

TESTING THE EFFECTS OF PAUL ANDERSEN'S QUIVERS METHOD ON
INTELLIGENCE MINDSET AND ACHIEVEMENT IN A 9TH GRADE BIOLOGY
CLASSROOM

by

Taryn Powers Surabian

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TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND1

2. CONCEPTUAL FRAMEWORK.....4

3. METHODOLOGY11

4. DATA AND ANALYSIS20

5. INTERPRETATION AND CONCLUSION43

6. VALUE.....49

REFERENCES CITED.....52

APPENDICES55

 APPENDIX A Website.....56

 APPENDIX B Mindset Survey.....60

 APPENDIX C DNA Replication Quiz65

 APPENDIX D Protein Synthesis Quiz71

 APPENDIX E DNA Test.....79

 APPENDIX F Post Unit Opinion Survey85

LIST OF TABLES

1. Data Triangulation Matrix	17
2. Sample Answers for the Five Minute Essay	19
3. Grade Comparison for Each Class	46

LIST OF FIGURES

1. Initial Growth Mindset Histogram.....	3
2. GM Intelligence Before and After QuIVERS.....	22
3. Change in GM Intelligence.....	23
4. Percent Increase vs Initial GM Intelligence.....	24
5. Pre and Post 5 Minute Essay Scores.....	27
6. DNA Replication Quiz Results.....	28
7. Protein Synthesis Quiz Results.....	29
8. Final Test Scores.....	30
9. Grade Distribution on Final Test.....	30
10. Student analysis section from Griffiths Lab.....	31
11. Student analysis section from Hershey and Chase Lab.....	32
12. Student overall Opinion (Midway).....	36
13. Positive Feedback (Midway).....	37
14. Negative Feedback (Midway).....	38
15. Overall Opinion of QuIVERS.....	39
16. Would you like to try QuIVERS again for another chapter?.....	40
17. Negative Feedback (Final).....	41
18. Positive Feedback (Final).....	41

ABSTRACT

The students in my classes struggle teaching themselves new material, and frequently avoid challenging problems. When they are asked to teach themselves something new or apply content they've learned, these otherwise high achieving students, frequently underperform. They have a strong aversion to failure and rather than risk getting something wrong they avoid answering. This aversion to difficult tasks and fear of failure is consistent with a fixed mindset.

In an effort to develop growth-minded intelligence in my students I implemented the QuIVERS teaching method developed by Montana Teacher of the Year, Paul Andersen (2012b). This teaching method combines the 5E learning system with a blended learning cycle to create a student-led learning environment. Along with measuring mindset, I also measured academic achievement, student resilience when working on difficult problems and student experience.

As a result of the QuIVERS intervention, students who had an initial fixed mindset shifted towards growth-minded thinking. Students also developed strong content knowledge (especially academically weak students) and worked on difficult problems longer. Despite thinking it was difficult, students had lots of positive feedback about the method.

INTRODUCTION AND BACKGROUND

Project Background

School Demographics

I currently teach ninth grade Biology at Ursuline Academy, an independent all girls Catholic middle-high school located 30 minutes south of Boston in Dedham, Massachusetts. There are 431 students enrolled in grades seven through 12. Tuition is \$18,990 a year and 22% of students receive need-based financial aid. Our students are 74% Caucasian, 2.6% Asian, 1.4% African American and are from 55 different communities in the greater Boston area. Students must pass a test for admission to the school and are all enrolled in honors Biology their freshman year.

Teaching Experience and Classroom Environment

Ursuline Academy is a college prep school and prides itself in the fact that 100% of its graduating classes attend 4-year colleges. This can result in a huge amount of pressure being placed on students from their parents and themselves to perform well in academics, extra curricular programs, and sports. Many students are grade driven and are more concerned about an assignment's score than its content. Consequently, our students have a high level of stress, a strong aversion to failure and avoid new things, taking chances, or solving problems they haven't seen before.

Identified Problem

Most students at Ursuline Academy do not struggle with following directions or memorizing facts; instead they struggle using previous knowledge and higher order thinking to explain unexpected results or solve new problems. They are very good at taking notes and studying for tests, but when asked to answer a challenging question or

assignment they won't try to answer or won't do the assignment. I've observed that if students don't think of the answer within one minute, rather than working to figure it out they expect to be told the answer. It seems they lack confidence in their ability to solve problems and are being held back by a fear of failure. A number of my students exhibit characteristics of unhealthy perfectionism: the desire to be perfect in everything one does. Common symptoms include: emphasis on perfect academic grades while avoiding risk of failure by not trying to solve new problems (Flett & Hewitt, 2014).

Esparza, Shumow and Schmidt (2104) have found that students who are hesitant to take risks and solve new problems tend to have a fixed mindset instead of a growth mindset of intelligence. Students with a growth mindset believe that their intelligence is something that can grow with hard work. These students embrace obstacles and challenges as a way to improve their intelligence. Students who feel this way have a mastery approach to education. In contrast, students with a fixed mindset feel that their intelligence is fixed and can't be improved upon. Students with this type of mindset shy away from obstacles and have a fear of failure.

After polling my students using a survey I made with Google forms (appendix B) I found that the average GM (growth mindset) score was 63.8%. There were four students who scored less than 50% which means they have a predominantly fixed mindset. The 28

other students had a predominantly GM but it ranged from 50% to 85% (see figure 1).

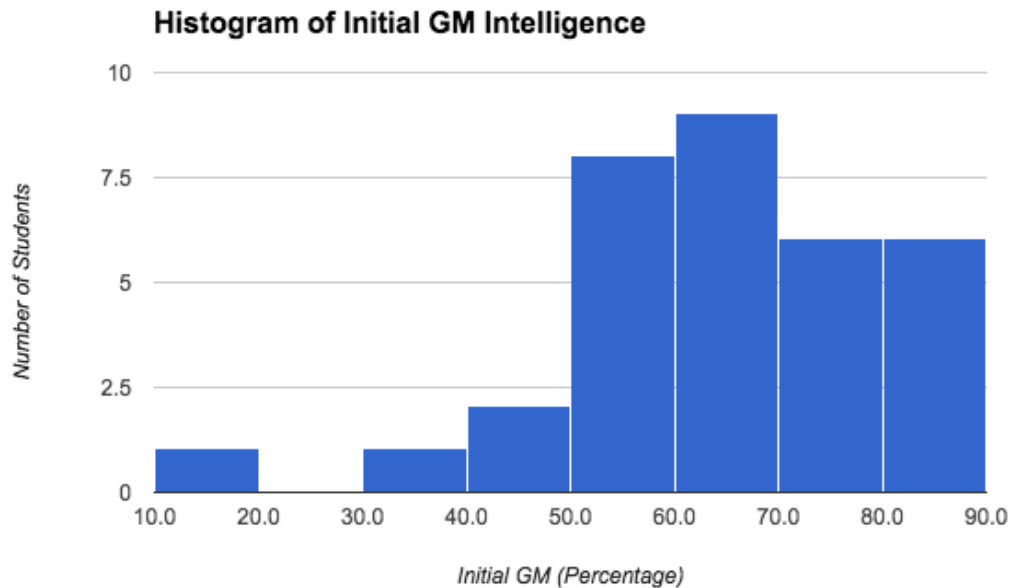


Figure 1. Results of student (N=32) initial survey on Mindset. Survey (appendix A) was 15 questions on a likert scale that asks students about how they perceive their own intelligence. Students scores were tallied and all students were given an initial percent GM (growth mindset) score.

There is a need to develop a growth mindset in all students so they can overcome challenges and enjoy learning.

Possible Solution.

In order to encourage my students to develop more of a growth mindset I used Paul Andersen's QuIVERS blended learning cycle to teach one unit of material. This method provided a framework for my students to use while practicing self-directed, mastery learning. QuIVERS is an acronym developed by Paul Andersen (2012b) that stands for *Question, Investigation, Video lecture, Elaborate, Review* and *Summary quiz*.

This is a blended learning style similar to the 5E learning method broken up into five stages; *engage, explore, explain, elaborate and evaluate* (Bybee et al., 2006).

The first step of QuIVERS is to ask a question about a proposed event or data, followed by an inquiry investigation. Students then expand on what they have learned by getting some background and more in-depth information from a video lecture, which is then supported by an elaboration on the material using their textbooks. Before moving on to take their final quiz students must review with the teacher to ensure they have a mastery of the content (Andersen, 2012b). The most important aspects of this method are student led pacing, student centered learning and a focus on mastery of material.

Focus Questions

My main research question was: does the QuIVERS learning cycle promote an increase in a growth mindset? I predicted that this kind of teaching technique would promote a growth mindset by encouraging students to realize their own abilities to learn independently and solve difficult problems.

I also asked; does this teaching style improve student academic achievement, increase student resilience when solving difficult problems and will students enjoy this teaching style? I predicted that it would improve student achievement and increase resilience. I thought my students wouldn't enjoy the fact that this learning style is more challenging for them.

CONCEPTUAL FRAMEWORK

Introduction

The QuIVERS teaching technique that I implemented was developed by Paul Andersen (2012b) and is a version of the 5E learning cycle, which has been extensively studied and used to promote student achievement. The QuIVERS method uses a combination of online learning and teacher-supported classroom learning which makes it a blended learning cycle. Part of this online learning uses video lectures so it is important to understand how videos are used and shown to be effective into flipped classrooms. The last two steps (review and quiz) promote mastery of material because students have to demonstrate that they understand key concepts before taking the quiz.

Mindset, Perfectionism and Aversion to Failure

Carol Dweck (2006) explains that there are two types of intelligence that influence the way we think about learning. These two mindsets are called the growth and the fixed mindset. People with the fixed mindset believe that their qualities are fixed meaning, they were born with certain abilities and they can't be changed. Fixed mindset people believe that every challenge they face will judge them as smart or dumb, talented or not. This mindset forces people to avoid taking risks and prevents people from living up to their potential. The opposite of a fixed mindset is a growth mindset. People with the growth mindset believe that they have the ability to grow and change and that working hard will help them improve. People with this mindset are not deterred by failure, in fact they can learn to love it because it is part of the process of growth and improvement.

Carol Dweck along with Lisa S. Blackwell and Kali Trzesniewski (2007) followed students as they transitioned from middle school through the first 2 years of high school and found that students with a fixed mindset tended to struggle with difficult

assignments and stricter grading policies and receive lower grades than their growth mindset peers. These students felt as though there was nothing they could do about their poor scores and tended to blame teachers or other outside forces. In contrast, their growth mindset peers were able to rise to the new challenges and succeeded. I used a test similar to the test developed by Blackwell, Trzesniewski, and Dweck (2007) to determine the mindset of my students. These questions on the test are answered using a likert scale of one to six. Of the test's 15 questions, nine are rated with one representing a fixed mindset and six representing a growth mindset while the other 6 are rated in reverse. Students' scores are added up so a percent growth mindset score is determined.

A fixed mindset is also linked with unhealthy perfectionism, a trait prevalent among teenagers, and even more so in teenage girls. Studies in Australia and China found one in four teenage girls suffer from unhealthy perfectionism. Unhealthy perfectionism is linked to anxiety, depression and increased suicide risk. Moreover, the teenagers suffering from this condition are unwilling to seek help because of their desire to appear perfect. "Extreme self-oriented perfectionism has several inherent features that limit its adaptiveness, including rigid and inflexible thinking, an abiding fear of failure, an excessive self-focus, and a propensity to react poorly following mistakes and setbacks (Flett & Hewitt, 2014)." This rigid mindset is consistent with a fixed mindset. They believe that intelligence or talent isn't something that can be improved on and so they feel enormous amount of pressure to pass the test and appear perfect. However, Flett and Hewitt found that a subset of students with perfectionism who maintain a growth mindset tended to view obstacles as part of the learning process instead of personal failures (Flett

& Hewitt, 2014). This evidence was also supported by a study by David Chan who looked at the connection between perfectionism and growth mindset in Chinese gifted students. He found that students who were evaluated as unhealthy perfectionist were more likely to have a fixed mindset compared to students evaluated as healthy perfectionists who mostly had a growth mindset (Chan, 2012).

Jessica Lahey is a researcher who studies how children deal with failure. Lahey cites work done by Wendy Grolnick on autonomy-supportive vs controlling parents. Grolnick studied mother-child pairs and found that children who have controlling parents are less likely to work on challenging tasks on their own. Lahey explains that this shows that children who are constantly guided through tasks are less resilient and less independent. In order for children to become independent problem solvers they need to work on challenging tasks independently. Lahey gives examples on how to offer autonomy-support to students by letting them make mistakes and fail and then asking them what went wrong and how they could fix it in the future. By putting the students in the driver seat they can become more independent and less risk-averse problem solvers (Lahey, 2015).

QuIVERS

The QuIVERS teaching technique, developed by Paul Andersen in 2012 is designed to use blended learning to present the 5E teaching technique. The most important aspects of this technique are the student-led pacing and the focus on mastery of the material. Because this technique involves autonomy-supportive teaching, it requires students to work at forming questions and finding their own answers. This process

requires students to feel uncertainty, failure and frustration and embrace it as a necessary part of learning. Paul Andersen likened this student-centered experience to handing each of his students' keys to a car: some went speeding away in the right direction while others drove directly into a tree (TEDx, 2012).

5 E Learning System

Paul Andersen's (2012b) QuIVERS method is derived from the 5E learning system. This 5 E learning system was created in 1980's by the Biological Sciences Curriculum Study Group (BSCS) and consists of the 5 phases: *engage, explore, explain, elaborate, and evaluate* (Bybee et al., 2006; Wilson, Taylor, Kowalski, & Carlson, 2009). Bybee et al. (2006) reviewed the use of the 5E instructional model and found there to be numerous benefits to this teaching technique including: mastery of subject matter, scientific reasoning and increased interest in science. Wilson, Taylor Kowalski and Carlson (2010) conducted a study involving 58 students ages 14-16 who were divided into two groups: one using traditional teaching methods and another using the 5E learning cycle framework. Students were from a range of schools and were taught material on sleep and sleep disorders because it was outside of the normal curriculum ensuring students had minimal previous exposure. They discovered that students exposed to the 5E framework showed greater improvement in both academic understanding as well as argumentation skills.

Blended Learning and Flipped Classrooms

QuIVERS is a student led learning method where students access their learning materials through a website and move through each module at their own pace. My

students had to complete some assignments virtually and independently while others had to be completed in class in small groups. This combination of online and classroom learning is called blended learning. Stacker and Horn (2012) define Blended learning as:

a formal education program in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path, and/or pace and at least in part at a supervised brick-and-mortar location away from home (p. 3)

Dikmenli and Unaldi (2013) studied three groups of students: one using a completely virtual classroom, another using a combo of blended virtual/teacher approach, and a traditional teacher based classroom. The students in the blended learning and virtual classrooms showed a significant positive difference in academic achievement when compared against the traditional classroom. Further, Yapici and Akbayin (2012) did a study of 107 high school Biology students and found that students taught with the blended learning technique showed an increase in understanding of the material based on pre and post test results.

An important aspect of the QuIVERS method is the video lectures. Video lectures have been used with increasing frequency in the context of a flipped classroom with success. Kevin Clarke (2015) conducted a study on flipped classrooms. His study consisted of an Algebra class of 42 students between 13 and 15. His study found students took a much more active role in a flipped classroom and they felt that it was a much better use of their time. In his study student academic achievement didn't improve, they had a positive experience with this type of learning. Teachers Moore, Gillett and Steele

(2014) set up an experiment where they tested the effects of two types of flipped classrooms. In each case, direct instructional material was covered outside of class through the use of online videos and class time was dedicated to students working collaboratively on solving problems. Success was measured by homework completion, student engagement and student feedback. Gillett noted that his students spent less time taking notes in class and more time solving problems. Students felt that it was hard because it required them to think much more about the concepts. Gillett saw an increase in homework completion by 5.4 percent. Moore's approach to a flipped classroom saw an average increase in homework by 13 percent. Moore's students enjoyed the use of technology in the classroom and she enjoyed the opportunity to talk to each of her students during class time as they were working on problems. Both teachers felt that one of the most beneficial parts of a flipped classroom was the ability to discuss with students in small groups and help them solve with difficult problems. They felt that the opportunity to learn about how their students worked made them better teachers.

Mastery

Mastery learning is an important part of the QuIVERS teaching technique. According to Benjamin Bloom (1986), a normal grading curve isn't what teachers should be striving for. If the material being taught is accessible for all students then grades should not fall on a normal curve, they should all be high scores. The method for ensuring mastery can vary depending on the needs of the individual and the type of material being presenting but the key is that students should not move on to new material until they have demonstrated a well rounded understanding of current concepts. Bloom

states that with enough time and effort all students are capable of mastery. He conducted a study of students enrolled in a course on test theory. He found that with traditional methods 20% of students received an A on the final exam, while the mastery method saw this number rise to 80% which is a difference of 2 standard deviations. With targeted corrections of common misconceptions and increased review of difficult material, this number rose to 90% in the following year. The QuIVERS method uses the mastery approach by forcing students to meet with the teacher in a review session and demonstrate understanding before they can move on to take the summary quiz.

The QuIVERS method combines a number of successful teaching techniques including 5E lessons, blended learning, mastery learning and video lectures. It forces students to take charge of their own learning and solve problems without leaning on the teacher for help. The hope is that students see their own success and gain confidence in their abilities to grow and improve in their academic endeavors.

METHODOLOGY

For my action research project I tested the effectiveness of the student-led blended learning cycle QuIVERS. My main question was: does this student-led blended learning cycle promote an increase towards a growth mindset? I also looked at whether this technique increases student understanding of scientific concepts and if it creates a positive learning environment.

The QuIVERS method starts with a question then moves to an independent investigation and inquiry lab, a video lecture on the material, an elaboration using the textbook along with other reading materials, a review session with me and finally a

summary quiz. Students moved through each of these stages at their own pace. At the end of both chapters a unit test was given (Andersen 2012b). In order to monitor and encourage student progress, checkpoints are used throughout the unit (Brunsell 2013). Students turned in assignments such as labs, textbook work and study guides to help me make sure they were on task. Paul Andersen (2012b) has mentioned that this method works for him but it has not been formally tested outside of his classroom.

Participants

The ninth graders involved in this study were mostly hard working students with the goal of attending a four-year college. All students were enrolled in honors Biology their freshman year; the lack of alternative levels means there are some students who constantly struggle and a few who find the class too easy. Student reaction to this teaching method was tested over the course of two units spread across 3rd and 4th term. Two classes of 16 students participated in the intervention with a total of 32 students. Another class of freshman biology students taught using a traditional lecture method was used for comparison of grades. This traditional class was taught using a teacher-led lecture style and had 16 students. The demographics of the students were representative of the whole student body approximately, 74% Caucasian, 2.6% Asian, 1.4% African American.

Intervention

I implemented Paul Andersen's "QuIVERS" method (Andersen 2012b) to teach two chapters on DNA and Protein Synthesis. The first chapter was on structure, function and replication of DNA and the second unit was on protein synthesis.

This method was compared to my previous, traditional style of teaching, which my students were exposed to since November. In my traditional classroom I typically presented a question for my students to answer. After they discuss it we worked together as a class to arrive at an answer. After the discussion I presented a series of lectures on the material. We did labs and activities as a class and students were responsible for homework from the text and labs through the lesson. At the end of a chapter we had a chapter test. In this traditional method the class moved through the material together and students didn't have a flexible timeline to move through material.

For my intervention, the students followed a more student-led approach through the material. We used the QuIVERS method, which consists of a *question, investigation, video lecture, elaboration, review session* with me and finally a *summary quiz*. At the end of two QuIVERS units the students took unit test. The students were in charge of their own learning pace and moved through the material individually, as opposed to my traditional class style, in which students and teacher move together. There is a mastery aspect to this teaching style because students had to meet with me in small groups in order to move on to the assessment. I created a website (Appendix A), using Google sites, with all of the assignments for the students so they knew what they had to do. All assignments that needed to be turned in had a due date next to them and a corresponding assignment on the Google classroom page so they had a place to turn them in digitally.

Unit One: DNA and DNA replication

Question. The first unit focuses on DNA and DNA replication. The initial question was “What is heredity”. Students did a brainstorming session on this question and were prompted to fill in background knowledge about nucleotides and amino acids.

Investigation. Students investigated each of the key experiments done to determine whether DNA or proteins are the genetic information. As they reach the Griffith's experiment, the Hershey Chase experiment and the Watson and Crick paper they met with me in small groups to work through the material. In the case of the experiments students had to do a background for the labs by answering questions and designing their own experiment. When they met with me we reviewed their background material and designed the experiment together. We then went through a mock version of each of the labs and students recorded their data. Students then had to do the analysis and conclusion independently. For the Watson and Crick paper the students read through the paper before meeting with me and then we reviewed the findings in a small group. It was important for me to make sure I was still involved in the learning process so students had to meet with me to work on the labs. This allowed me to use directed inquiry in small groups.

Video. After establishing a background on DNA and structure, students watched a video I made on DNA replication and took notes (Surabian, 2016).

Elaborate. Students read a section in their book on DNA replication and made a summary sheet explaining how DNA replicates in eukaryotes.

Review and Summary Quiz. Unfortunately, I had to be out of school when students were ready to meet with me to review DNA and DNA replication. I didn't want

to hold them up from moving on so I allowed them to continue to the next unit before meeting with me. When they were ready to review the material for both units we did our review sessions and quizzes. I met with students in small groups to discuss DNA and DNA replication. If students seemed like they didn't understand the material they had to go back and review the material they struggled with. After demonstrating that they understood the material, students were allowed to take the corresponding online quiz made using Google forms (see Appendix C).

Unit Two Protein Synthesis

Question. The question that the students had to answer was

If DNA is the genetic material there must be some kind of connection between DNA and the proteins that make up our traits. How might they be related? What do you know about how proteins are made? What are they made of, how and where are they assembled, what is important for making sure a protein works properly?

Investigation. Students had to read sections 13.1 and 13.2 about RNA and Protein synthesis. They then had to answer the following questions.

- How is RNA different from DNA? Describe and draw each of the 3 types.
- Describe the process of transcription. What is the goal? How does it happen?
- Describe the process of translation. What is the goal? How does it happen?

Video. Students watched a video from Paul Andersen's Bozeman Biology on Transcription and Translation (2012a) and took notes.

Elaborate. Students completed models and acted out the stages of transcription and translation using a kit.

Review and Summary Quiz. After students met with me to review DNA and DNA replication, they took the quiz. They met with me separately a second time to review protein synthesis. Before each meeting, students had to prepare by making paper study guides. In our protein synthesis meeting I made sure students understood the process of protein synthesis and how it was different from DNA replication. Once students demonstrated understanding of the material they were sent links to the online quiz made using Google forms (see Appendix D).

Chapter Test. Once all students took the quizzes, I used an online rubric program to grade the quizzes and send them a copy of their answers as well as the answer key and their score. They were able to use this to study for the test. Everyone took the pen and paper test on the same day during class time. This test was on material from both units and consisted of both multiple choice questions and open response short answer questions (see Appendix E for test).

Data Collection

Data was collected for each of the focus questions using three metrics. In order to test for a change in mindset students were given the same survey to take before and after the intervention, students were interviewed, and I led a class discussion. In order to collect data about student content achievement I looked at pre and post 5-minute papers, final quizzes, tests and the analysis section for two labs. I tested for student resilience when solving difficult problems by using a pre and post unit survey, student interviews

and my own observations. In order to figure out if this was a positive experience for my students I used anonymous midpoint comment sheets, post unit survey questions and student interviews.

Table 1
Data Triangulation Matrix

<u>Questions</u>	<u>Data Source</u>		
Focus Question: Is there an increase in growth mindset vs fixed mindset?	Student pre and post unit survey.	Student post unit interviews.	Class discussion.
Sub-question 1: Is there an increase in student understanding of content?	Student quizzes and final tests.	Pre and post 5 minute paper scores	Analysis section of lab grades
Sub-question 2: Is there an increase in students resilience when solving difficult problems?	Student pre and post unit survey.	Student post unit interviews and class discussion	Teacher observations
Sub-question 3: Is there a positive student reaction to this teaching technique?	Student post unit survey.	Student interviews and Class Discussion	Mid-point feedback

Mindset survey

At the beginning and end of the intervention all students were given an anonymous Google forms survey to fill out (Appendix B). To ensure that I got paired, anonymous data, I asked students to fill out the form using a private code name. The survey asked students to answer some questions about how they understand their own intelligence. I used a test (see Appendix B) similar to the test developed by Blackwell, Trzesniewski, & Dweck to test for mindset (2007). These questions were

answered using a likert scale of one to six. Nine of the 15 questions had option one representing the fixed mindset and six representing the growth mindset. The other six questions were the opposite and were reverse-scored. Students' scores were added up, and scaled so the lowest score possible was zero and the highest was 75. Each student score was divided by 75 and each student was given a percent growth mindset score. This survey was given at the beginning of the intervention and again at the end.

Student Interviews

Four randomly selected students were interviewed in a one-on-one setting at the end of both unit and were asked their thoughts on the QuIVERS teaching style. Students were asked if they felt these units impacted their confidence in their ability to solve problems and teach themselves something new. I asked if this teaching style has changed the way they approach learning something new. I also got some feedback about what they liked about the teaching style and what they didn't like. Conducting personal interviews and a large class discussion provided a sense of the individual and group mentality.

Class Discussion

At the end of the intervention a class discussion was had to learn more about the impact on mindset, resilience and see what the overall opinion of the QuIVERS method was.

Student Opinion Survey

A new section was added to the mindset survey after the QuIVERS Intervention to find out what the students thought about the method. They were asked their overall opinion of the method as well as the things they liked best and least about the method. I

also asked them how much time they were spending on work outside of class but there was a problem selecting answers and so that data had to be discounted. See Appendix F for final survey.

Grades

In order to test for understanding of content, students were asked to write a 5-minute paper before and after treatment, the analysis sections from two labs were evaluated, and two quizzes and one chapter test were given. One the first and last days of the intervention, students were given five minutes to write down everything they knew about DNA and DNA replication. The results to this question were collected and scored. I gave one point for every correct fact the student mentioned. This is a list of some of the facts I gave credit for:

Table 2.
Sample Answers For The 5-Minute Essay

DNA stands for Deoxyribonucleic Acid	5' end has a phosphate	Replication proved by Meselson and Stahl
Order of the bases matters	3' end has an OH	Replicates in bubbles
DNA is the genetic material	Know how the bases pair	There is a leading strand and lagging strand
DNA controls proteins	Structure was discovered by Watson and Crick	DNA polymerase is the enzyme used in replication
DNA is made of nucleotides	Double helix	DNA replicates in preparation for cell division
Structure of a nucleotide	Bases on the inside, phosphates and sugars on the outside	Semi conservative replication
The sugar is called Deoxyribose	Anti-parallel Strands	Full names of the bases

This scoring was not shared with the students and the assignment did not count towards the student's grade.

Observations

I kept a log of observations throughout the intervention. I was looking to record how students worked on problems independently. I was also recording any successes and struggles with the process.

Halfway Feedback

When we finished up unit one I asked students to give me some feedback about QuIVERS. I handed out some blank paper and asked them to anonymously tell me what they thought about the process. I asked them to write down what they liked and what they didn't as well as how they felt about the material.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained.

DATA AND ANALYSIS

Through the use of surveys, student interviews, class discussions, lab reports quizzes, 5-minute papers, and test grades I was able to evaluate the QuIVERS method. QuIVERS lead to a large shift towards a growth mindset for students who started with a fixed mindset, it improved academic achievement for low performing students, some students showed some signs of increased resilience and there were many things they like and disliked about the intervention.

Impact of QuIVERS on Student Mindset

Based on the results of the survey I conducted, there was a significant shift towards growth mindset for students who started with a mostly fixed mindset. When

averages of all of the students were examined there seemed to be no increase in growth mindset due to the QuIVERS method.

Survey results

The mindset survey showed a significant increase in growth mindset, due to the QuIVERS teaching method, for students who started with a fixed mindset but no significant difference in mindset for the population as a whole. The results of 15 questions related to mindset were added together and a percent GM Intelligence was assigned to each student. Students took this survey before and after the treatment and the percent difference for each student was calculated. A T test was done to test for statistical difference between the first survey and the second survey and while there was no significant difference for the whole population. The students who started with a GM Intelligence below 50% showed the largest increase. When these students were analyzed separately, this correlation was shown to be statistically significant. Responses to each question were analyzed both before and after the treatment and there was no significant difference between pre-treatment and post-treatment for any of the questions.

At the beginning of the intervention students scored an average of 63.8% GM (standard deviation = 15.12). At the end of the intervention when students were asked the same questions they scored an average of 66.3% GM (standard deviation = 13.35). This shows an overall 2.5% shift towards growth mindedness (see figure 2). A Student T-test was done to test for statistical difference between the pre and post data and the p value = 0.1 which is not statistically significant. This means that the null hypothesis is accepted and the small difference in mindset for the whole class is not statistically significant.

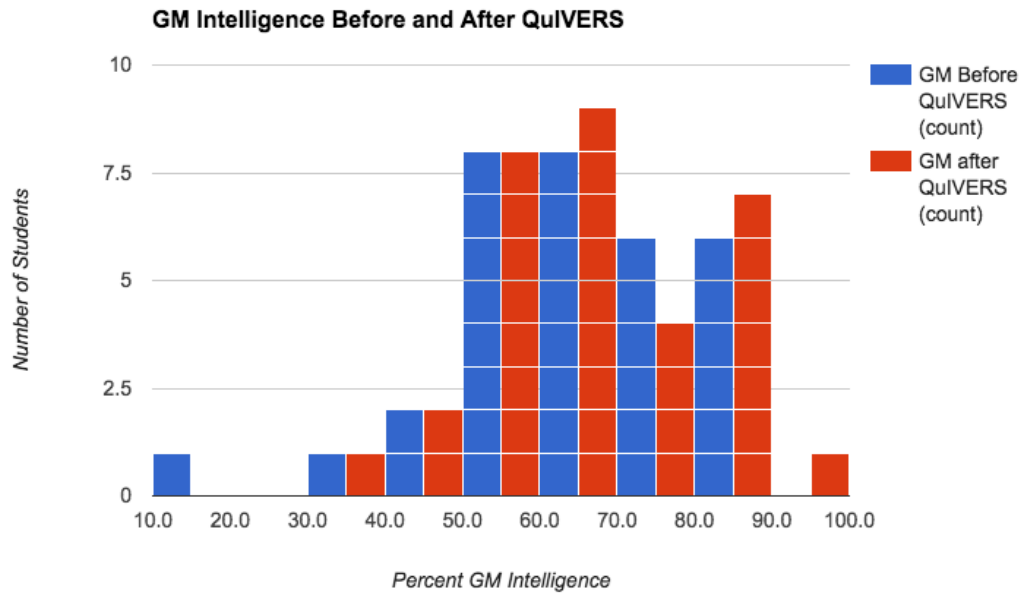


Figure 2. Histogram that shows the distribution of growth mindedness of students ($N=32$) at the beginning of the intervention vs the end of the intervention.

Despite there being no difference overall, there was a large change in mindset for some students. Six students showed a shift towards the fixed mindset greater than 6% with the highest shift of 15%. Ten students showed a shift towards the growth mindset greater than 6% with the highest shift of 27%. Figure 3 shows the change of each student.

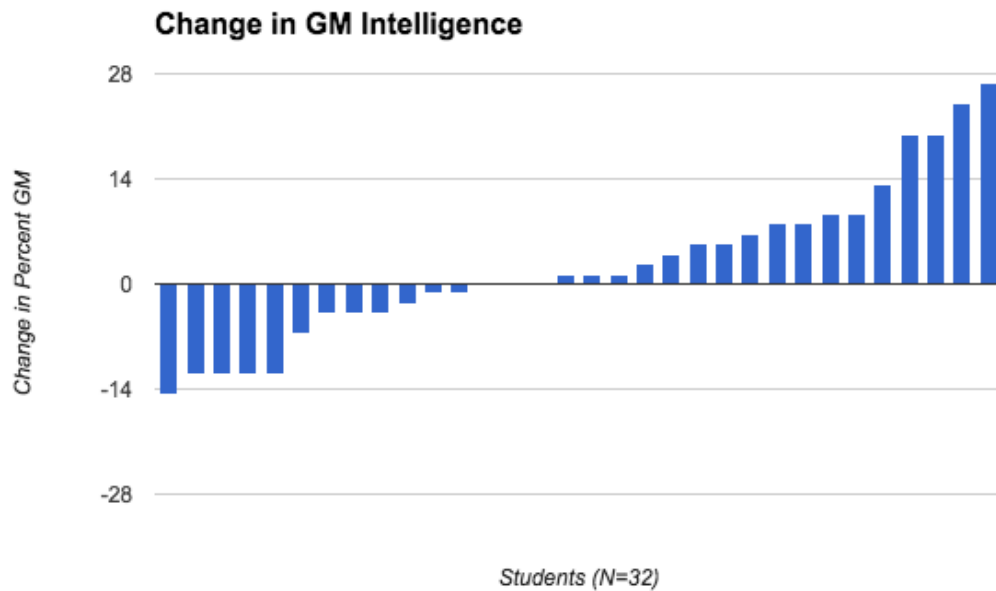


Figure 3. Shows the change in percent GM (growth mindedness) for each student ($N=32$) over the course of the QuIVERS intervention.

There is an interesting correlation between the initial GM score of less than 50% and a large shift towards growth minded thinking. Figure 4 shows that students who have a initial growth mindedness of less that 50% (a predominately fixed mindset) show the largest shift towards growth mindset after the intervention. A T test was done on the initial and final results of these four samples to test for significant change and the p value was calculated to be less than 0.05 which means that the alternative hypothesis is accepted; there is a significant shift towards a GM for students who started with a fixed mindset.

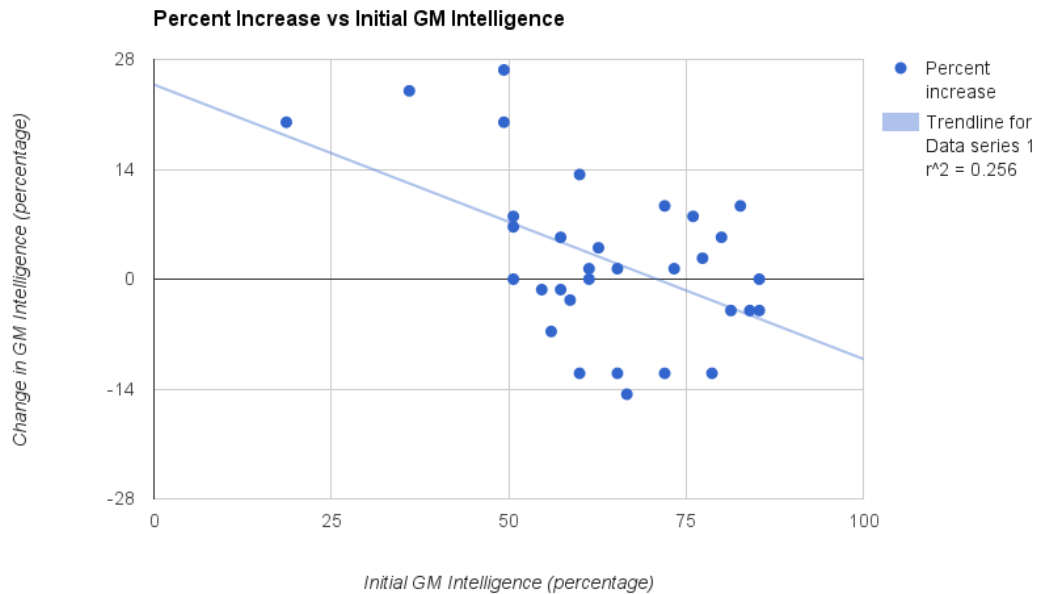


Figure 4. Shows that relationship between initial mindset and percent shift towards growth mindedness over the course of QuIVERS.

The average responses for each question (scored on a scale of one to six) were analyzed and showed no significant difference between pre and post QuIVERS for any of the individual questions. The average of the responses, for each of the question, was calculated and it showed that most of the questions were answered indicating a growth mindset. The one question that averaged the lowest score (indicating a fixed mindset) was: “I feel like people are naturally good or naturally not good at science”. Most students (even though they had an overall GM) agreed that when it came to science some people were naturally talented and others just had to work hard at it.

Interview result

I randomly selected four students (Erin, Julia, Julianna and Sarah) to be interviewed. Three of the students said that they felt that the harder they worked on their

assignments the better they would understand the material. Julia said, “I think it (QuIVERS) made me realize I am able to process it on my own. If you really think about it and look over it, it works really well for the future.” I asked Julia if she felt like struggling is a normal part of learning and she said “When I am struggling I don’t feel like I am doing it wrong, all the ideas got cleared up in the review sessions and I was like: Oh, that makes sense.” Overall these students all demonstrated a growth mindset. They each made comments that demonstrating their belief in their ability to get smarter the harder they worked however, it wasn’t evident from their answers if they became more growth minded because of QuIVERS.

Class Discussion

I held a class discussion over the span of two days in both classes. The first set of questions I asked them were related to mindset. Overall students demonstrated a growth mindset with their responses but it was not clear if the QuIVERS method contributed to this.

Overall, students felt that they could get smarter the harder they worked at their assignments. One student said “I think that the harder you work at something...the more time you spend in it... working at it, it becomes easier and you get a better understanding.” Most students said they also felt that the more work they put into their assignments the better they would understand the material. However, one student said, “Even if you put as much effort into the assignment as possible you could still possibly not get what you put down.” Students seem to agree with this sentiment that just because

you spent a lot of time on an assignment doesn't mean it was right or that you understood it.

I asked the students if they felt like working on QuIVERS changed the way they thought about their ability to teach themselves something? One student said "The more I taught myself the better I got at it" and lots of students agreed with that sentiment from both classes. One student said, "I was kind of surprised, I didn't think I was going to do as well as I did." One student noticed that the class was getting better at working together, "In the first couple of labs we did, we weren't as talkative and when it came to the last lab everyone was chatting it up." Another student said she felt like she stayed the same in her abilities. I asked if they felt like they could get better using the QuIVERS method and most students said yes, even if they didn't want to continue with QuIVERS.

Overall students in both classes demonstrated a growth mindset showing that they felt they could continue to get better at QuIVERS and get better and teaching themselves the material. Students did feel like they learned both content and skills during the intervention however, students did not demonstrate a change in their growth mindset because of QuIVERS.

Academic Achievement

There seemed to be an improvement in student achievement for my lowest scoring students. While my higher achieving students showed no change, my lower scoring class improved their test averages quite a bit. I also saw significant improvements for individual struggling students thanks to the QuIVERS method.

Five Minute Papers Pre and Post Treatment

On the first and last day of QuIVERS students were asked to do a five minute open response essay where they were asked to write down everything they knew about DNA, its structure and how it replicates. The papers were scored by giving one point for every correct fact. Students did this at the beginning of the treatment and again just before they took their test on DNA and protein synthesis. These papers were anonymous and not graded. The average score before the treatment was 2.9 (SD = 1.5) and the average after was 9.1 (3.8 standard deviation). Figure 5 shows the histogram breakdown for the pre and post treatment scores. A T test was done to test for statistical change before and after QuIVERS and the calculated T value was 14.95. The T value for 0.05 confidence with 31 degrees of freedom is 1.69, which means we reject the null hypothesis, there is a significant increase in score thanks to this method

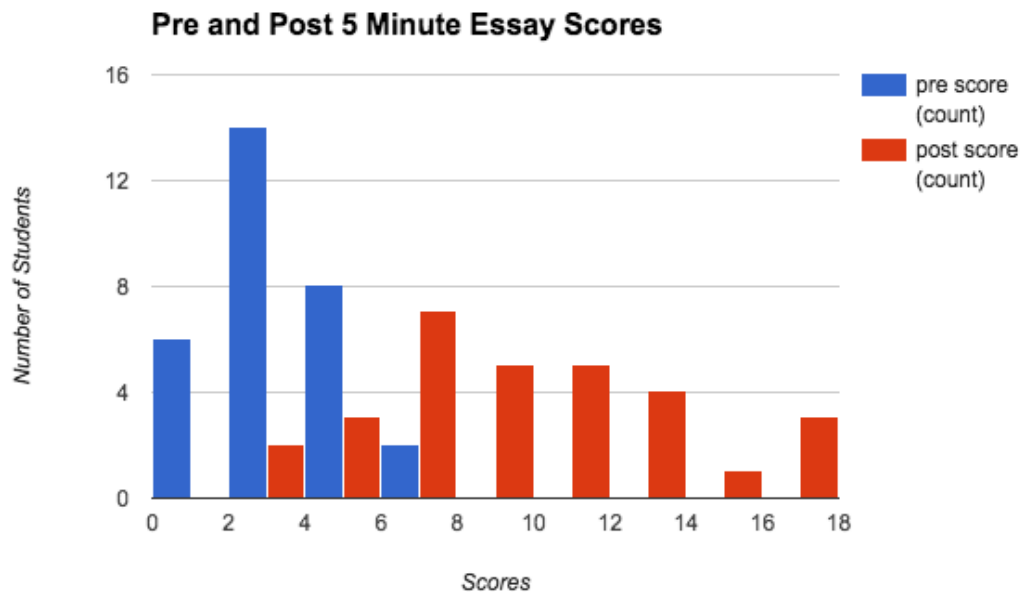


Figure 5. Results of the pre and post five minute essay questions, ($N = 31$).

Quiz Grades.

Students were given two quizzes, one on DNA and DNA replication, the other one was on Protein synthesis. For the DNA replication quiz the classes that received the intervention had an average of 86.28% (with one failure) and 76.43% (with four failures). The same quiz was given to another one of my classes that did not receive the treatment, they were taught using a traditional method of teacher led- instruction. This traditional class had an average of 86.22% (with three failures) see figure 6. For the protein synthesis quiz, the averages for the two treatment groups were 88.1% and 85.7% compared to the traditional class which was 86.6% (see figure 7). The academic achievement as measured by these quizzes is comparable between all three classes.

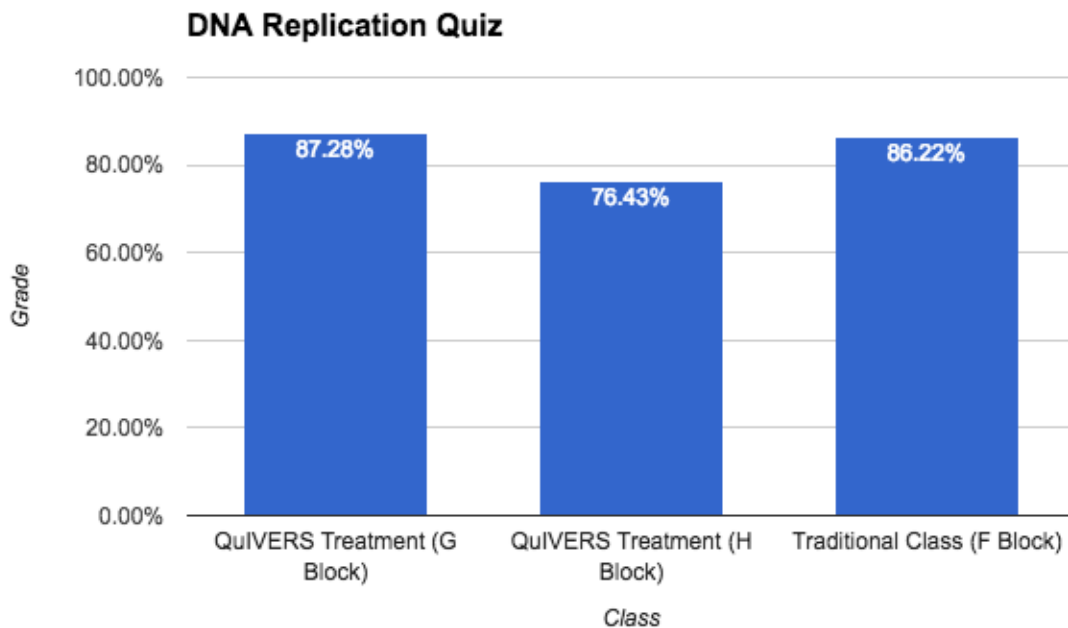


Figure 6. Scores on DNA Replication quiz for the two treatment classes and one traditional class, ($N = 16$ in each class).

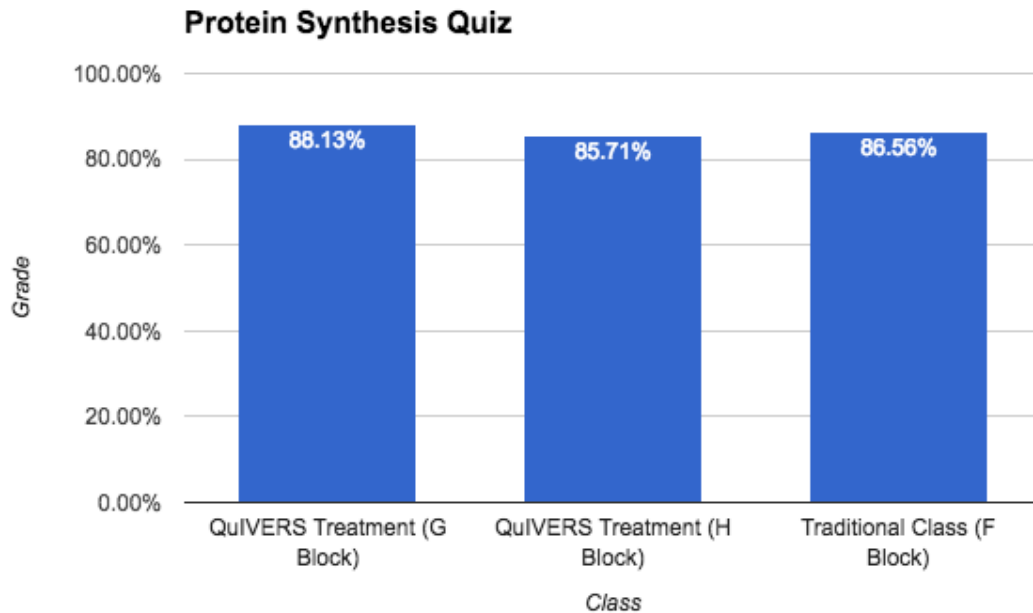


Figure 7. Scores on proteins synthesis quiz for the two treatment classes and one traditional class, ($N = 16$ in each class).

Test Grades

The same final test on the material was given to the two treatment classes as well as the traditional class. The average grades for the treatment classes were 84.6% and 82.4% while the average grade for the traditional class was 86.4%. One thing that was interesting about this data is the average of my H block (82.4%) is much higher compared to their previous two tests. My H block class scored 6 and 8 points below the total average on their previous two tests, but for this test, they are only 2 points below the total average (figure 8). The important take-away from this grade comparison is that the QuIVERS method provides close to the same amount of academic achievement as a traditional class overall but improved the grades of my lowest scoring class.

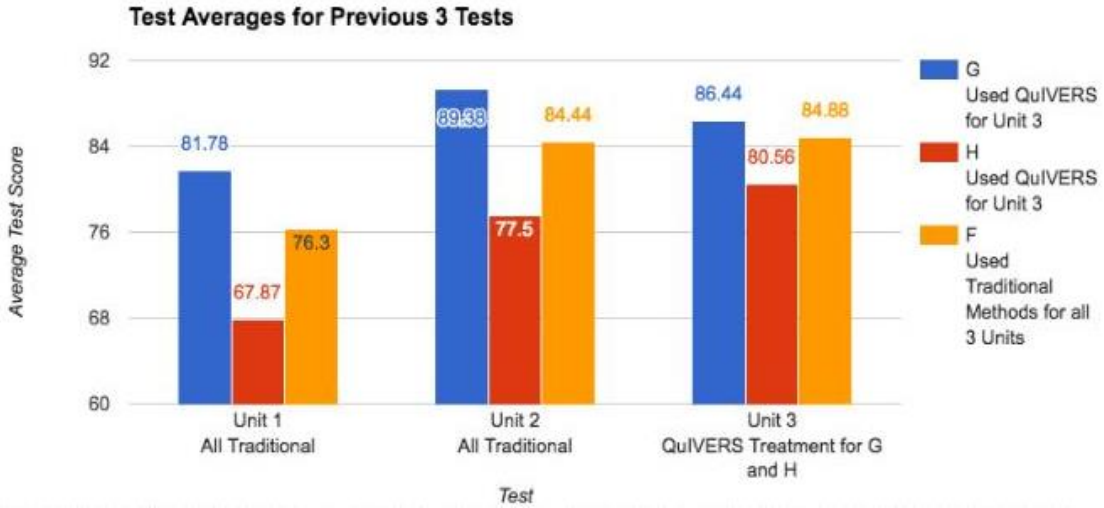


Figure 8. This figure shows the average test scores for the past three tests for all classes. Classes G and H were part of the treatment group for unit 3 while class F was taught using the traditional method for all 3 units. This graph shows that the QuIVERS method seemed to work best for the lowest scoring class, H block.

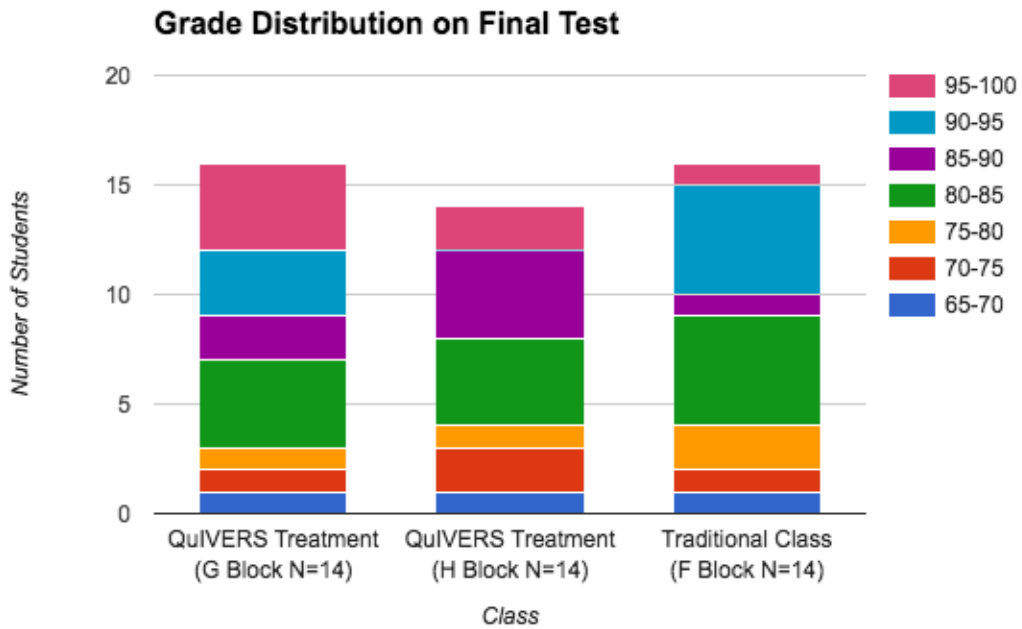


Figure 9. Grade distribution for each class on the final test, (N= 46).

Lab analysis and conclusion

Students turned in two lab write ups as part of their investigation section, they were on the Griffiths lab and the Hershey and Chase lab. Students were required to use the claim, evidence, reasoning format (Brunsell, 2012) for their analysis section and I focused on this section to assess their understanding of the lab. This lab was done in small groups of about five students. I asked them questions as we re-enacted the Griffith's experiment using paper mice and bacteria. Students had to figure out what caused the mix of non-virulent bacteria and heat-killed virulent bacteria to kill the mouse. This was very challenging but all groups eventually figured out that *something* must have been transferred from the dead virulent strain to the non-virulent strain, causing it to become virulent, this “something” is our genetic material. We came up with this claim together and students finished the analysis and conclusion on their own. Overall most students demonstrated a strong understanding of the lab and the class averages for the analysis section were 92% and 83%. Most students were able to provide clear evidence to support their claim but some struggled with the reasoning section. Figure 10 shows an example of student work that shows a clear understanding of the lab.

Claim: Some virulent information transferred from the heat killed virulent to the non-virulent and caused the non-virulent bacteria to become virulent


Evidence: The mouse that was swabbed with the non-virulent bacteria lived and the mouse with the virulent heat killed bacteria also lived. But the mouse that was swabbed with the heat killed virulent and the non-virulent bacteria did not live.

Reasoning: For the mix of heat killed virulent and non-virulent bacteria to kill the mouse, then ^{virulent} information from the heat killed bacteria must have transferred to the non-virulent and made it virulent. Without this transfer, the bacteria of both heat killed and non-virulent would remain harmless, proven by their lack of virulence in earlier tests.

Figure 10. Screen shot from the analysis section of a student's Griffiths lab write up.

Also part of the Investigation section, I met with students in small groups to do a mock reenactment of the Hershey and Chase experiment which identified DNA as the hereditary material. Students did background research on viruses and radioactive isotopes and then when we met they helped design the lab to test if DNA or proteins are the genetic material. We reenacted the lab using oil to mimic *E. coli* cells, red alcohol to represent protein labeled virus and green water to represent DNA labeled virus. I looked at the analysis section which students again had to answer using the claim, evidence, reasoning format, to assess for understanding. We came up with our claim together in class which was “DNA is the genetic material” and students had to write the rest of the analysis and conclusion independently. One of my classes did a great job on these sections (see student work in figure 11) but the other class struggled with their evidence section. Overall students struggled with this lab on their own but meeting in our review session at the end of the unit helped clarify the results.

data:



This shows that DNA is what the Genetic material of the virus is. Because the DNA is with the cells

Analysis:

Claim- DNA is the genetic material that's injected into the cell

evidence - The cells were green after using the centrifuge to separate the virus and cells.

reasoning- This is shown because when the cells were separated DNA was present within the cells and we know this because the cells were green. They were green because the DNA was tagged with phosphorus 32 which made it green.

Figure 11. Screen shot of one student's data and analysis section from the write up for the Hershey and Chase Lab.

Resilience

While students didn't show an increase in resilience thinking according to the survey, they did exhibit resilience behavior in their classwork and their responses to interview questions. Some students felt they had to work harder on problems because they knew that I wasn't going to tell them the answer in class. They also showed that they were getting better at working independently on challenging work as the unit went on. Overall, students demonstrated some increase in resilience with challenging assignments and over a longer intervention this could improve even more.

Survey results

In the survey there were questions that asked about dealing with difficult problems. Both of these questions were worded using the fixed mindset or low level of resilience, they were reverse scored and then added together to get a resilience score of two (least resilient) to 12 (most resilient). The resilience scores were compared before

and after for each student and showed an average difference of 0.125 which is not significant. The questions used were:

- "I feel that if I don't understand something after a few minutes I won't understand it no matter how hard I try."
- "If I don't know how to solve a problem I will most likely wait to solve it until someone explains it to me to avoid getting it wrong. "

The fact that this score remains unchanged shows that QuIVERS does not have an overall impact on student resilience towards difficult problems.

Student interviews and Class Discussion

In my student interviews I asked students if they worked longer on challenging problems while working on QuIVERS. Both Julia and Sarah agreed that they worked longer on challenging problems than they would have normally while Julianna felt like she worked about the same amount of time. When I asked my classes this question one of my classes felt like there was no change for them, the other class felt like you had to stick with challenging problems more because you couldn't just go into class the next day and get the answer.

The two classes seemed to differ in how they dealt with difficult assignments. My G period class said they didn't skip any assignments while my H period class admitted to skipping assignments when they were challenging. A student in my H period class said, "I'm just gonna skip it and go to the next question and go back if I have time." People agree with this student and admitted to skipping these difficult questions. I asked them why they felt the need to skip things and they said, "it seemed like at first if you see

something you aren't familiar with you get a little nervous, (you say) you know what I'm gonna skip this for now and come back later, you're not comfortable." Another student said it was similar to what you do on a quiz, if you don't know the answer to a question you move on and look for answers to it later on in the quiz. Most students agreed that if they found it challenging they figured they should just skip it and try to figure out the answer from the next assignment. Based on our class discussions it seemed like there was more resilience in my class G block class than my H block class.

My Observations

I noticed that at the beginning students seem very reluctant to attempt to answer difficult questions. At the beginning of the Investigation section we did a lab on the Hershey and Chase experiment. I asked students to do some background research on viruses and radioactive isotopes and told them the question we were trying to answer was "Is DNA or protein the hereditary material?" I then asked students to design an experiment using viruses and radioactive isotopes to answer this question. I didn't expect students to be able to come up with the Hershey and Chase lab but I did expect them to come up with something that would test our question. Most students felt that this was too hard to figure out on their own and either read ahead in the book to the Hershey and Chase experiment and filled out what they did, or they didn't attempt it at all. When I asked them what they came up with many students admitted that they didn't come up with anything.

During the Investigation labs where we met in small groups students were very reluctant to answer questions. It was unclear to me if they didn't do the preparation or

were just not confidence in their answers. I met with one group for almost 80 minutes because they were so reluctant to participate in the lab. They were silent and tried to wait for me to tell them the answers so we could move on. After lots of waiting they began to participate and complete the lab. This unwillingness to participate shows the lack of resilience when faced with a challenging question.

As the QuIVERS method went on, and I met with students in small review groups they were much more willing to talk and participate. I noticed that they were acting much more independently and less reliant on me for answers.

Student Enjoyment

Students were very conflicted about this new teaching method. While they loved the self-pacing and reduced homework, they felt the assignments were challenging and often struggled teaching themselves the material.

Midway feedback

At the end of the first unit students were asked to write down their thoughts on the use of QuIVERS. I gave them some informal prompting asking them,

- Do you like it?
- What do you like what don't you like?
- What would you change?
- Do you feel like you are understanding the material?

Student Overall Opinion (Midway)

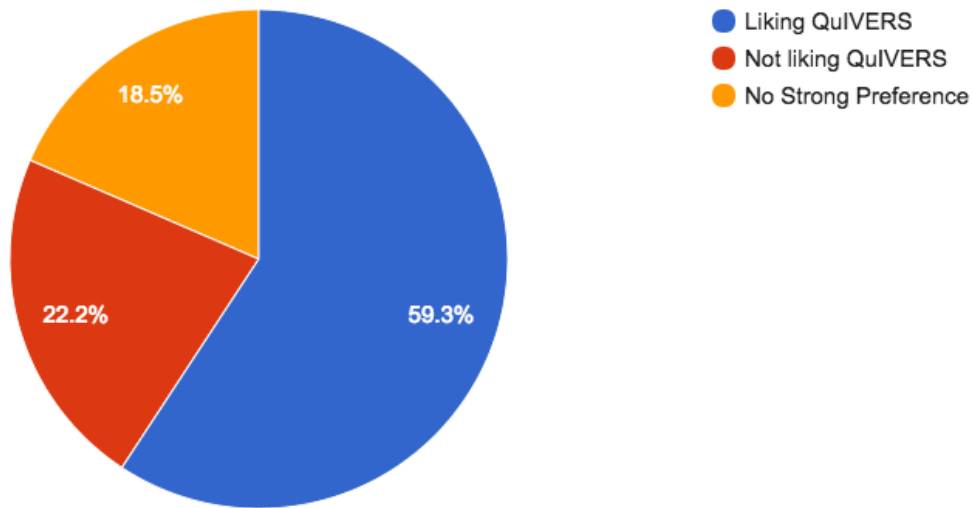


Figure 12. Results of student ($N=27$) feedback on QuIVERS halfway through the intervention.

At the halfway point Figure 12 shows 59.3% of students said they liked using QuIVERS and 22.2% said they didn't. Five students (18.5%) listed positive and negative feedback without a strong opinion either way. Because this was an open response survey, I got lots of different answers about what they liked and what they didn't like about QuIVERS. The most common pieces of positive feedback were that students liked working at their own pace, they liked working on the labs in small groups with me, they felt like it was less stressful and they liked having enough time to keep up with the work (figure 13).

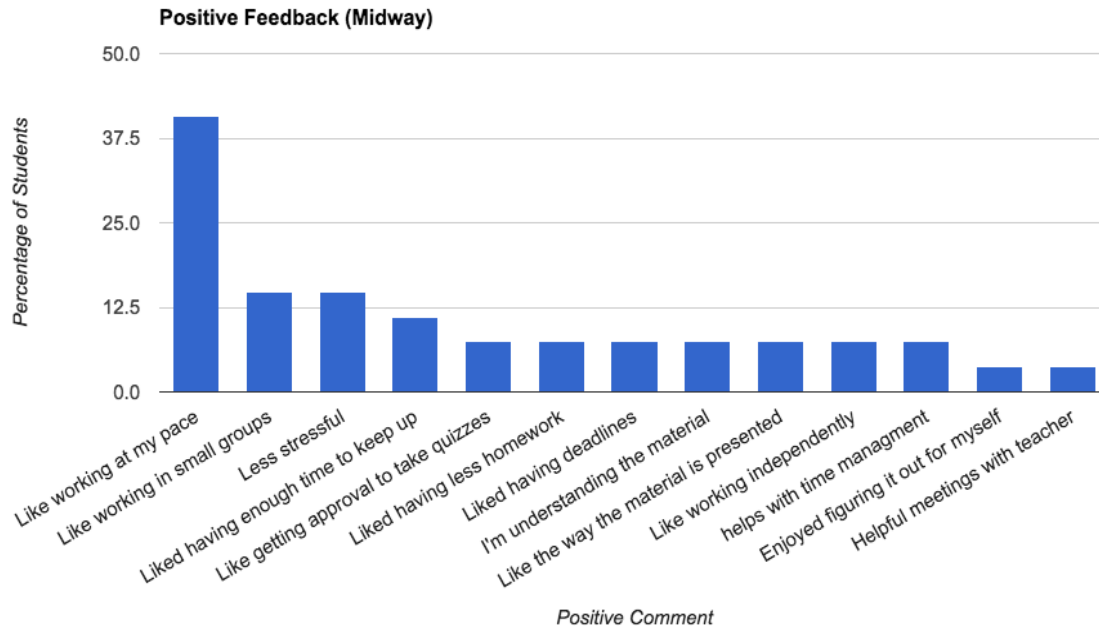


Figure 13. Positive comments from students ($N=27$) about QuIVERS halfway through the intervention.

Even though most students said they liked the method overall they had lots of negative comments to share. The most frequent negative comments were they missed taking notes as a class, they felt that they were having a hard time understanding the material, they didn't like waiting to meet with me, they felt confused about some of the assignments and they felt that it was difficult to teach themselves the material (figure 14). Students had to meet with me as part of the intervention step to work on labs in small groups. Sometimes there was a backlog of students waiting to meet with me. This was a problem that I fixed in Unit 2 by not requiring students to meet with me as much. Overall students felt like they were struggling on their own to take organized notes, complete assignments and teach themselves the material. Students were used to me guiding them through all of these things so it makes sense they felt unsure about their abilities to develop these skills.

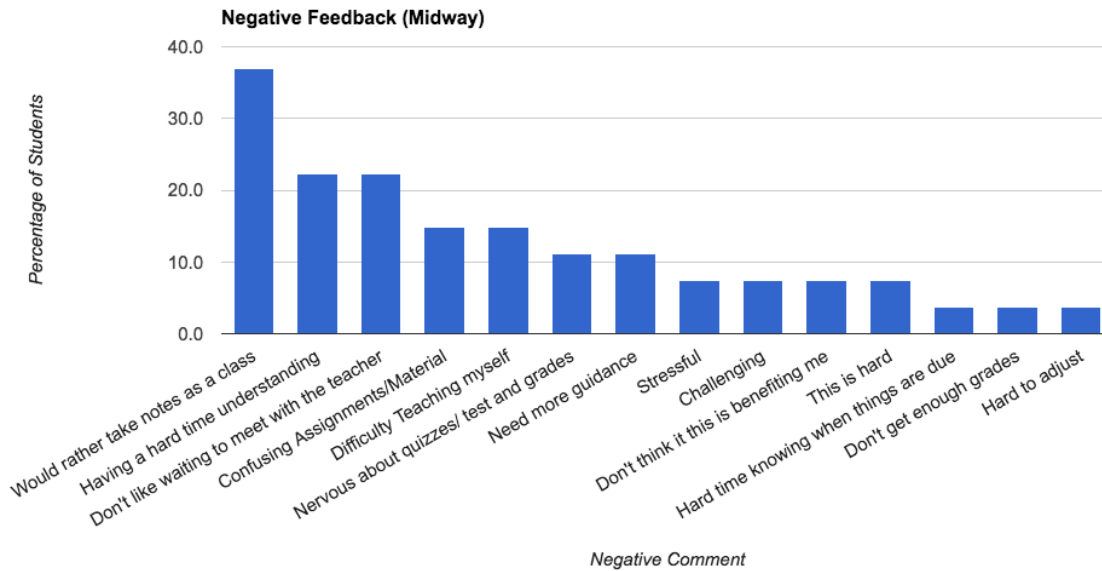


Figure 14. Negative comments from students ($N=27$) about QuIVERS halfway through the intervention.

At the halfway point students really appreciated the self paced and more “relaxed” work load but were not comfortable working independently. They felt like they weren’t understanding it without me explaining it to them and they missed my notes telling them exactly what they needed to know for the test. At the time of this survey they hadn’t met with me to review the material so they were feeling nervous about the quiz and test. At the end of the intervention as part of their final survey, they answered some questions about what they liked and didn’t like about QuIVERS. Students were able to chose from a list of comments the things they liked and didn’t like about the method. These comments were from the feedback I got from them at the halfway point. In the survey all students were asked to check a box next to each comment they agreed with so it is hard to compare the numbers of student responses from the halfway point which was an open response assessment. Just because a student felt a certain way doesn’t mean they wrote

about in the free-form response I asked for the first time.

Overall Opinion of QuIVERS

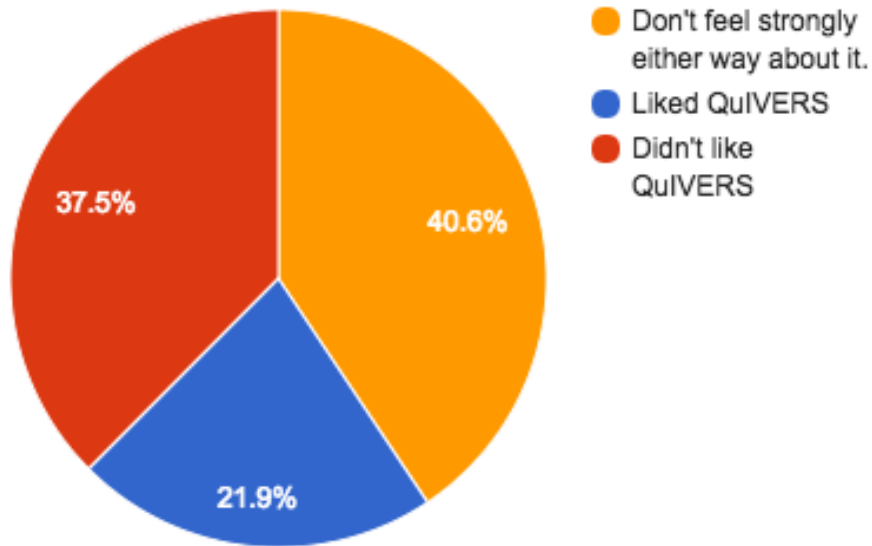


Figure 15. Overall student ($N=32$) response to the QuIVERS method.

Would you like to try QuIVERS again for another chapter?

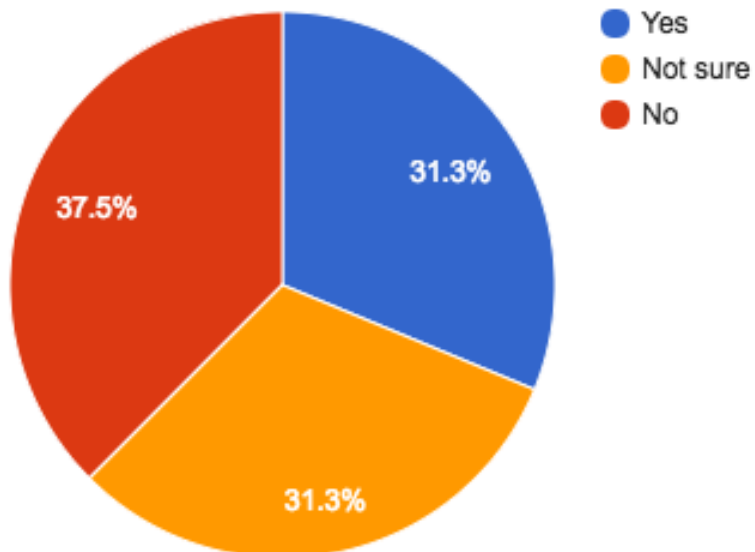


Figure 16. Response from students about trying QuIVERS for another chapter.

Overall students didn't feel a strong like or dislike for the QuIVERS method and this came across in their feedback because most students had many comments to share both positive and negative. When asked if they would like to try it again for another chapter they answered almost evenly Yes, No and Not sure (see figure 16). In the final survey I wrote up the positive and negative comments from the midway point and asked them to check as many as they agreed with.

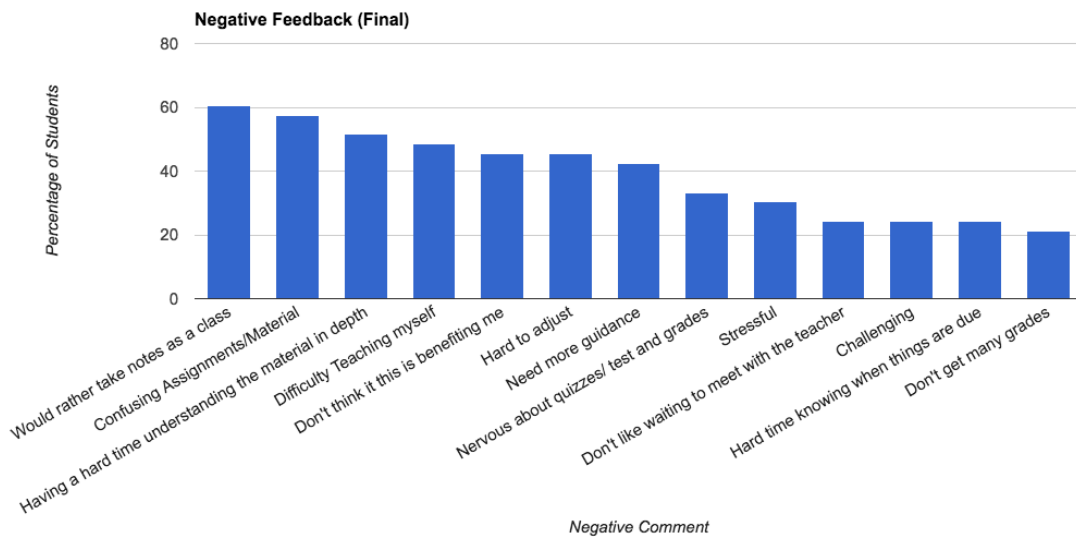


Figure 17. Negative comments from students ($N=32$) about QuIVERS at the end of the intervention.

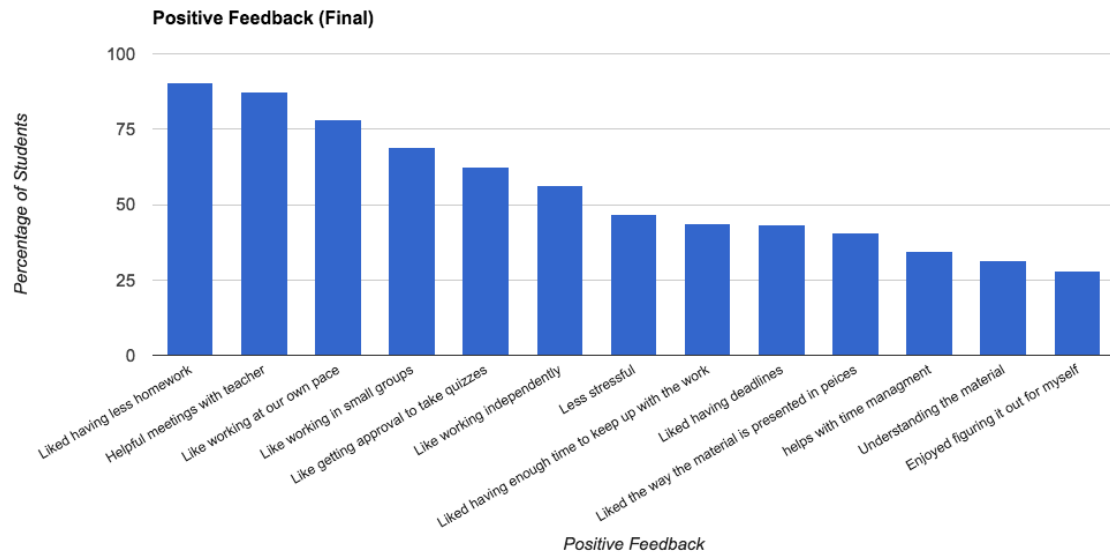


Figure 18. Positive comments from students ($N = 32$) about QuIVERS at the end of the intervention.

It is hard to compare the actual percentages of students at the halfway point and the final survey but we can look at the five most popular comments in each. There were three out of the top five positive comments overlapped between the halfway point and the final, these were; “liked working at our own pace, liked working in small groups, and like getting approval to take the quizzes.” The two comments that were popular at the halfway point but less so in the final (less than 50%) were that it was less stressful and they “liked having enough time to complete assignments”. The two most popular positive comments in the final survey were they liked “having less homework” and they “liked the helpful meetings with the teacher.” It makes sense that these showed up only in the final survey because at the halfway point survey they hadn’t met with me yet for a review session.

There is only one difference in the top five negative comments between the halfway point and the final survey. The four common comments in both cases are ‘I would rather take notes as a class’, “The assignments/material is confusing” and “I’m

having a difficult time teaching myself”. At the halfway point the last most common comment was they didn’t like waiting to meet with me. This isn’t surprising because this was a timing problem in the first unit that was fixed in the second unit by requiring them to meet with me less. The fifth most common comment in the final survey is “I don’t think this is benefiting me.” Overall, most of the negative comments centered around students feeling like they were struggling teaching themselves and wanting more help and guidance from me for assignments and note-taking.

Class Discussion and Student Interviews

Based on the class discussions there were a number of positive and negative comments about QuIVERS. One class said they didn’t enjoy this method at the beginning but towards the end they began to like it. They felt like after they knew what to do it got easier, the second unit was easier. The best parts of this technique were the less stressful pacing, taking the quizzes before the test, and the small group reviews before the quizzes. In the student interviews Julianna said the best part was the labs in small groups. Sarah said she liked having enough time to get things done and go at a pace that helped her make sure she understood it. Erin said her favorite part was that there was no pressure and she could work at her own pace. Julia said it was less homework and less stress.

In the class discussions students said the most challenging part was doing all the work independently and teaching themselves. One student said, “We’re 14/15 year old girls, we don’t know everything about science.” Another student said, “I wanted the teacher to tell us what we needed to know.” Lots of students felt that taking notes was hard because they felt like they didn’t know what was important. In her interview Erin

said “I felt like I learned the material but I didn’t feel ready for the quizzes or tests. I wanted you to tell it to me so I felt more comfortable.” Many students in the discussion echoed Erin’s sentiment, at times they were frustrated, confused and were worried about making mistakes learning the material. One student said, “I didn’t understand it and I had to teach myself it and I didn’t know how.” Many students also felt that it would just be a lot easier if I could just explain things to them. The biggest complaint for students was that they struggled teaching themselves the material.

INTERPRETATION AND CONCLUSION

Overall I am happy with the results of this intervention. The QuIVERS teaching method showed:

- An increase in growth mindset for students who started with a fixed mindset.
- An increase in understanding of content over the course of the treatment but not necessarily more than a traditional method of instruction.
- No change in student resilience overall but an increase towards the end of this treatment.
- Some positive feedback about this teaching style from students.

My primary question was “Is there an increase in growth mindset vs fixed mindset? I was most excited about this result because of the correlation between a low initial GM and a large increase in GM. Throughout the course of QuIVERS the four students who started with a fixed mindset shifted their thinking towards a growth mindset (see figure 2). Carol Dweck’s (2006) work shows that this is an important shift because

having a growth mindset allows students to reach their full learning potential. The focus on independent learning forced students to take a much more active role in learning the material. When they were able to see that they were capable of teaching themselves new things they became more convinced of their ability to improve their own intelligence. Julia mirrored this sentiment in her interview when she said she was surprised by what she was able to accomplish. Another student said she was also impressed with how much she was able to teach herself when she wrote the 5-minute essay the second time. Both classes agreed that if they kept doing QuIVERS they would get better at teaching themselves the material. The survey showed that most of the students had a growth mindset at the start of QuIVERS but four of them developed one as a result of this teaching method (figure 4).

It was interesting to find that while most of the class had a growth mindset, the majority of them believed in the fixed mindset idea that people are either naturally good or not good at science. It seems that they believe they can work hard at it and are capable of learning but they think that the material is easier for some students over others. This idea didn't change over the span of the intervention and it is something I look forward to exploring with my students.

Students showed an increase in an understanding of the content based on the 6.2 point increase of scores of the five minute essays. Students were given a point for every correct fact they wrote about DNA and DNA replication. The initial average shows that students didn't know much about the subject matter before we started, only writing down two or three correct facts most often the simplest facts (DNA is a double helix, there are

four bases, it is made of nucleotides, it is the genetic material). At the end of the intervention students showed a much deeper understanding of the material, filling the whole page with details about the structure of DNA, explanations of how it replicates and the names of important scientists.

The lab grades showed that while most students understood the labs, some were struggling with writing clear and correct analysis sections. The students who were struggling were mostly able to clear up their confusion in small group review sessions.

It is hard to compare the effectiveness of this teaching method to a traditional teaching method in terms of improving academic achievement because pre and post tests were not done for the quizzes and tests. I included the scores from my traditionally taught class for reference to show the typical average on these quizzes and tests.

Table 3.
Grade Comparison For Each Class

Class	Assignment	Class Average
G Block (Quivers Treatment N=16)	DNA and DNA replication Quiz	87.28
H Block (Quivers Treatment N=16)	DNA and DNA replication Quiz	76.43
F Block (Traditional Classroom N=16)	DNA and DNA replication Quiz	86.22
G Block (Quivers Treatment N=16)	Protein Synthesis Quiz	88.13
H Block (Quivers Treatment N=16)	Protein Synthesis Quiz	85.71
F Block (Traditional Classroom)	Protein Synthesis Quiz	86.56

N=16)		
G Block (Quivers Treatment N=16)	Chapter Test	84.56
H Block (Quivers Treatment N=14)	Chapter Test	82.36
F Block (Traditional Classroom N=16)	Chapter Test	86.44

I did notice an overall improvement on the test scores of my H block students. This is typically my lowest scoring class and on their previous two exams they scored six and nine points below the average of all three classes. For this test they scored two points below the average of all three classes (84%). It is hard to tell, with such limited data, but this method could be responsible for improving the understanding of my lowest scoring students. It stands to reason that these students would benefit the most from the mastery aspect of this teaching. Most students in this class appreciated meeting with me in small groups to review the material before taking the quiz. They also liked the fact that I wouldn't let them move on until they demonstrated an understanding. I appreciated the freedom that this technique gave me to meet with individual students as many times as they needed it to review the material. I know that this helped two of my struggling students who earned their highest test scores of the year, a 81 (previous test scores of 54, 70) and a 71 (previous test scores were both 60). This increase in test averages for my lowest performing students is consistent with Bloom's (1986) improvement using mastery. The survey and the class discussion showed that a number of students felt like they really benefited from these small group review sessions.

Based on the results of the survey, students did not show an increase in resilience thinking. Most students felt like they responded to difficult problems the same way before and after the intervention. However, based on the class discussion and my observations there was a slight increase in resilience towards difficult problems while working on QuIVERS. Some students started the process skipping difficult steps and waiting for me to give them the answers to difficult questions. They said eventually they realized that they had to keep working on difficult problems because they knew they weren't going to get the answers from me in class. I noticed that towards the end of the intervention students were much more likely to discuss difficult ideas without waiting for me to tell them the answer. It seemed like while the QuIVERS method didn't increase their resilience attitude overall, students did show more willingness to work on difficult problems independently.

Overall most students didn't feel strongly for or against QuIVERS. I think that this is because there were a lot of things that they really liked about this method and others they didn't. They felt that QuIVERS made things easier by moving at a slower pace and reducing stress about getting assignments done. On the other hand they felt that QuIVERS made things harder for them. They didn't like it because they felt like it was hard to teach themselves the material. While some students said they felt like they understood it better because they figured it out for themselves, others still just wanted me to tell them what they needed to know so they could memorize it. While they felt like there were getting better at teaching themselves they weren't happy about it. Overall I think this is valuable feedback. I was not surprised to hear students say, "it is better if you

just tell me what I need to know. ” This kind of learning is much harder than memorizing lecture notes so it is expected that students wouldn’t like it as much. I think that on such a short time scale there was a steep learning curve. If students were expected to teach themselves over the course of the whole year I think they would become more comfortable with this student-led learning and enjoy it more. If I were to use this technique again there are changes I would make to help them learn how to teach themselves such as tips on how to read a text book, how to organize their notes and how to pull out the important pieces of information. I would also coach them on strategies for solving difficult problems.

Overall, using the QuIVERS technique was beneficial for me and my students. I saw an increase in growth minded thinking in my fixed mindset students, a strong understanding of the material (especially for struggling students), a small increase in resilience when solving difficult problems and many positive comments from students.

VALUE

The most exciting finding for me was the shift towards growth mindset for fixed mindset students. This correlation was made with only four students who started out with a fixed mindset so I would like to see more evidence collected from a group of more fixed minded students. I was surprised by how many of my students started with a growth mindset. Based on my student’s resistance to difficult problems and taking risks I expected more of them to start out with a fixed mindset. It would be a great senior project to do a survey of our entire student body to see the differences in thinking between grades

and among the faculty. This preliminary finding suggests that more research needs to be done looking at the connection between inquiry student led learning and mindset.

I found that this was a valuable method of learning academic content based on the lab notebooks, quizzes and tests. This is a good method to test for basic understanding of the concepts but I would have liked to see the effectiveness of this method to get students to think independently and apply what they know. If I do this method again I will incorporate a section where students have to apply what they know. I would like to see if this method of teaching prepares students for making models and applying the content to real world situations.

I would also like to see more research done on resilience. It would be interesting to see if long term exposure to student-led teaching would build more resilient students. I was beginning to see some evidence of this behavior but there needs to be a much longer exposure to know for sure, as this is a skill that takes time to build.

When I was setting up this lesson I struggled setting due dates for the assignments I wanted turned in. Because students had to meet with me first, some were able to complete the assignments early while others had less time because they were waiting to meet with me. It seemed like all students turned in work at the same time regardless of when they met with me. If students felt like they were ahead they didn't do any work at home while students who were behind had to do lots of work at home. I asked the students for a suggestion on how to handle this problem while still maintaining a self-paced learning environment. They suggested that when students turn in an assignment they automatically get a due date created for the next assignment. I'm not sure how I

could automate this but it is a great idea to keep students moving forward while letting them set the pace.

One unsolved challenge was working in groups. I put signs around the room for each section and I thought that students would sit in the appropriate section when they got there which would let them work with other people in the same section. I thought that students would move at their own pace and they would be constantly working with new people. For the most part this didn't happen. Students instead started working with a group of about 4 students, that they chose, and stayed with that group through all of the assignments. There were some good things about this because they became familiar with each other and worked well together. The problem with this was that some students felt that it held them back from moving forward while others felt that the group was moving too fast for them to understand a concept. I'm not sure how to redesign this method to provide more flexible student grouping.

Overall I think this is a very promising technique which can be very beneficial for students. I plan to modify and use it again with my students next year. I think that with a little more guidance and a longer timeline, students can become very good at teaching themselves material. Based on their feedback I think there are things I can do next time to help them succeed with this. I would provide more guidance for students on how to teach themselves. I would lead a class discussion and provide some resources on things they can do to help them take notes, read the textbook, keep their information organized and manage their time. Without this guidance many students figured out what they needed to do but there was a steep learning curve. I would like to expand my research about

mindset to the rest of our student body and work with other faculty members to adopt similar inquiry based teaching styles and test their effectiveness. In particular, I'm interested to see how this teaching helps my students apply what they know to make models, solve problems and move beyond just passing a test.

REFERENCES CITED

- Andersen, P. (Bozeman Science). (2012a, April 07). *Transcription and Translation* [Video file]. Retrieved from <https://www.youtube.com/watch?v=h3b9ArupXZg>
- Andersen, P. (Bozeman Science). (2012b, September 13). *Blended learning cycle* [Video file]. Retrieved April 21, 2016, from <https://www.youtube.com/watch?v=-apJDi7cx9o>
- Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit Theories of Intelligence Predict Achievement Across an Adolescent Transition: A Longitudinal Study and an Intervention. *Child Development*, 78(1), 246-263. doi:10.1111/j.1467-8624.2007.00995.x
- Bloom, B. (1986). Learning for mastery. *UCLA CSEIP*, 1(2). Retrieved April 21, 2016, from <http://programs.honolulu.hawaii.edu/intranet/sites/programs.honolulu.hawaii.edu.intranet/files/upstf-student-success-bloom-1968.pdf>
- Brunsell, E. (2012, September 25). Designing science inquiry: Claim + evidence + reasoning = explanation. Retrieved from <http://www.edutopia.org/blog/science-inquiry-claim-evidence-reasoning-eric-brunsell>
- Brunsell, E., & Horejsi, M. (2013). Science 2.0: Gamify AP Biology. *The Science Teacher*, 80(8), 8.
- Bybee, R. W., Taylor, J., Gardner, A., Scotter, P. V., Powell, J. C., Westbrook, A., & Landes, N. (2006, July). The BSCS 5E Instructional Model: Origins and effectiveness, executive summary. Retrieved from http://www.bsos.org/sites/default/files/legacy/BSCS_5E_Instructional_Model-Executive_Summary_0.pdf
- Chan, D. W. (2012). Life Satisfaction, Happiness, and the Growth Mindset of Healthy and Unhealthy Perfectionists Among Hong Kong Chinese Gifted Students. *Roeper Review*, 34(4), 224-233. doi:10.1080/02783193.2012.715333
- Clark, K. (2015). The effects of the Flipped Model of Instruction on student engagement and performance in the secondary mathematics classroom. *Journal of Educators Online*, 12(1).
- Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Ballantine Books.
- Esparza, J., Shumow, L., & Schmidt, J. A. (2014). Growth Mindset of Gifted Seventh Grade Students in Science. *NCSSMST Journal*, spring, 6-13. Retrieved November 22, 2015.

- Flett, G. L., & Hewitt, P. L. (2014). A Proposed Framework For Preventing Perfectionism And Promoting Resilience And Mental Health Among Vulnerable Children And Adolescents. *Psychol. Schs. Psychology in the Schools*, 51(9), 899-912. doi:10.1002/pits.21792
- How to Assess Statistical Significance. (2016, March). Retrieved from <http://www.wikihow.com/Assess-Statistical-Significance>
- Kimberly Bilica (2012) A 5E Nature of Science Introduction: Preparing Students to Learn about Evolution, Science Activities: Classroom Projects and Curriculum Ideas, 49:1, 23-28, DOI: 10.1080/00368121.2011.587035
- Lahey, J. (2015). *The gift of failure: How the best parents learn to let go so their children can succeed*. New York, NY: HarperCollins.
- Moore, A. J., Gillett, M. R., & Steele, M. D. (2014). Fostering Student Engagement with the Flip. *The Mathematics Teacher*, 107(6), 420-425. doi:10.5951/mathteacher.107.6.0420
- Surabian, T. (MrsSTheStudyofLife). (2016, March 16). *DNA replication* [Video file]. Retrieved from <https://www.youtube.com/watch?v=AZkQWWJcDe4>
- TEDx Talks. (2012, April 24). *Classroom game design: Paul Andersen at TEDxBozeman* [Video file]. Retrieved from <https://www.youtube.com/watch?v=4qlYGX0H6Ec>
- University of Washington. (n.d.). T-Tables. Retrieved from <http://faculty.washington.edu/heagerty/Books/Biostatistics/TABLES/t-Tables/>
- Wilson, C. D., Taylor, J. A., Kowalski, S. M., & Carlson, J. (2009). The relative effects and equity of inquiry-based and commonplace science teaching on students' knowledge, reasoning, and argumentation. *J. Res. Sci. Teach. Journal of Research in Science Teaching*, 47(3), 276-301. doi:10.1002/tea.20329

APPENDICES

APPENDIX A
WEBSITE



Mrs. Surabian Biology

Search this site

Mrs Surabian's Classroom

Home

Assignments

1. Question: What is Heredity?
2. Investigate : Griffiths Lab
3. Avery, McCarty, McLeod
4. 1950 Chargaff
5. Hershey and Chase
6. Franklin
7. Watson and Crick
8. DNA Replication Video
9. Book assignment
10. Review DNA
11. Question: How does DNA actually control how we look?
12. Investigation: Read sections 13.1 and 13.2
13. Video: Watch this video and take notes on Protein synthesis
14. Mutation Lab

Contact Me

More Stuff

[Class Announcements](#)

[Classroom Page](#)

Current Poll



Click Here to
Take the Poll

Before we begin our unit please fill out this [survey](#)

The Search for the Hereditary Material

Welcome back to [1928](#).
You are a research scientist and you are working on the very important task of finding the molecule responsible for hereditary. Here is what you know so far:

- The hereditary material is either DNA or Proteins.
- You think it is most likely proteins because they are so much more complex and varied, plus they are so much more interesting than that boring DNA molecule.
- You know that something must be getting transferred between organisms to influence the way they look and behave. You just don't know what it is.
- You know the monomers (or building blocks) of DNA and proteins, you just aren't sure how they combine into polymers.
- Work hard young scientist! You have to be the first one to discover the hereditary material so you can rise to fame and fortune in the scientific field and claim a nobel prize!

Question:
[What is Heredity?](#) due: Friday 3/11 on classroom

Investigate:

- [Griffiths Lab](#) due **Wednesday 3/15** on classroom
- [1944 New Paper by Avery, McCarty and McLeod](#)
- [1950 Chargaff Research](#)
- [1952 Hershey and Chase Lab](#) due **Friday 3/18** on classroom
- [1953 Franklin Research](#)
- 1953 We got scooped! Read this paper from [James Watson and Francis Crick](#).

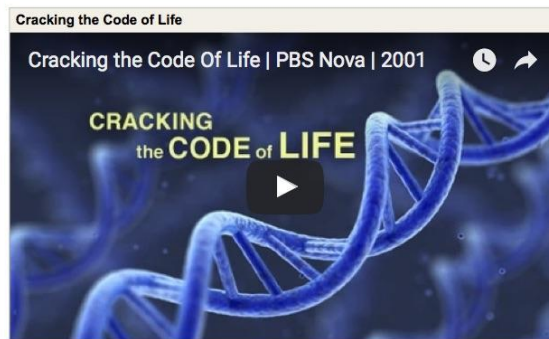
Video:
[Watch this video and take notes on DNA replication](#)

Explanation:
[Read section 12.3 in your book about DNA replication.](#) due **Wednesday March 30th**

Review:
[Make a study guide.](#) Make a study guide on paper (not on your ipad) reviewing everything we have learned about the search for DNA, the structure of DNA and how it replicates.

Optional:

Watch this video about how they read the genome (the sequence of letters on every chromosomes in a single cell).



Question: How does DNA actually control how we look?
Due Friday April 1st

Investigation: Read sections 13.1 and 13.2 about RNA and Protein synthesis.

How is RNA different from DNA? Describe and draw each of the 3 types.
 Describe the process of transcription. What is the goal? How does it happen?
 Describe the process of translation. What is the goal? How does it happen?

Due Tuesday April 5th

Video: Watch the video and take notes on Protein synthesis

Explanation:

- Use the models in class to demonstrate how a protein is made from a genetic sequence. Record each step with a picture in your lab notebook.

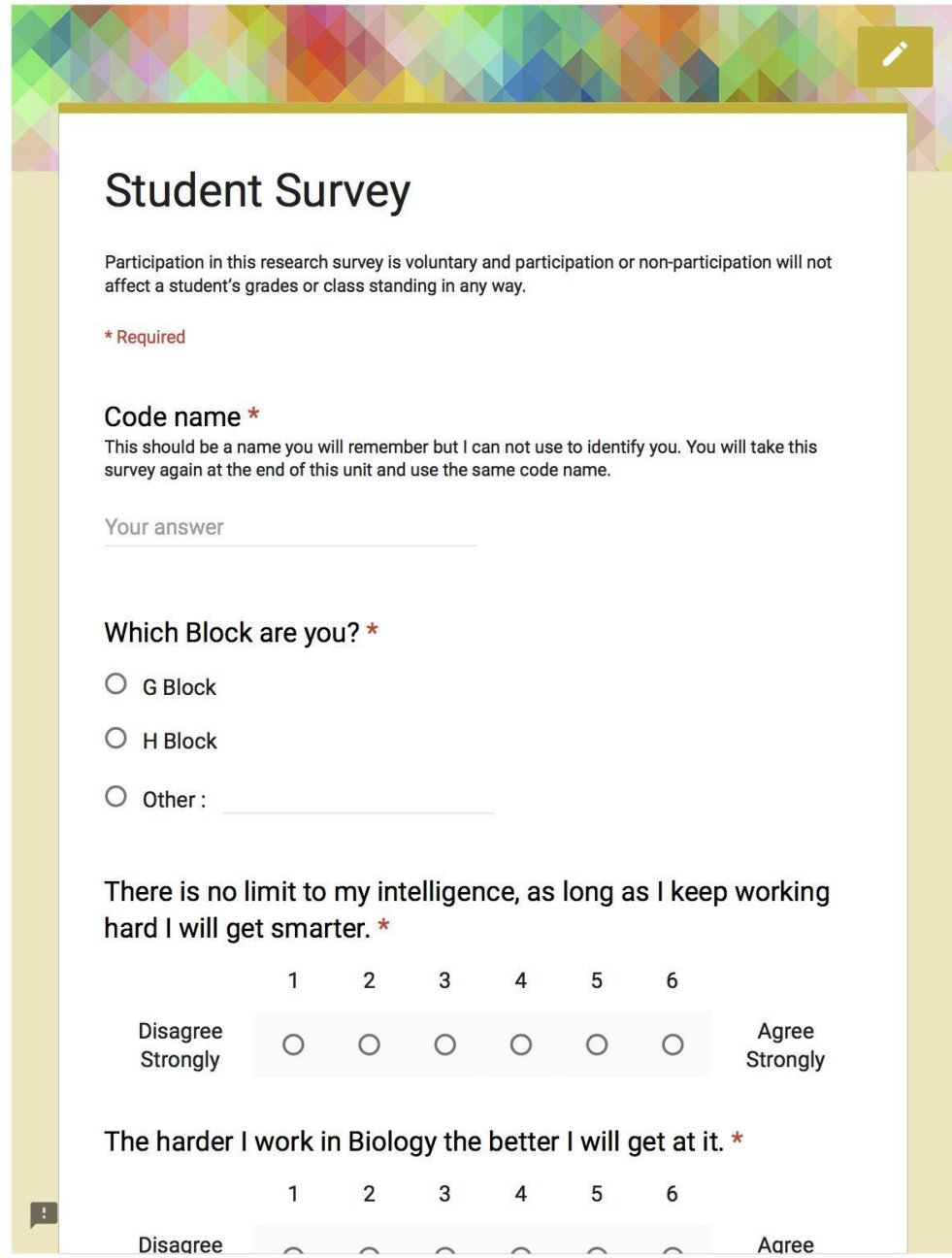
- Do the lab to see what happens when you have a mistake or a mutation in your genetic code. Due April 7th

-Optional: Complete this worksheet on transcription and translation.

Review:

Make a study guide on Protein synthesis bring both of your

APPENDIX B
MINDSET SURVEY



Student Survey

Participation in this research survey is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

*** Required**

Code name *
This should be a name you will remember but I can not use to identify you. You will take this survey again at the end of this unit and use the same code name.

Your answer _____

Which Block are you? *

- G Block
- H Block
- Other : _____

There is no limit to my intelligence, as long as I keep working hard I will get smarter. *

	1	2	3	4	5	6	
Disagree Strongly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree Strongly

The harder I work in Biology the better I will get at it. *

	1	2	3	4	5	6	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Aagree

Strongly

Strongly

I can do well in Biology if I want to do well and I put my mind to it. *

1 2 3 4 5 6

Disagree Strongly

Agree Strongly

I feel like people are naturally good or naturally not good at science. *

1 2 3 4 5 6

Disagree Strongly

Agree Strongly

I feel that it doesn't make much of a difference if I study hard or not, I will get a similar grade. *

1 2 3 4 5 6

Disagree Strongly

Agree Strongly

People are born with a certain amount of intelligence and they really can't do much to change it. *

1 2 3 4 5 6

Disagree Strongly

Agree Strongly

I feel that if I don't understand something after a few minutes I won't understand it no matter how hard I try. *

1 2 3 4 5 6

Disagree

Agree

Strongly

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

Strongly

Failure is a necessary part of solving new problems *

1 2 3 4 5 6

Disagree Strongly

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

Agree Strongly

When I approach a new problem I know I will get some things wrong. *

1 2 3 4 5 6

Disagree Strongly

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

Agree Strongly

If I don't know how to solve a problem I will most likely wait to solve it until someone explains it to me to avoid getting it wrong. *

1 2 3 4 5 6

Disagree Strongly

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

Agree Strongly

When I get a question wrong on an assignment or test I... *

1 2 3 4 5 6

feel bad about myself and my ability to do well in this subject

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

don't feel bad about myself, I know that I am learning.

If I get a bad grade on a test I feel *

1 2 3 4 5 6

That I am not

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

That I need to

as smart as I should be

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

work harder at this subject

When I get back an assignment with lots of wrong answers or corrections I typically *

1 2 3 4 5 6

Go over each of the things I got wrong and try to learn from them

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

Ignore the mistakes because they make me feel dumb

I am confident in my ability to teach myself something new? *

1 2 3 4 5 6

Disagree strongly

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Agree strongly

I feel confident in my ability to solve a problem I haven't seen before? *

1 2 3 4 5 6

Disagree strongly

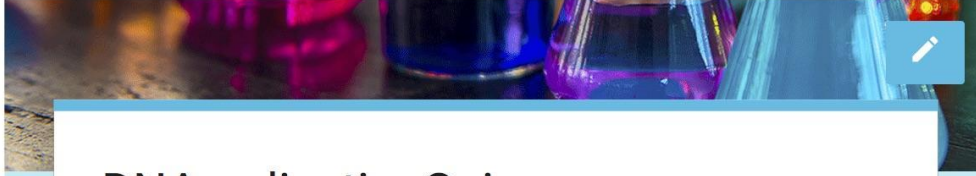
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Agree strongly

NEXT

Never submit passwords through Google Forms.

APPENDIX C
DNA REPLICATION QUIZ



DNAreplicationQuiz

Your username (tsurabian@ursulineacademy.net) will be recorded when you submit this form.
Not you? [Sign out](#)

* Required

Name *

Your answer _____

Block *

G Block

H Block

F Block

_____ were the first ones to put together that DNA is a double-helix and received the Nobel Prize in Medicine in 1962.

Griffiths

Hershey and Chase

Avery, McCarty, McLeod

Messelson and Stahl

Wilkins and Franklin

Watson and Crick

Chergoff

Chargaff

_____ separated out DNA and proteins and proved that when DNA was added to bacteria it changed its appearance.

- Griffiths
- Hershey and Chase
- Avery, McCarty, McLeod
- Messelson and Stahl
- Wilkins and Franklin
- Watson and Crick
- Chargaff

_____ proved that there are always the same number of A's and T's and the same number of G's as C's.

- Griffiths
- Hershey and Chase
- Avery, McCarty, McLeod
- Messelson and Stahl
- Wilkins and Franklin
- Watson and Crick
- Chargaff

_____ proved that DNA was the genetic material by radioactively labeling virus protein and virus DNA and seeing which one the virus injected into bacteria. They are known for using a kitchen blender :-)

_____ proved that DNA replication is semi-conservative using 2 isotopes of Nitrogen.

- Griffiths
- Hershey and Chase
- Avery, McCarty, McLeod
- Messelson and Stahl
- Wilkins and Franklin
- Watson and Crick
- Chargaff

_____ studied pneumococcus bacteria and proved that something was moving from virulent heat killed bacteria to non-virulent bacteria making it become virulent.

- Griffiths
- Hershey and Chase
- Avery, McCarty, McLeod
- Messelson and Stahl
- Wilkins and Franklin
- Watson and Crick
- Chargaff

_____ studied pneumococcus bacteria and proved that something was moving from virulent heat killed bacteria to non-virulent bacteria making it become virulent.

- Griffiths
- Hershey and Chase
- Avery, McCarty, McLeod

- Messelson and Stahl
- Wilkins and Franklin
- Watson and Crick
- Chargaff

_____ took X-ray pictures of DNA and showed it's shape to be a helix.

- Griffiths
- Hershey and Chase
- Avery, McCarty, McLeod
- Messelson and Stahl
- Wilkins and Franklin
- Watson and Crick
- Chargaff

What is attached to the #3 carbon of the sugar in DNA?

- Phosphate
- Base
- OH group
- the base on the opposite strand
- Option 5

What does semi-conservative replication mean?

- When DNA copies itself the new strands are half old, half new.

- When DNA copies itself it results in one strand that is completely old and one that is completely new.
- When DNA copies itself it results in 2 strand where some sections are old and some sections are new.

What is the name of the enzyme used to join nucleotides to make a strand of DNA?

- DNA polymerase
- RNA polymerase
- Helicase
- Ligase

What is the name of the enzyme that unwinds and unzips the DNA?

- DNA polymerase
- RNA polymerase
- Helicase
- Ligase

What does it mean to say that the strands of DNA are antiparallel?

- a. The two strands are parallel and go in the same direction.
- b. If a strand ends with a 5' end the same end on the opposite strand will also end with a 5'
- c. The two strands are parallel and go in opposite directions
- d. If a strand ends with a 5' end the same end on the opposite strand will end with a 3'

- a and b
- c and d

APPENDIX D
PROTEIN SYNTHESIS QUIZ

DNA or RNA?

For each of these questions mark weather the description is for DNA, a specfic type of RNA or all RNA.

Made with Ribose Sugar

- DNA
- mRNA
- tRNA
- rRNA
- all RNA

In the shape of a double helix

- DNA
- mRNA
- tRNA
- rRNA
- all RNA

Contains all the information needed to make all the proteins in an

- DNA

5/1/2016

Protein Synthesis Quiz - Google Forms

- mRNA
- tRNA
- rRNA
- all RNA

Copies information to make one specific protien

- DNA
- mRNA
- tRNA
- rRNA
- all RNA

Makes up the ribosome

- DNA
- mRNA
- tRNA
- rRNA
- all RNA

Reads mRNA and brings the correct amino acid.

5/1/2016

Protein Synthesis Quiz - Google Forms

- DNA
- mRNA
- tRNA
- rRNA
- all RNA

Read in triplicates called codons.

- DNA
- mRNA
- tRNA
- rRNA
- all RNA

Bases are Adenine, Thymine, Guanine and Cytosine.

- DNA
- mRNA
- tRNA
- rRNA
- all RNA

5/1/2016

Protein Synthesis Quiz - Google Forms

Uses Uracil instead of Thymine.

- DNA
- mRNA
- tRNA
- rRNA
- all RNA

After section 2 Continue to next section

Section 3 of 3

Protein Synthesis

Description (optional)

If a DNA sequence reads AAT GCG TGA CGA GTC what is the correct sequence in mRNA?

- AAT GCG TGA CGA GTC
- TTA CGC ACT GCT CAG
- UUA CGC ACU GCU CAG
- AAU GCG UGA CGA GUC

The process of transcription refers to

- Copying DNA
- Making mRNA
- Making a chain of amino acids
- Folding a protien

Transcription happens

- in the nuclues
- in the ribosomes
- Other...

The process of translation refers to

- Copying DNA
- Making mRNA
- Making a chain of amino acids
- Folding a protien

Translation happens

- in the nucleus
- in the ribosomes

5/1/2016

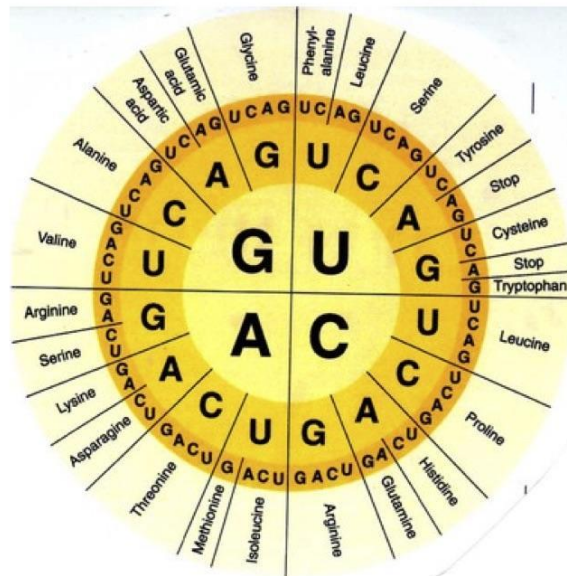
Protein Synthesis Quiz - Google Forms

 Other...

If a mRNA sequence reads AUG GGC AUC GCU what will the amino acid sequence be?

Short answer text

Codon Chart



True or False mRNA copies the whole strand of DNA

- True
- False

All genes start with the amino acid

5/1/2016

Protein Synthesis Quiz - Google Forms

- Met
- Ala
- Stop
- Leu
- Val

A ribosome knows that it is done making a protein when it reads...

- Met
- Ala
- Stop
- Leu
- Val

What is it called when the wrong base placed in a strand of DNA?

- a mutation
- transcription
- translation
- replication

Why is an addition or a deletion more harmful than a substitution?

LONG ANSWER TEXT

APPENDIX E

DNA TEST

Name:
DNA and Protein Synthesis Exam

1. Where does protein synthesis take place in a cell?
 - a. Mitochondria
 - b. Nucleus
 - c. Golgi Apparatus
 - d. Ribosome

2. Which of the following statements is not true of DNA?
 - a. It is made up of four nitrogen bases (adenine, thymine, cytosine, guanine).
 - b. It is a double-helical shaped molecule.
 - c. It contains information for protein synthesis.
 - d. It contains the sugar ribose.

3. The enzyme that adds nucleotides to a replicating DNA molecule is
 - a. DNA polymerase
 - b. RNA polymerase
 - c. catalase
 - d. nucleotidase

4. A portion of one strand of a DNA molecule has the sequence shown below.
ACCTGAAGG
Assuming there are no mutations in this portion of the DNA, what is the corresponding sequence on the complementary DNA strand?
 - a. ACCTGAAGG
 - b. GTTCAGGAA
 - c. TGGACTTCC
 - d. UGACUCC

5. Which is not a step in protein synthesis:
 - a. amino acids are strung together by tRNA in the ribosome
 - b. DNA copies itself.
 - c. completed polypeptide is released from ribosome
 - d. mRNA template is made

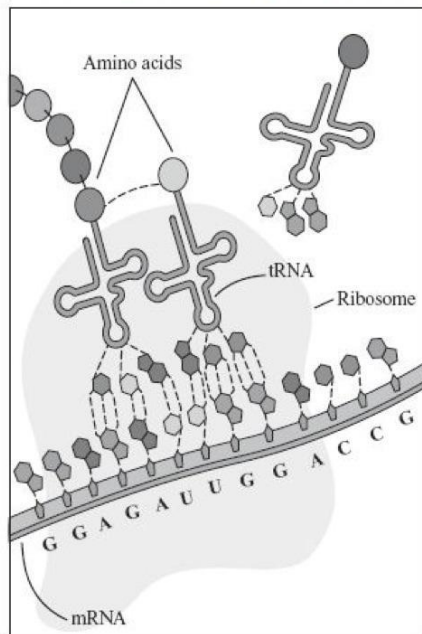
6. the end of the DNA molecule with a phosphate is the
 - a. 5' end
 - b. 3' end
 - c. OH end
 - d. nitrogenous base end

7. Watson and Crick described the DNA molecule as
 - a. branching chain
 - b. straight chain
 - c. single strand
 - d. an antiparallel double helix

8. If the code for an amino acid is ATG on the DNA molecule, the codon on the mRNA molecule may be written as:

- ATG
- UAC
- CTG
- AUG

9. The diagram below represents part of a process that occurs in cells.



What is the name of the process?

- DNA replication
- Transcription
- Translation
- Mitosis

10. Why is the particular sequence of bases in a segment of DNA important to cells?

- Some base sequences code for protein production.
- Some base sequences cause the release of lipids from the nucleus.
- Some base sequences contain the order of sugars in polysaccharides.
- Some base sequences produce electrical signals sent to the cytoplasm.

11. In phenylketonuria (PKU), an enzyme that converts one amino acid into another does not work properly. Which of the following is the most likely cause of this genetic condition?
- an error in the transcription of the gene for the enzyme
 - a mutation in the DNA sequence that codes for the enzyme
 - an excess of the amino acids necessary to produce the enzyme
 - a structural variation in the amino acid modified by the enzyme
12. Specific DNA sequences called "promoters" provide binding sites for the enzyme that synthesizes RNA. Promoters are directly involved in which cellular process?
- active transport
 - crossing over
 - replication
 - transcription
13. Based on the information in your codon chart, which of the following changes is least likely to produce a phenotypic change in an organism?
- GAU to GGU
 - GAU to GUU
 - GAU to GAA
 - GAU to GAC
14. Which type of cell must contain a mutation in order for the mutation to be passed from a woman to her offspring?
- blood cell
 - brain cell
 - skin cell
 - egg cell
15. Fireflies produce light inside their bodies. The enzyme luciferase is involved in the reaction that produces the light. Scientists have isolated the luciferase gene. A scientist inserts the luciferase gene into the DNA of cells from another organism. If these cells produce light, the scientist knows that which of the following occurred?
- The luciferase gene mutated inside the cells.
 - The luciferase gene was transcribed and translated.
 - The luciferase gene destroyed the original genes of the cells.
 - The luciferase gene moved from the nucleus to the endoplasmic reticulum.

Name: _____

Block: _____

Please answer all questions on this page.

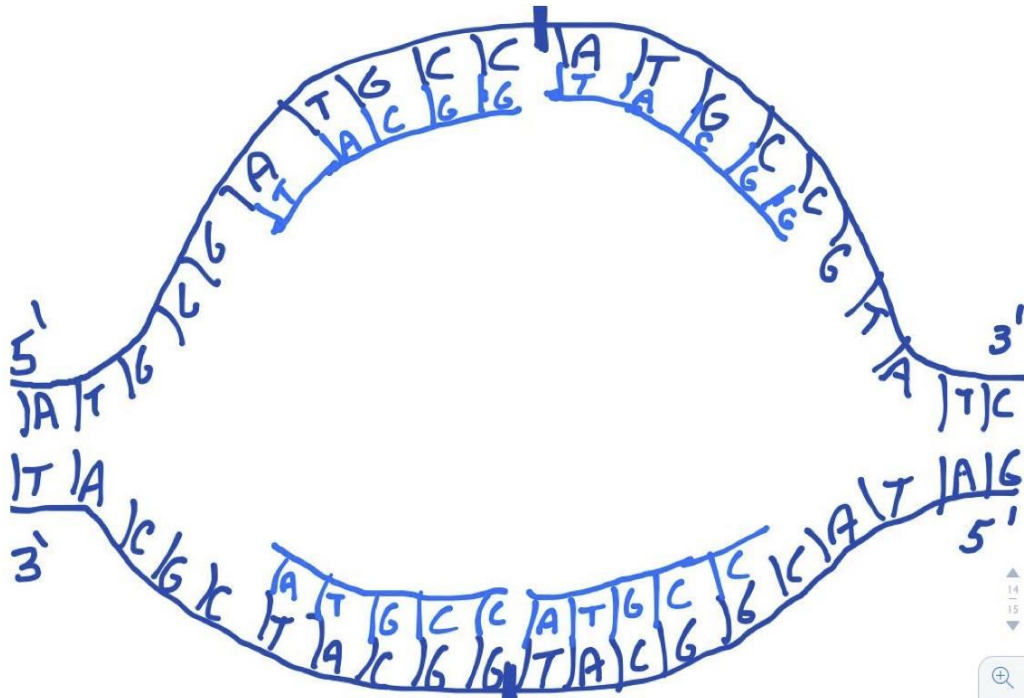
1. _____ Griffiths
 2. _____ Avery, McCarty and McLeod
 3. _____ Hershey and Chase
 4. _____ Chagraff
 5. _____ Wilkins and Franklin
 6. _____ Watson and Crick
 7. _____ Meselson and Stahl
- a. Were the first ones to put together that DNA is a double-helix and received the Nobel Prize in Medicine in 1962.
 - b. Separated out DNA and proteins and proved that when DNA was added to bacteria it changed it's appearance.
 - c. Proved that there are always the same number of A's and T's and the same number of G's as C's.
 - d. Proved that DNA was the genetic material by radioactively labeling virus protein and virus DNA and seeing which one the virus injected into bacteria. They are known for using a kitchen blender :-).
 - e. Proved that DNA replication is semi-conservative using 2 isotopes of Nitrogen.
 - f. Studied pneumococcus bacteria and proved that something was moving from virulent heat killed bacteria to non-virulent bacteria making it become virulent.
 - g. Took X-ray pictures of DNA and showed it's shape to be a helix.

Very Short Answers (You do not need to use complete sentences).

1. Describe three differences between DNA and RNA.
2. Why does transcription only copy a small section of DNA and what is this small section called?
3. Draw and label the 2 main parts of a tRNA molecule and why are they important?

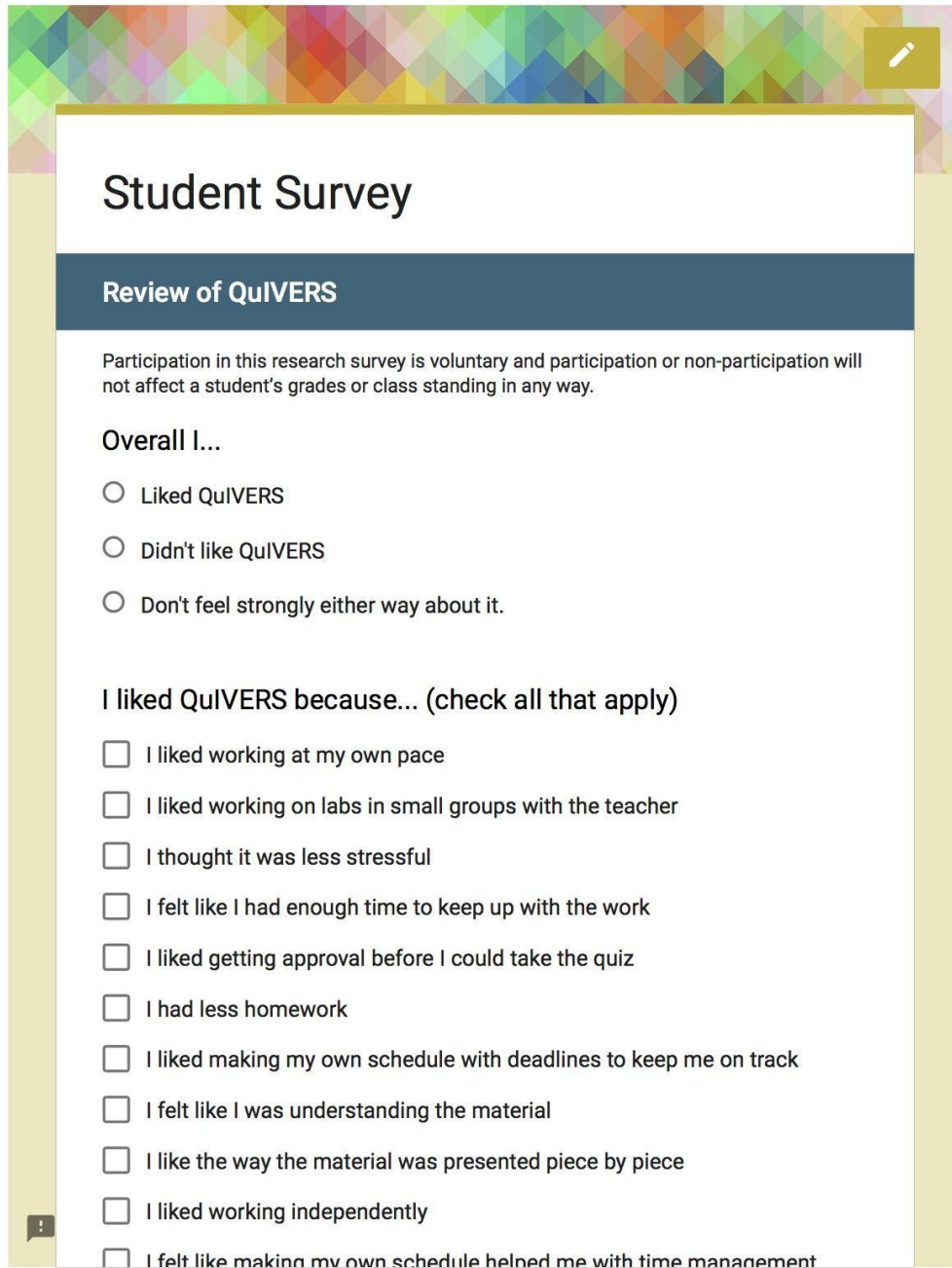
Longer Essay Questions:

1. DNA replication
 - a. What is the goal of DNA replication?
 - b. Label each of the new strands as leading or lagging.



- c. Name two enzymes used in DNA replication and explain what they do.

APPENDIX F
POST UNIT OPINION SURVEY



Student Survey

Review of QuIVERS

Participation in this research survey is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Overall I...

- Liked QuIVERS
- Didn't like QuIVERS
- Don't feel strongly either way about it.

I liked QuIVERS because... (check all that apply)

- I liked working at my own pace
- I liked working on labs in small groups with the teacher
- I thought it was less stressful
- I felt like I had enough time to keep up with the work
- I liked getting approval before I could take the quiz
- I had less homework
- I liked making my own schedule with deadlines to keep me on track
- I felt like I was understanding the material
- I like the way the material was presented piece by piece
- I liked working independently
- I felt like making my own schedule helped me with time management

5/1/2016

Student Survey

I like making my own schedule helped me with time management skills

I enjoyed figuring things out for myself

I felt like the small group meetings with Mrs. Surabian were helpful

Other: _____ 

I didn't like QuIVERS because... (check all that apply)

I would rather take notes as a class

I struggled keeping my notes organized

I struggled knowing what to write down in my notes

I had a hard time understanding the material on my own

I didn't like having to wait to meet with Mrs. Surabian

I wasn't sure how to do some of the assignments

I had a hard time teaching myself the material

I am disappointed in my grades

I felt like I needed more guidance

I found it stressful

I found it challenging

I don't think it benefited me

I had a hard time keeping track of when things were due

I felt like I didn't get enough grades

It was hard to adjust to

Other: _____

I would like to try QuIVERS again for another chapter

Yes

- No
- Not sure

If we were to do it again I would make the following changes

Your answer _____

While we were working on QuIVERS how much time did you spend working on Biology outside of class?

	per week	per night
None	<input type="radio"/>	<input type="radio"/>
0-10 mins	<input type="radio"/>	<input type="radio"/>
10-20 mins	<input type="radio"/>	<input type="radio"/>
20-30 mins	<input type="radio"/>	<input type="radio"/>
30-40 mins	<input type="radio"/>	<input type="radio"/>
40-50 mins	<input type="radio"/>	<input type="radio"/>
50-60mins	<input type="radio"/>	<input type="radio"/>
Over 60 mins	<input type="radio"/>	<input type="radio"/>

Before we were working on QuIVERS how much time did you spend working on Biology outside of class?

per week per night

5/1/2016

Student Survey

None	<input type="radio"/>	<input type="radio"/>
0-10 mins	<input type="radio"/>	<input type="radio"/>
10-20 mins	<input type="radio"/>	<input type="radio"/>
20-30 mins	<input type="radio"/>	<input type="radio"/>
30-40 mins	<input type="radio"/>	<input type="radio"/>
40-50 mins	<input type="radio"/>	<input type="radio"/>
50-60mins	<input type="radio"/>	<input type="radio"/>
Over 60 mins	<input type="radio"/>	<input type="radio"/>

Any other comments about this teaching method?

Your answer

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