter break, semester

finals, snow days, standardized testing, and in-service days, the Plants unit started six weeks after the Protists and Fungi Unit and it took five weeks to complete the fifteen instructional days. During the flipped units, having the content delivered outside of class freed up time available during class. This allowed more one-on-one interactions with students, more discussions on the material and more active learning strategies like Process Oriented Guided Inquiry Learning (POGIL) activities. Additionally, students completed more labs in both units, including a lab that lasted the entire Plants unit. A typical class period started with five minutes for students to take care of their Wisconsin Fast Plants, make observations, and record data. Then, a few minutes were available for students to ask questions about video content they were assigned. Following the questions, students worked on assignments individually or in groups to reinforce the material learned in the videos or the labs. Both the flipped units culminated in a unit exam and a questionnaire to compare the difficulty of the unit to past units. As can be seen in Table 1, there were a variety of data collection methods to help answer my research questions.

Table 1
*Data Collection Matrix for Action Research on Flipped Model of Teaching.*

| | Data Collection Methodologies | | | | |
|---|---|---|---|---|---|
| Research Questions | Pretreatment Survey | Formal Observation | Unit Test | Assignment data | Final Survey/ Interview |
| Main Topic<br>What are the effects of implementing flipped units on students' performance in the biology classroom? | X | X | X | | X |
| Sub-question #1<br>What are the effects of implementing flipped units on student attitude? | X | X | | | X |
| Sub-question #2<br>What are the effects of implementing flipped units on assignment completion? | X | | | X | X |
| Sub-question #3<br>What are the effects of implementing flipped units on me as a teacher? | | X | | X | X |

I implemented student surveys via Google Forms. Prior to the start of the Cells unit, I had all students take a survey to get an insight into the students' attitudes towards the class (Appendix A). The survey was adapted from a previous capstone paper (Donna Tully, 2014) which helped improve the reliability and validity of the results. I also implemented a survey after the final unit. For the post survey, I used the questions from

the pretreatment survey and added a few questions to investigate the impact that the Flipped method had on student attitudes (Appendix C). I compared the results of these surveys to determine if there was a change in student attitude from beginning to end. After the treatment was over, I interviewed a group of students (Appendix D) to obtain more thorough explanations for some of their responses. I asked all students if they were interested in being interviewed, and then selected seven students who showed interest.

To get another perspective, I had the school psychologist do a formal observation of my teaching on two different days. The psychologist focused observations on four students while I lectured to the students the first day and while doing a guided inquiry activity the second day. Every minute she recorded on and off task behavior of each student. The results of this are shown in Appendix E. Lastly, I used data from assignments and assessments to determine the overall completion of work as well as the performance grade.

## DATA AND ANALYSIS

This classroom research attempted to determine the effectiveness of the flipped teaching method on student performance by measuring student attitudes, unit exam grades, and homework completion.

Figure 1 shows the results of the Likert-scale surveys given to students through Google Forms. The pretreatment survey (Appendix B) contained 15 questions that addressed five different themes: Interest in Biology Content; Value of school; School Work Completion; Attitude toward Mr. Johnson’s teaching; Perception of teacher-student interactions. The post treatment survey (Appendix C) contained the same 15 questions as

the pretreatment survey and contained a few questions more specific to the flipped teaching style.

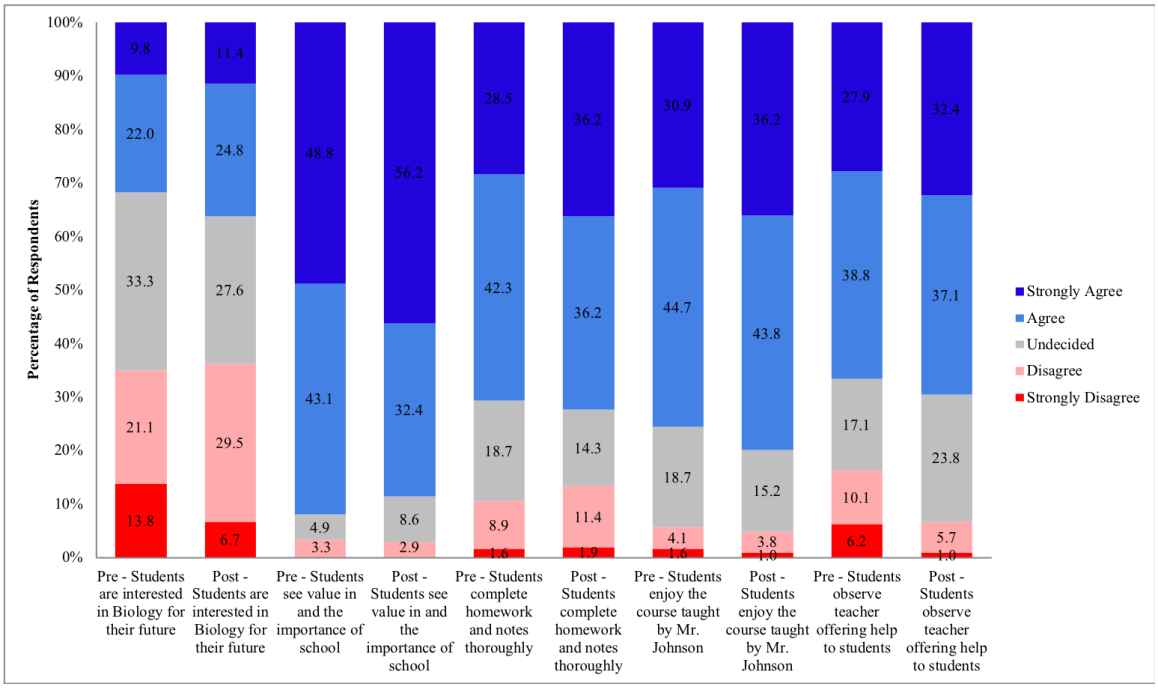


*Figure 1*. Responses to Likert-scale survey questions before and after the treatment. The questions are arranged into themes. The number value shows the percentage of responses, Pret-treatment (*N*=41), post-treatment (*N*=35).

As can be seen in Figure 1, most students had a positive attitude (agree) toward the themes before and after the treatment. There was slight variation for each of the themes, but it was negligible. For the first theme about their interest in biology for their future, students shifted slightly more positive. Originally, 13.7% of students ‘strongly disagreed,’ and at the end it had decreased to 6.7% with more students moving into the ‘disagree.’ There was also a slight increase with students ‘agreeing’ or ‘strongly agreeing’ they were interested in biology for their future. Students’ who saw value in school also experienced slight change. More students strongly agreed with the statement switching from 48.8% to 56.2%. Strangely enough, a few more students became

uncertain, moving from 4.9% to 8.6%. For their self-assessment on homework completion, a few more students agreed they turned in their assignments changing from 28.5% to 36.2%. A few more suggested they complete fewer with the number of students disagreeing increasing from 8.9% to 11.4%. These first three themes show that overall, the students see value in school, do their work, and overall have some interest in the Biology content. One student wrote, that "while I'm not interested in this subject" the class "will help us to be more cautious and observant of the world around us … [and] will help us all in the future." While I may not be able to teach this idea, I hope more students can learn to appreciate this idea and what is learned in class.

Figure 2 shows the performance on the unit exams from this year as well as last year. This figure shows the Interquartile Range of the unit exams. The mean for each is designated by the X. It compares the student performance on each unit exams from the 2017-2018 ($N$=44) school year and includes the scores from the 2016-2017 school year as a comparison group ($N$=41)

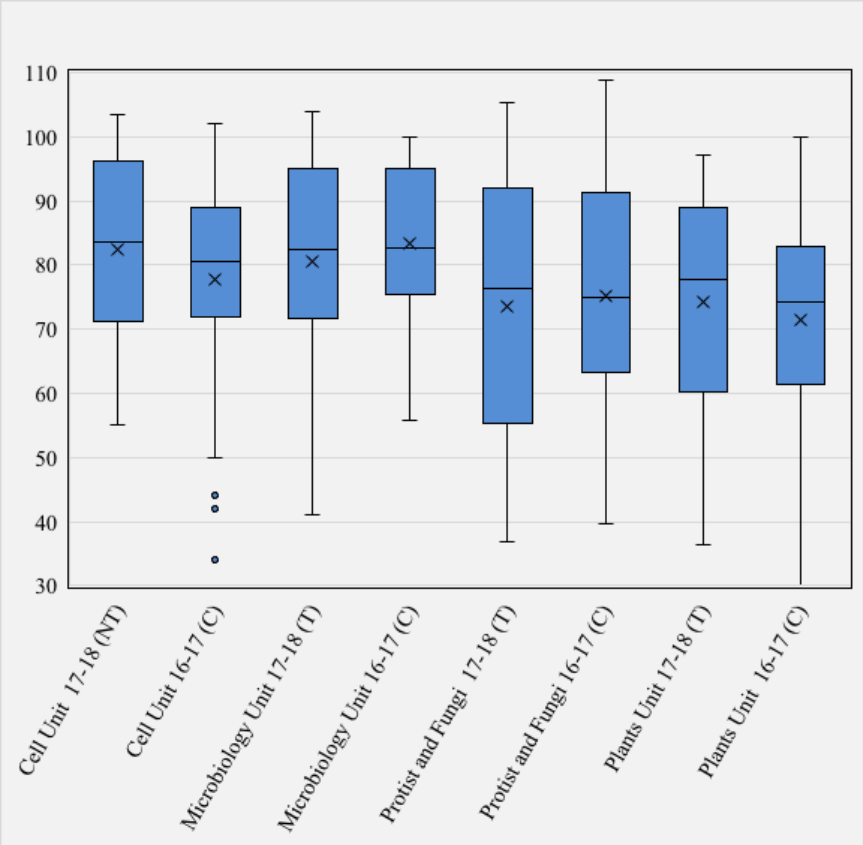


*Figure 2.* Box and whisker plots for unit exams in 2017-18, (*N*=44) and the comparison group (C) in 2016-2017, (*N*=41). NT = non-treatment, T= treatment

Figure 2 shows that students did better during the traditionally taught Cell Unit as well as the Mixed methods taught Microbiology Unit compared with the Flipped taught units. A One-Way ANOVA test was performed comparing the 2017-2018 test scores and it showed statistical significance at $p < 0.05$ with an *f-ratio* value of 2.48. While the results are significantly different, and could be attributed to the different teaching styles, this is a similar trend to the unit exam scores from 2016-2017. The 2016-2017 group of

students is a comparison group that had different students and a slightly different test, so it cannot be compared perfectly to my classes from this year, however it does provide some insight. When compared with this group, there was no significant difference between scores on the Protists and Fungi unit test nor the Plants unit test. Instead of the difference in test scores being attributed to teaching methods, it is possible that the difficulty of the units played a roll, and that the comparison group contained different students.

Figure 3 shows the relative difficulty of the units compared with each other based on student responses to survey questions. Students responded to the question, “How was the difficulty of the current unit compared with the previous unit?” Due to the time between the first unit (Cells) and the last unit (Plants) and an irregular survey method, it is difficult to compare each unit head to head. During the Microbiology Unit, students were asked to rate the difficulty of the Microbiology Unit and then compare the unit to the previous Cells Unit. Then, during the flipped units (Protists/Fungi and Plants), students were asked how the unit compared to the previous unit. Despite a lack of quantitative data, figure two does give an idea of difficulty. Nearly half of respondents (47%) stated the Microbiology Unit was easier than the Cells Unit, 26.5% said it was about the same, and 26.5% said it was more difficult. After questioning the students upon completion of the Protists/Fungi unit and again after the Plants unit, over half (51%) responded the unit was about the same. According to students, there is not a huge difference in the difficulty of the units. While this is how students responded, I think there was too much time between units for students to really assess an accurate level of

difficulty. As a result, I am inclined to think the latter two units were more difficult which correlates with the lowered test scores from both years. I was not able to get a difficulty rating from the 2016-17 group.

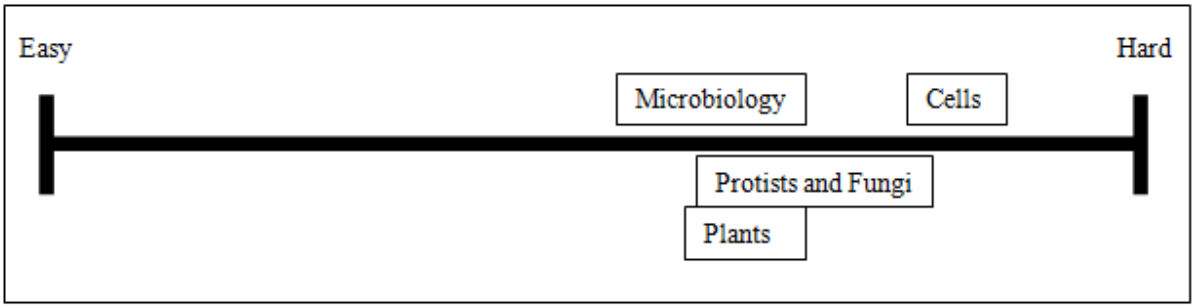


*Figure 3*. Compares the difficulty of units compared to each other based on student responses to survey questions, (*N*=44).

One question I wanted to answer was how the flipped teaching method impacted homework completion. As shown in Figure 4, the data collected shows striking differences between the flipped method taught unit and the traditionally taught and mixed methods units. To obtain this data, I tallied the number of missing assignments and late assignments, and found the average of number missing or late out of all the assignments that should have been turned in. For the Cells Unit, only 6.8% of assignments were missing. The number decreased to 4.5% of assignments with the mixed methods teaching during the Microbes Unit. There was a large increase during both the flipped units with 20.5% of assignments missing in the Protist/Fungi Unit and 10.3% during the Plants Unit. This shows students turned in fewer assignments during the flipped units. It is interesting to note, that during the Plants unit, there were 6.5% of students with late assignments. The good news is these were missing and then the students turned them in. I accept late through the end of the quarter, so students had the opportunity to turn in their

assignments to get partial credit. The Protist/Fungi Unit ended the day before winter break. There was only two weeks of class before the end of the quarter, so for the Protist/Fungi unit, students did not have as much time to make-up the missing work. Had there not been a break, followed by finals, it is possible that more students would have turned in the work and the percentage of missing would have decreased, and the late work would have increased.

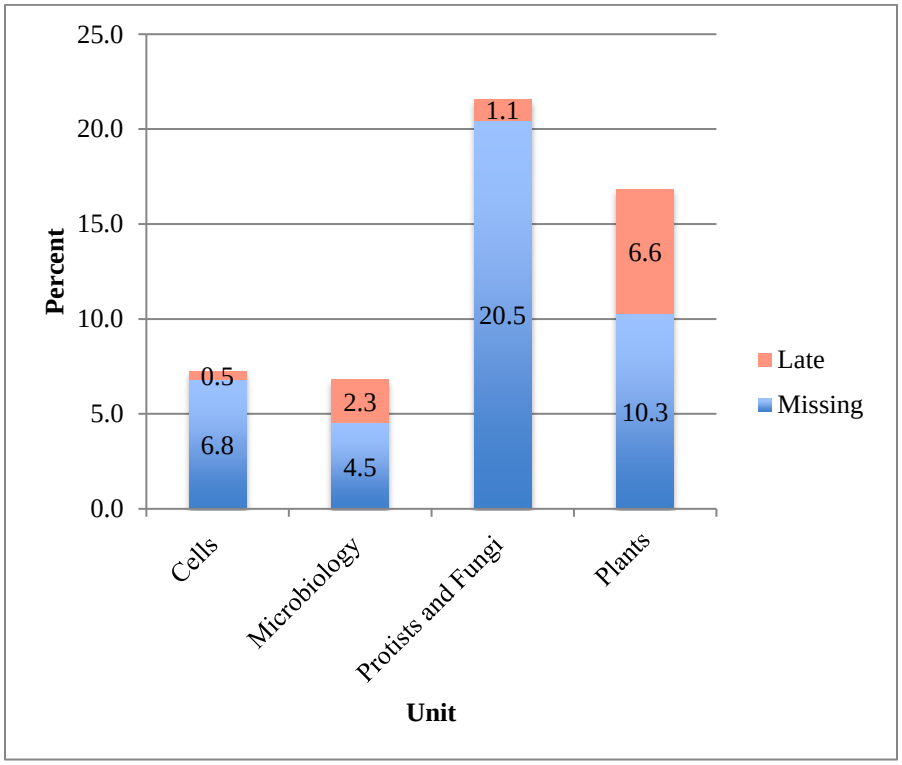


*Figure 4.* Percentage of missing assignments and the late assignments for the each of the unit.

There were two days with a formal observation done by the school psychologist. She focused her attention on four students for two different class periods. One student was earning a 'D,' two were earning a 'B,' and one was earning a high 'A.' For one class period, I lectured the whole hour and students took notes. The other day students were working in groups with a guided inquiry activity. She monitored the four students and

collected on-task/off-task data at the start of every minute (Appendix E). During the lecture, students were on-task 80.9% of the time as compared to 80.0% the time during the guided inquiry activity. She did comment that during the lecture "students' body language appeared lethargic at times with sinking in their seats and hands in their heads, but they did take good notes." For the guided inquiry, despite being off-task a little bit more, students "appeared more energetic," and "overall they seemed to enjoy the activity and were actively engaged in their learning." While there was no significant difference in the amount of time on-task during the in-class lecture compared with the guided inquiry activity, the qualitative data showed students were a bit more engaged during the activity (Appendix E). These observations coincide with many of the comments received by students. One student said the activities "help me learn better because I am a visual and hands-on learner," and another said, "it's refreshing compared to every other class where we sit down and take notes."

Not everyone shared this sentiment however. "Lectures are cut to the point and easy to understand," said a student. Regarding other activities, the same student said, "it's hard to focus or do the work, understand what we're supposed to do or learn, and pay attention to what's supposed to be happening in the experiment." Another student shared similar thoughts saying, "I don't feel as if the labs do anything for me learning-wise" whereas the student can "understand more when I am taking notes and listening to you lecture."

In the post-treatment survey students shared insight regarding their engagement with activities, their completion of the videos, and their preference of the flipped teaching

methods. The results are shown in Figure 5. Unlike the pre-survey questions (Appendix B) that were separated into five themes (Figure 1), these responses only had one question for each. I chose fewer questions because I was worried students would get tired of the survey questions and responses would be less valid. The '*Lecture video at home preferred' was not an additional question, but simply reversing the data from the previous question so it would better compare with the 'Prefer the flipped style' theme.

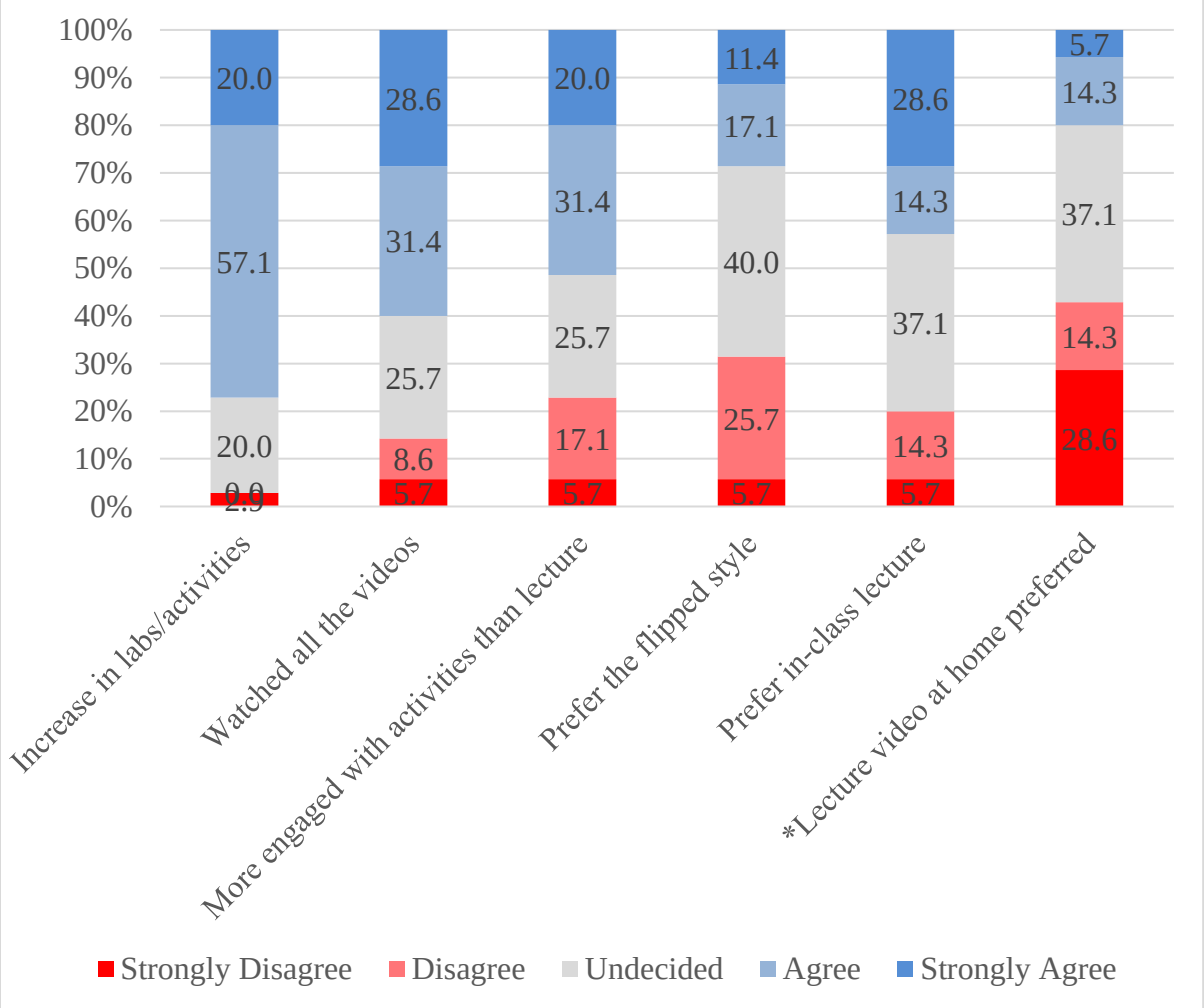


*Figure 5*. Results of post treatment survey, (*N*=38).

As can be seen, the students agreed there were more activities during the flipped units, and 55.2% of students agreed they were more engaged during the activities

compared with lecture. When asked about their preference for the flipped style teaching with video lectures as homework, over lectures done in class, 26.3% of students preferred the flipped style, while 29% of students disagreed. When worded in the opposite manner, 18.5% showed preference to the flipped method and 48.9% responded with preference towards the in-class lectures.

While the post-treatment survey makes it appear students lean a bit towards favoring the in-class lectures, a survey in Google Classroom given after the first assignment during the Plants Unit suggests a significant preference to in-class notes over watching a video lecture for homework. Twenty-five out of the twenty-eight respondents to the question said they prefer taking notes in class. The common reasons for the preference of in-class notes were a lack of time after school, it is "easier to understand them" in class, learning is improved "when the teacher lectures and I have to take notes," and students have trouble remembering to do it, as "most of us are still not used to having assignments online yet." The irony of these responses is that, apart from the last quote, the lecturing via video should allow students to learn the same information as the information I cover in the videos is the same information I would have covered in class. Additionally, students will still have to find time to complete homework assignments, whether it is watching a video or completing some other task. I am inclined to think students are just coming up with an excuse for me to hand them the information in class, like this student who prefers "when you have the notes sheets where we can fill in the answers." While it is true that students might forget, and evidently forgot more often, I

think this is part of the learning curve for both students and teachers as we use Chromebooks more often.

The twenty-five responses preferring the in-class lectures does not tell the whole story. Two of the students preferred the flipped videos because “you can pause the video and re-watch the material multiple times” and it allows students to “work at their own pace.” Plus, there is the added benefit of having “more time for labs and hands-on activities,” which can enhance the learning from the lecture. Both students are active in sports and other co-curriculars and miss class a fair amount. I think they recognized the potential benefit the video lecture provides to avoid missing content. Instead of having to get notes from a friend that may not be up to their standards, they could watch the video lecture and take notes just as they would have in class. Among the students who did not respond to this survey were three students who in other surveys and in the interviews, showed they had a strong preference for the flipped method. All three mentioned they were a “hands-on learner” and don’t learn well by listening in class and taking notes. The videos allow them to watch and re-watch the material several times in the same amount of time it takes to get through the in-class lecture, which can be helpful for those that decide not to take notes in class.

An unexpected theme I uncovered through the interviews was a sense of altruism regarding the in-class lectures. Four of the eight students that were interviewed mentioned that while they could watch the video and complete the assignments, their classmates might struggle, so it was better if lectures took place during class. “They might not get all the right information, whereas in class we know what exactly we need to

know" and "everyone gets the same information in class, but not everyone might watch the video at home." When questioned further about how a video with me lecturing over the slides was less clear than the in-person lecture, the student responded by saying "I guess because a lot of people wouldn't watch the video." The way students said these comments, made it appear they were thinking about the well-being of their classmates, but it also could have been a way to suggest the teaching method they preferred without claiming it was their personal preference. Regardless of the reasoning, this is a concern that I will need to address. If students don't watch the videos, what can I do to get them caught up? A possible solution to this, ties into the Flipped Mastery ideas promoted by Bergmann and Sams. When a student demonstrated mastery, they can move onto new material or enjoy some engaging enhancement activities while the others catch up. This is something to consider for teaching in future years.

For me as a teacher, the flipped method was quite a challenge to implement smoothly. During the traditionally taught unit, I wrote in my journal that, "I wish I had a video for students to watch, so they could be better prepared in class." I went into the classroom research thinking the flipped teaching would be a huge success for the students and make it easier on me. The reality of making and editing a video was more difficult. During the first flipped unit, Protists and Fungi, I wrote in my journal that "I wish making the video took less effort. I notice mistakes each time I make a video, so it is taking longer than anticipated." Overtime, I became better at making the videos, and also accepted the fact there might be a long pause here or there in the video. While small mistakes are common in various online video content, it is still frustrating realizing there

was a small error and being unsure whether it is worth redoing the whole video. A concern of mine is the message it might send to students, “Maybe they will think less of me and teachers over all if I don’t take the time to fix the mistake,” I wrote. The reality is that there is not enough time to make everything perfect, and I could always try and clear-up any mistakes in class. Perhaps the small pauses here and there were helpful for students to see that even a teacher needs to stop and think mid-sentence.

Another challenge with the flipped method was trying to develop quality activities to do in class with the extra time and also fit the videos into the week at an appropriate time. While small changes to curriculum have been common each year, it was more time consuming this year during the flipped units to plan and set-up the activities. I wanted students to explore information and then get the direct instruction through the video, but timing that was also more difficult than expected. I forewarned students of upcoming videos, but sometimes we did not finish an activity in class, so I would want to postpone assigning the video, so they could continue to ponder the concepts before being provided with answers. These change in plans made it more difficult with due dates as I always wanted to provide students with at least two days to watch the video and complete the assignment in-case students had co-curricular activities or struggled with internet access certain nights. It also became more difficult than expected when there were snow days or weather-related delays/releases. I anticipated that flipping the class would help in these situations, however students are not yet used to checking their emails or expecting computer work if there is a snow day, so one class got behind the other similar to previous years.

There were times during the flipped unit, when I found myself unsure whether to answer students' questions or not. I could tell if students had watched the video, or at least submitted the assignment, so when questions came up in class about the content I wasn't sure how to respond. I did not want to answer all the questions and suggest that students could get away with skipping the videos, but I also wanted to clear up confusion for those students that did watch the videos. Perhaps I could have had students that didn't complete the video move to another corner of the room and plug into their Chromebook to watch the video, while the rest of us discussed.

In additions to the frustrations I encountered, there were also numerous benefits to me as a teacher especially with my interactions with and observations of students in the classroom. Just as I expected, I had more class time that I was able to devote to more activities. During the plants unit, students started the class period in their groups taking care of the plants. They worked together to water, pollinate flowers, collect seeds and make general observations of what was going on. I got enjoyment out of the students being more active and doing science. Rather than just seeing an image of a flower to learn the parts, it was more rewarding to teach the students about the flower and pollination by pollinating them. Student were able to visually see the impact of transferring pollen from one flower to another when they noticed some fruits were more developed than others. This was a more enjoyable method of teaching than had I just lectured in class about the flower.

While students are active and social together with lab activities I have implemented in the past, it was satisfying to see students do this each and every day. In

addition to my teaching, I have lunch duty where I monitor the lunchroom. During this time, it can be disheartening to see many students focused on their phones rather than the classmates around them. Are students losing the ability to communicate in person with their constant connection to the internet? I get the feeling that implementing more activities where students need to interact and communicate with each other may help this process. I became more energized as I walked around and helped students ask and answer questions based on their observation. I enjoyed overhearing their conversations and chiming in as I found it appropriate. After one day, I wrote "Their discussion about the different minerals found in the different types of water was great to listen to. Each student had an explanation for why certain plants were doing better than others based on the different waters used." Sometimes I provided explanations, and other times I encouraged students to try to answer questions by having them research it themselves. Even when students' discussions moved away from the class material, it provided opportunities to learn about student's lives outside the classroom and connect with them on a deeper level. I learned about their involvement with co-curricular activities through the school and other activities they were interested in. Overall, the interactions I had with students as they worked in groups were more meaningful than interactions I had during a lecture.

## INTERPRETATION AND CONCLUSION

With this classroom research, I set out to find out how the flipped method would impact the students and myself as our school implements 1:1 Chromebooks. I hoped this would be an effective way to utilize the technology and free up more class time. This would provide more opportunities for more inquiry-based activities and start

incorporating the 3-Dimensions of the NGSS. I was pleased that most students recognized the extra activities that were implemented during the flipped units and enjoyed the hands-on learning. This is a step in the right direction towards how students experience the Science and Engineering Practices, however as shown by the quotes above, not all students think of these activities as a chance to learn. It is more for enjoyment and "working with friends in class."

While students enjoyed the additional labs, they preferred having lectures done in class to the lectures in video format. Many think they learn better when the teacher lectures to them and they write down the information. They might feel this way because this is a common form of teaching so they assume it is best or perhaps they have heard from somewhere that lectures and notes are best. One student said, "Notes in class are proven to help students remember what they are taught more than watching a video." I am not sure where she came up with this idea, but she felt strongly that the notes in class were better than the videos. It was also evident that most of the students did not make the connection the video lectures were a substitute for the in-class lectures. They may have viewed it as just a task to complete and earn points, but not really learn from. A few students understood and their reasons for preferring the video lecture matched the benefits I saw. They could re-watch the videos, move at their own pace, enjoy activities in class, and 'make-up' a missed lecture on their own time. A few students mentioned that a benefit for typical homework assignments and in class notes, was ability to use it to study for the test. Others recognized the video as a great opportunity to review for the test. Moving forward, I will need to do a better job of sharing with students the benefits,

or better yet, get classmates to share the benefits of the flipped video format. Additionally, I should consider changing the way I assign the videos so students recognize the importance of watching the video for learning, just like it was a lecture in class. Instead of an embedded question format or a worksheet with questions, I may need to require written notes, either free-form, or by providing a skeleton so it is more closely resembles the in-class lecture.

Despite the preference for the in-class lectures over the flipped videos, students still had positive attitudes towards the class and me as a teacher. It is great to know the flipped style did not turn students off from the class as student enjoyment with the class increased slightly from the first survey to the last survey.

A key finding through this was the decrease in homework completion. While the timing with the Protists and Fungi Unit coinciding with break and semester finals played a role, I think the increase in missing assignments is due to the novelty of the Chromebooks. Teachers are still learning how to embrace them, and students are not quite sure how they should be used. With proper instruction the confusion should clear up. Direct instruction about checking email, Google Classroom notifications, and Google Calendars will be needed. Additionally, professional development for colleagues may be necessary to students have similar expectations from all their teachers.

Student performance was declined slightly due to the decrease in homework completion, however there was minimal difference when comparing test scores. I would have liked to see an increase in the test scores, but trending right with the comparison group is better than experiencing a huge drop-off that did not previously occur. Some of

the students who felt the Plants unit was harder acknowledged they did not prepare for as well as they should have, so some of the decreased scores may have been a result of a lack of preparation.

For me as a teacher, it was a challenge to implement the flipped units. I am still developing the curriculum and was frequently making slight changes to plans a day or two in advance, sometimes that same day. This made it challenging to have the videos ready to go at the appropriate times and make sure I covered all the content I wanted. While the videos that I created were based from slide presentations I have used in the past, I still felt it necessary to tweak each presentation. Perhaps in the future I will be able to create videos that will last for years, but as of now, I can't imagine wanting to use these exact videos for next year. There will be edits I will want to make here and there. One of the potential benefits I foresee for flipping the classroom, is not needing to lecture every year whether it is in person, or on video. As of now I wonder if that is reality. How long will the videos last and be applicable?

One of my favorite parts of the Plants unit was starting each class with students actively involved in the care of their Wisconsin Fast Plants. I liked that students were out of their desks, communicating with one another, making excited observations, asking questions to each other, and making connections with the plants and the content from the videos and other activities we would do. It was more fun to start class this way, rather than be scrambling to make one last edit to a slide, in the futile attempt to create more engagement with my lecture. Just like the school psychologist witnessed, I felt more

energy and excitement with the students when they were in an activity compared to taking notes in class.

Overall, I feel like the flipped method worked fine. It was not great, but it was also not a disaster. Most of the negative attitudes may be adjusted as students learn about the potential benefits with flipped instruction and the use of Chromebooks becomes more common in our school. If there is a cultural shift in our district and especially our science classes that moves away from lecture-based instruction, perhaps students will recognize the merits of flipped instruction.

## VALUE

This project provided students a great opportunity to reflect on their learning and experience, and it gave me an opportunity to learn about their reflections. While inquiry and science practices have been around for a long time in science education, I think they are getting renewed interest as more and more states and school district adopt NGSS or NGSS-based standards. Students attitudes and engagement were increased regarding the lab activities done in class. By utilizing class time to incorporate more inquiry, students will have the opportunity to have a greater understanding of science. These activities can be followed up with lectured content in the flipped format so students still receive some direct instruction which may help make the content clearer for them.

Reading through student's comments helped me realize that I and likely many other science teachers could do a better job of being explicit about connections between class content and life outside of school. One student who responded that she is uninterested in learning in school mentioned "Most things we get taught in school are

useless in our adult life," especially regarding the details taught in some classes, like the life cycle of insects. This person then responded positively towards working hard and the importance of school and mentioned that she had goals of being a nurse. Amazing to think that a future nurse doesn't see the value in Biology content for her future. I am guessing that after completing a nursing program she will think otherwise. While, the life cycle of insects might not be critical everyday knowledge for a nurse, this sentiment suggests to me that connections between content and relevance for life during or beyond high school are not always getting across to students. It would be nearly impossible to show how every detail learned in class is critical for each students' future, but it is important to help make those connections as much as possible. Providing opportunities for students to open up and share questions, comments, and concerns about the content, could reveal simple content areas where students are missing the connection to the big picture. Help bridging these gaps could go a long way to improving student attitudes and performance in every science classroom.

For my own classroom, I anticipate continuing to try and improve on the flipped method from this year. While I don't anticipate fully flipping my class, I do think I will continue to incorporate video lectures in key areas that students struggle in most. This would allow them to re-watch me lecture as much as they need. I also anticipate incorporating in-class lectures that are shorter, and still allow more time to do activities in class. I think this would be a nice balance that helps with students who feel they need the direct instruction in class, and the students who feel they learn best through hands-on

activities. Would this be effective? Perhaps a future classroom research project will need to be conducted to see.

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# APPENDICES

# APPENDIX A

# PRETREATMENT SURVEY

**Biology Attitudes Survey**

This survey is to help me with my teaching and to provide feedback so I can improve my teaching. This survey is completely voluntary and the responses to this survey will not impact your grade in any way.

---

I take good and thorough notes in this class.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I am interested in learning biology.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Doing well at school is important in my life now.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

My teacher does a good job of answering student questions.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

This class bores me to tears. I just want to come to class and sleep.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Please explain why you answered the way you did for this question.

My teacher should help students more when they have questions or need help.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Doing well at school is important for my future.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I look forward to coming to this class with Mr. Johnson.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I always complete my homework.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Learning and understanding biology is important in my life now and in my future.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Please explain why you answered the way you did for this question.
I would recommend this teacher to a friend and/or sibling.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

My teacher encourages students to share their ideas in class.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I always complete my assignments on or before the due date.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I am interested in pursuing a career in biology or a biology-related field.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I am interested in learning at school.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

# APPENDIX B

# INSTITUTIONAL REVIEW BOARD EXEMPTION

MONTANA
STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
**For the Protection of Human Subjects**
**FWA 00000165**

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**MEMORANDUM**

**TO:** Erik Johnson and Walt Woolbaugh

**FROM:** Mark Quinn Mark Quinn CJ
Chair, Institutional Review Board for the Protection of Human Subjects

**DATE:** October 31, 2017

**RE:** *"The Effects of Implementing a Flipped Classroom in High School Biology"* [EJ103117-EX]

The above research, described in your submission of October 30, 2017, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

X (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

X (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

___ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

_____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

# APPENDIX C

# POST TREATMENT SURVEY

**Biology Attitudes Survey**

This survey is to help me with my teaching and to provide feedback so I can improve my teaching. This survey is completely voluntary and the responses to this survey will not impact your grade in any way.

---

I take good and thorough notes in this class.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I am interested in learning biology.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Doing well at school is important in my life now.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

My teacher does a good job of answering student questions.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

This class bores me to tears. I just want to come to class and sleep.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Please explain why you answered the way you did for this question.

My teacher should help students more when they have questions or need help.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Doing well at school is important for my future.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I look forward to coming to this class with Mr. Johnson.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I always complete my homework.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Learning and understanding biology is important in my life now and in my future.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

Please explain why you answered the way you did for this question.
I would recommend this teacher to a friend and/or sibling.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

My teacher encourages students to share their ideas in class.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I always complete my assignments on or before the due date.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I am interested in pursuing a career in biology or a biology-related field.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

I am interested in learning at school.

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

**Flipped Teaching Questions**

The last couple units you have experienced flipped teaching where in class lectures were replaced by videos to watch at home.

The flipped method allowed for more labs and hands on activities

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

I watched all the videos assigned.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

I prefer learning with in-class lectures and less lab time compared with videos to watch outside of class and more labs in class

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

I am more engaged in class during activities with other classmates than during lectures.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

I prefer Biology taught in the flipped style with more labs compared with the lectures in class.

- Strongly agree
- Agree
- Neutral
- Disagree

- Strongly disagree

Please explain why you answered the way you did for this question about the preferred teaching method.

Would you be willing to participate in a short interview so I can hear more about your thoughts on the flipped teaching vs traditional lecture-based teaching styles?
Mark only one oval.

- Yes
- No
- Maybe

# APPENDIX D

# INTERVIEW QUESTIONS

**Interview Questions**

Reminder, your participation or non-participation will not affect your grade or class standing.

Here were your responses to a few of the questions. What do you think?

Did the flipped format make it easier or more difficult to learn the content? Can you give some reasons why?

Was it beneficial having additional time in class to work to have more activities?

What was most and least beneficial to you about the video lectures? Why?

How do you think watching the videos affected your engagement (participation, interest, confidence) in Biology class?

We have since had a few reading assignments online. Which do you think you'd prefer - If you were assigned readings from a textbook or a video lecture?

Can you suggest any changes or improvements to the format or content of the videos for next time? Please provide reasoning.

Is there anything else you would like to add about your experience working in the flipped classroom?

# APPENDIX E

## FORMAL OBSERVATION DATA

Observation #1: 02/21/2018

| On-Task Behaviors: 80.0% as a group | | | | | |
|---|---|---|---|---|---|
| | Student 1 (low) | Student 2 (avg) | Student 3 (avg) | Student 4 (high) | Totals As A Group: |
| Response to teacher/lesson | 13.3% | 23.3% | 23.3% | 30.0% | 22.5% |
| Peer interaction | 43.4% | 56.7% | 66.7% | 53.3% | 55.0% |
| Attending to teacher check-in with packet work | 3.3% | 0.0% | 0.0% | 6.7% | 2.5% |
| Student Totals: | 60.0% | 80.0% | 90.0% | 90.0% | 80.0% |

| Off-Task Behaviors: 20.0% as a group | | | | | |
|---|---|---|---|---|---|
| | Student 1 (low) | Student 2 (avg) | Student 3 (avg) | Student 4 (high) | Totals As A Group: |
| Inattention | 20.0% | 6.7% | 3.3% | 10.0% | 10.0% |
| Talking to peers | 20.0% | 13.3% | 0.0% | 0.0% | 8.3% |
| Fidgeting with objects (distracting) | 0.0% | 0.0% | 6.7% | 0.0% | 1.7% |
| Student Totals: | 40.0% | 20.0% | 10.0% | 10.0% | 20.0% |

Additional Notes:

- On-/off-task data was collected at the start of every minute.
- 7 minutes of lecture then the rest of the time was group/partner work with packet.
- About 20 minutes into the lesson (after 13 minutes of working on the packet) the talking increased on the left side of the room. Talking was not focused on the packet. Teacher proximity helped when he was working with individual groups, but the talking increased as he moved to the right side of the room.
- The students' body language appeared more energetic and even though they did get off-task at times, most students did come back to the work independently. Overall they seemed to enjoy the activity and were actively engaged in their learning.

Observation #2: 02/28/2018

| On-Task Behaviors: 80.9% as a group | | | | | |
|---|---|---|---|---|---|
| | Student 1 (low) | Student 2 (avg) | Student 3 (avg) | Student 4 (high) | Totals As A Group: |
| Response to teacher/lesson | 43.3% | 70.0% | 70.0% | 76.7% | 65.0% |
| Video | 10.0% | 20.0% | 20.0% | 13.3% | 15.9% |
| Student Totals: | 53.3% | 90.0% | 90.0% | 90.0% | 80.9% |

| Off-Task Behaviors: 19.1% as a group | | | | | |
|---|---|---|---|---|---|
| | Student 1 (low) | Student 2 (avg) | Student 3 (avg) | Student 4 (high) | Totals As A Group: |
| Inattention | 30.0% | 6.7% | 6.7% | 10.0% | 13.3% |
| Talking to peers | 10.0% | 3.3% | 0.0% | 0.0% | 3.3% |
| Phone | 6.7% | 0.0% | 3.3% | 0.0% | 2.5% |
| Student Totals: | 46.7% | 10.0% | 10.0% | 10.0% | 19.1% |

Additional Notes:

- On-/off-task data was collected at the start of every minute.
- Lecture style format with students taking notes. Teacher had provided an outline to take notes, which appeared helpful.
- Students' body language appeared lethargic at times (i.e., sinking in their seats, heads in their hands), but they did take good notes. The teacher paused long enough for them to copy the notes down. If he had moved at a faster pace it is likely that Student 1 would not have had enough time to copy (as he was one of the last ones done) and he would have likely demonstrated more off-task behaviors as he gave up.