THE EFFECTS OF A FLIPPED LEARNING MODEL UTILIZING VARIED TECHNOLOGY VERSES THE TRADITIONAL LEARNING MODEL IN A HIGH SCHOOL BIOLOGY CLASSROOM

by

Donna Raquel Tully

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Masters of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2014

STATEMENT OF PERMISSION TO USE

In presenting this professional paper in partial fulfillment of the requirement of a master's degree at Montana State University, I agree that the MSSE Program shall make it available to borrowers under rules of the program.

Donna Raquel Tully

July 2014

ACKNOWLEDGEMENTS

First and foremost, I am grateful to all my students who supported my research project through their participation and endless patience in completing survey after survey with great enthusiasm. Not only would my project have been impossible without them, but also they have provided me with invaluable feedback to inform my classroom instruction in making improvements to the flipped learning model for all the students that will follow them. Second, I am indebted to John Graves, my project advisor, for always picking up his phone to answer all my questions, and his understanding of life situations. His support and patience have allowed me to comprehensively complete my project. I am also very thankful to my science reader, Terrill Paterson. Not only has he provided me instrumental feedback on my project, he taught me statistics in a way that I can understand and can actually use in my classroom. I am also ever so appreciative of the MSSE program and all the staff, especially Dr. Peggy Taylor and Diana Paterson. Finally, I am thankful for the support from my colleagues and the administration at Kamehameha Schools for approving and supporting my project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

In this classroom research project, students in four high school biology classes were studied over the course of five units for the effects of a flipped learning model utilizing varied technologies verses a traditional teaching model. The pre-treatment units incorporated a traditional learning model whereas the treatment units incorporated a flipped learning model during which students completed homework assignments using varied technologies. A mixed-methods design utilizing both qualitative and quantitative data resources was used to answer the research question. The results using qualitative data of this study provided evidence that a flipped learning model using varied technologies verses the traditional model had effects on student attitudes, preferences, homework completion, comprehension and learning, preparedness, interest, motivation, and engagement. This study also found the flipped model as more effective than the traditional model on student attitudes, preferences, interest and motivation, engagement, homework completion, and preparedness with variable effects on student learning and comprehension, and achievement. Student attitudes toward the flipped learning model were in favor of varied technologies to video-lectures alone. It was found that varied technologies, such as WebQuests, virtual labs, tutorials, animations, and interactive videos are more engaging.

INTRODUCTION AND BACKGROUND

For the past five years, I have been employed as a full-time faculty member at Kamehameha High School, Kapālama Campus, situated in Honolulu, Hawai'i. Kamehameha is a PK-12 Christian non-denominational Protestant school currently serving 5,392 students between three campuses – Kapālama, Hawai'i and Maui. Kapālama campus currently serves 3,196 students, which includes a boarding population of about 400 students (Kamehameha Schools, 2014). The school is a private charitable educational trust endowed in 1887 by the will of Princess Bernice Pau'ahi Bishop (Kamehameha Schools, 2013a). The school gives preference to children of Hawaiian ancestry to the extent allowed by the law. Approximately 15 – 25% of the student body is orphan or indigent (Kamehameha Schools, 2013b). The student body is comprised of one recognized ethnicity – Asian/Pacific Islander (Great Schools, 2013). Educational programs and initiatives are supported by the endowment to include 21st Century Learning. To support this initiative, each student is issued a MacBook Air laptop computer at the beginning of every school year (Kamehameha, 2010). The 21st century learning initiative is built on a framework that involves the blending of content knowledge, specific skills, expertise, and literacies students must master in order to succeed in life and in the work place (P21, 2013).

Students in this study comprised four groups consisting of 86 freshmen, sophomores, and juniors. Based on student grade point average and middle-school exit exam results, approximately 75% of the students in this study were medium to high-level achievers with the remaining 25% performing at the low to medium-level. Based on information provided by students at the beginning of the school year, student career interests varied significantly. Students were either undecided about their professional goals or were seeking careers in diverse science-related and non-science related fields ranging from medicine, engineering, teaching, nursing, sports medicine, law, modeling, and professional sports.

My teaching career began at a rural public school in Marlow, Oklahoma where I taught eighth grade science, high school biology and physical science. After two years, I transitioned my career to Kamehameha Schools, where I have taught the past five years. Throughout the seven years of my teaching, I have primarily taught students exercising a traditional teaching model where students came to class and spent the majority of their time sitting through PowerPoint lecture presentations recording notes as they listened to me do all the talking. The lecture format was the way I was taught through all my years in school so it not only seemed an effective way to teach, it was the only way I knew how to teach. Little time was devoted to engaging students in hands-on activities due to lack of time trying to cover content deemed essential by my colleagues. In addition to the substantial amount of content taught in the classroom, there was a hefty amount of homework assigned in order to reinforce the content. Homework involved completing concept review questions, completing worksheets, writing lab reports, and completing assessments to gauge student comprehension. The complaint I most often heard from my students was the homework load was too heavy, and it was boring. Ultimately, from observations and student feedback, I learned student motivation, engagement, and interest were lacking using this model. While several students stated they enjoyed my lectures and found them helpful for learning content, it was these same students who would return to class the following class day expressing confusion, frustration, and inability to complete homework due to lack of understanding. It became clear student retention of the vast amount of material delivered during lecture was minimal. Although student notes from the previous day's lecture were thorough and accurate, students lacked the ability to synthesize and apply the content. This also became evident in student achievement on quizzes and unit exams, which was highly variable because this method of instruction also does not accommodate for diverse learning styles in students. Last school year, 2012-2013, the flipped learning model was piloted, a reverse technology-driven teaching model that delivers lectures at home through interactive teacher-created videos allowing class time to be used for practice. During the pilot, students completed a video worksheet as they viewed a video lecture that had been created by another colleague. The videos varied in length from 15 to 25 minutes. The overall goal of the flipped learning model was to have students learn content at home allowing for more class time to complete differentiated labs and activities. The ultimate goal of the model was to get students excited about biology and to get them motivated about coming to class to engage in activities that may result in greater understanding and retention of content.

However, after experience and student feedback, it was learned not all students watched the video lectures due to length and detailed content, which left them unprepared for the following day's lab or activity. Additionally, student feedback revealed some found the video lectures boring. These students admitted to not viewing the videos or not entirely engaging in the videos. Through my own observations of the students who did watch the video lectures at home, I found their level of engagement and motivation in class to be much greater, particularly on days with labs and activities. The pilot left me wanting to learn more about the effects of a flipped learning model on my students and how to best implement the model for efficacy.

In carrying out my research, I incorporated a flipped learning model into my biology classroom during the Spring 2014 semester. In this flipped model, homework assignments were not limited to video lectures but also included other technologies. When video lectures were used, they were shortened significantly, ranging in length from five to eight minutes. These modifications were the result of student feedback obtained from verbal interviews and online surveys during the pilot. Of 27 survey responses, 100% of students reported a preference for several short video lectures as opposed to one longer video lecture. When asked what could be done to make the flipped learning model more effective, more engaging, and more interesting, several students reported they preferred a combination of video lectures, virtual labs, and WebQuests for homework. One freshman student shared:

> I like having a variety of things to do for the flipped classroom. I would rather have virtual labs and the web quests [sic] instead of the videos. This is because videos don’t really get us engaged, while with web quests [sic] and labs we have to actually pay attention and know what is happening to do it right.

Another student shared, “I prefer that Ms. Tully does [sic] multiple of things because when you only do one like video lectures it will make it less interesting because you will be doing it over and over again.” Furthermore, all students reported a preference for an increase of in-class activities including labs, group projects, outdoor learning activities, learning games and other hands-on activities.

These experiences led to the creation of my focus question, *What are the effects of a flipped learning model utilizing varied technology verses the traditional learning model in a high school biology classroom?* In addition, the following sub-questions were researched

(1) In what ways is a flipped model more or less effective than the traditional classroom model?

(2) What are student attitudes towards the use of varied technology in a flipped model?

CONCEPTUAL FRAMEWORK

In 2007, chemistry teachers Jonathan Bergmann and Aaron Sams raised the question, "What is the best use of face-to-face time with students?" They found talking at their students for the majority of the day was not the best use of time and concluded students were struggling with difficult concepts and problems. They reasoned the best use of class time centered on engaging students in hands-on, enriching activities and experiences (Bergmann & Sams, 2012a). As a result, they implemented a flipped classroom in which they recorded video lectures their students watched at home via video podcasts, freeing up class time for activities and learning experiences without sacrificing course content. While Bergmann and Sams utilized video lectures when they first implemented their flipped classroom, it is important to note a flipped classroom does not have to have videos and nor do the videos have to be viewed at home. Likewise, the flipped classroom is not an online course, nor is it about replacing teachers with videos. The flipped classroom is a way of facilitating student-teacher interaction in a collaborative environment blended with direct instruction and constructivism where students are engaged in and take ownership of their own learning. The flipped classroom also prevents students who are absent from falling or being left behind. However, before a teacher embarks on the flipped classroom, it is imperative that an equitable learning environment be created. If all students cannot participate due to unequal access to appropriate technology, the teacher should not flip until the issues have been addressed allowing every student equal access and participation (Bergmann & Sams, 2012b).

The goal and key component for the flipped classroom is to place attention on the learner, thus removing attention from the teacher creating a student-centered learning environment. In doing so, students are exposed to and are responsible for acquiring new content knowledge prior to coming to class by means of first exposure (Bergmann & Sams, 2012b). The medium used for the first exposure can vary from textbook readings to lecture videos, podcasts, and screencasts. Another key component of the flipped classroom is to provide students an incentive to prepare for class, such as earning points for completion of a quiz or other assessment. Providing a mechanism to assess student understanding is also key (Brame, 2013). The secondary goals of the flipped method are multifold, driving its adoption in various classrooms as a means of increasing homework completion rates, improving student attitudes toward homework, providing differential learning experiences for students, simplifying the protocol for missed material by students who are absent from class, and creating responsible, independent learners who are in charge of and invested in their learning (Camel, 2011). Another reason for flipping the classroom is this model allows students with multiple learning styles and abilities to learn at their own pace. Also, when lectures become homework, class time is used for collaboration between students and learning concepts through engagement activities and experiential exercises (Gerstein, 2013). For Bergmann and Sams (2012b), this model proved very effective in their classrooms and is highly regarded by students who like watching videos and having the ability to pause and rewind lectures. According to an NSTA survey of science educators who were asked if they had flipped and what their experiences had been, 70% of respondents said they had flipped some or all of their science classes (Petrinjak, 2012). Of those who had flipped, 59% said they were doing more labs, 39% said the number of labs had not changed, and 2% were doing fewer labs. Furthermore, this same NSTA survey quoted several teachers and administrators. According to a middle and high school educator in Costa Rica, "The majority of students respond well to this approach. Students who need extra time when learning a new concept are particularly benefited since they can pause and replay videos as needed" (p. 1). Another high school educator from Texas shared, "Yes! They like being able to pause and rewind when they are taking notes, and they love getting to do more labs in class. The atmosphere is more self-paced, and the class goes by much faster for them because they are engaged" (p. 2). An Indiana high school educator said, "[Students] can do homework as a group more often instead of at home individually. Lessons take half the time because the student watches the lesson the night before and then can be ready for large- or small-group discussions in class" (p. 2). Furthermore, a study by Johnson (2013) looking at student perceptions of the flipped classroom revealed that students were doing less homework than in the traditional classroom and also reported class time was spent more efficiently when the classroom was flipped. With respect to student accomplishment, Marlowe (2012) researched the effect of the flipped classroom on student achievement and stress and found her low performing students showed the greatest increase in semester grades due to greater opportunities for working in small groups and individual teacher interaction that are not possible in the traditional classroom. She also reported a decrease in student stress levels due to the increased class time during which students could independently complete work in class and with the assistance of another student or teacher. Finally, the flipped classroom has been regarded as a step in creating a student-centered classroom. An Alberta, Canada educator stated with this model, students become responsible for their own learning and their own success (Petrinjak, 2012).

Additional benefits of the flipped classroom are it teaches students to take responsibility for their own learning, creates a way to personalize and differentiate the classroom, makes learning the center of the classroom, and provides opportunities for remediation. Furthermore, the flipped classroom increases active learning in which the learner does more than passively listen. The student learns through activities that engage higher-order thinking skills, such as analyzing, evaluating, synthesizing, and problem solving (MacDonald, 2013). A recent comprehensive literature review on flipped learning cited various case studies including one at Byron High School in Minnesota where, after four years following a move to flipped learning, the passing rate for the state mathematics test increased from less than 33% to 74% of students (Hamdan, et al., 2013). At Clintondale High School in Michigan, following a change to the flipped classroom, failure rates dropped by almost 33% and student discipline cases went from 736 in 2009 to 249 in 2010 (Green, 2012; Hamdan, et al., 2013). While quantitative and rigorous qualitative data on flipped learning are both limited, substantial research supports key elements of the model in terms of pedagogical strategies.

Despite its positive attributes and benefits, flipping the classroom does have its drawbacks and concerns. One argument suggested online instruction and lecture prevent opportunity for students to immediately ask questions which would otherwise allow for whole-class discussions (McIntosh, 2011). Other concerns include the lack of Internet accessibility in the homes of certain students, determining which subjects are easily flipped, the potential impact on students if every class were flipped, and the role of the flipped classroom in a time where there is a push for teacher accountability (Bergmann & Wadell, 2012). According to Bergmann, the flipped classroom works best in subjects that are linear, such as science, math, and foreign language (Bergmann & Sams, 2012b). The model is not restricted to specific subjects and has been implemented in entire schools (Hamdan, et al., 2013). An educator from Texas shared in the NSTA survey, "The biggest drawbacks are the prep times needed for teachers to accomplish the flip. I am having a tough time staying ahead of the kids, creating and editing videos, rendering them…so that they are accessible to all students" (Petrinjak, 2012, p. 3). Struggles using this model are also apparent when students fail to watch videos resulting in students being unprepared to participate in classroom activities (Bergmann & Sams, 2012b). Dave Kawecki, a high school physics teacher, addressed this issue by assigning online and in-class quizzes on the video content. Additionally, to raise student interest, he gives a preview of the homework videos at the end of class. At the beginning of class, as a formative assessment tool, he hands out movie tickets to ensure students viewed the video and to identify student questions about content (Brunsell & Horejsi, 2013). It has also been suggested by students video lessons be more interactive with the inclusion of buttons and interactive quizzes to make the experience of watching the video more active

(Johnson, 2013). Furthermore, teachers can incorporate creativity in the classroom with warm-up activities prompting students to ask questions related to the video content (Bergmann & Wadell, 2012). Research by Zappe et al. (2009) on the effects of the flipped classroom to explore active learning suggested the following guidelines for flipping of the classroom:

- Students should be held accountable for viewing the flipped material through the use of "gateway" assessments.
- Flipped materials, especially videos should be relatively short (no longer than 20 - 30 minutes) in order to ensure students watch them.
- Instructors should briefly review flipped course content with students at the beginning of class or activities to ensure the majority of students have sufficient understanding of the materials.
- Flipped materials should include multi-media materials to increase student interest and engagement.

It is important to note a theoretical framework for the flipped learning model has not been established (MacDonald, 2013). Bergmann and Sams (2012b) remind their readers, "there is no single way to flip your classroom – there is no such thing as *the* flipped classroom. There is no specific methodology to be replicated, no checklist to follow" (p. 11). However, since their publication and with increasing research on flipped classrooms, attempts at identifying a theoretical framework have been made. According to Osborn and Vinton (2013), the theoretical framework for flipping a classroom resides in two key components: educational technology and active learning through which students watch lectures at home at their own pace while they communicate in online discussions with their peers and teacher, allowing for concept engagement in the classroom with the teacher as the facilitator. Theoretical frameworks to guide the design of in-class activities have also been considered. Bishop and Verleger (2013) stated, “The theoretical foundations used for justifying the flipped classroom typically focus on reasons for not using classroom time to deliver lectures” (p. 6). The reasons stem from literature on student-centered, cooperative, peer-assisted, experiential, problem-based and active learning theories with constructivism being the source.

Despite the lack of theoretical framework, it is important to note the flipped classroom is an ideology, not a methodology. Brian Bennett (2011) blogged, “Video itself will not help kids achieve more in your class. The flipped classroom is about making connections with learners and differentiating your instruction. If videos are a part of that multi-faceted plan, great. If they are not, still great.” He further wrote, “The video isn’t important. The relationships, the discussions, and the experiences matter” (p. 1). According to Sams, “Anyone who blindly adopts ‘The Flipped Classroom’ (or inquiry, or lecturing, or unschooling, or whatever) model and never modifies it to meet the needs of his or her students will blindly lead his or her students into educational ruin” (Bergman & Sams, 2012b). Hence, when developing an effective flipped learning model, it is important to focus on student needs and not just the video itself.

An essential question currently being asked by educators and administrators is whether or not the flipped learning model works. There are skeptics. In a recent article in USA Today, Atteberry (2013) reported “bad news” for proponents of this model claiming the flipped classroom might not have an impact on learning, drawing conclusions from data collected in a study conducted by four professors at Harvey Mudd College in

Claremont, California. She further claimed benefits of the flipped model are dubious. In response to the article, Darryl Yong, a member of the research team, defended his study stating while they have not seen differences in student outcomes, their study is only in its first year (Hill, 2013). Atteberry also found professors have to spend considerably more time creating and editing video along with developing engaging in-class hands-on activities. She quoted one of the researchers as stating, “Given these drawbacks, the fact that the actual learning outcomes seemed unaffected by the switch suggested that it might not be worth the hassle.” In his review of current literature of 18 selected publications, MacDonald (2013) found a lack of empirical evidence showing a relationship between the flipped learning model and student achievement, suggesting a need for additional research. His claim is further supported by Goodwin and Miller (2013) who, in their review on the flipped classroom, claimed there is no scientific research base to indicate exactly how well the flipped learning model works, although preliminary nonscientific data suggested the model does produce benefits.

Since its inception, the ideology regarding the flipped classroom and flipped learning continues to evolve as evidenced in this literature review. In an effort to dispel the common misconceptions, confusions, and myths about flipped learning, the Flipped Learning Network (FLN, 2014) released in March of 2014 a formal definition of flipped learning, one “crafted” by the governing board and key leaders comprised of experienced flipped educators, including Aaron Sams and Jon Bergmann. According the FLN, the definition for flipped learning is:

> “Flipped Learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting

> group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter” (p. 1).

FLN also pointed out the terms, “Flipped Classroom” and “Flipped Learning” are not interchangeable, in that, a flipped classroom can, but does not always, lead to flipped learning. Hence, while the flipped classroom may have their students learning introductory content through the use of readings and viewing supplementary videos, the distinction between the flipped classroom and flipped learning involves flexible spaces where instruction is learner-centered giving students have choice. Flexible spaces also promote a culture where teachers must evaluate which content they need to teach directly to allow for enriching and engaging classroom activities, where teachers are actively involved in observing students, providing relevant feedback, and where teachers are reflective in their teaching practices constantly striving to improve instruction (Flipped Learning Network, personal communication, March 12, 2014).

METHODOLOGY

Research was conducted on four class periods containing a total of 86 high school level students. Of these, 62 were freshmen, 23 were sophomores, and one was a junior. The research was conducted over the course of five units – evolution (unit 5), microbes, protista and fungi (unit 6), animalia (unit 7), plantae (unit 8), and photosynthesis and cellular respiration (unit 9) – during the 3rd and 4th quarters of the Spring 2014 semester. 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.

A within-subjects study design was used to collect data for analyses and to measure for change in means over two conditions – the pre-treatment and the treatment. The pre-treatment for this study used the traditional learning model where course content and objectives were introduced and delivered through in-class lectures and presentations. The pre-treatment was conducted during the evolution (Pre-treatment 1) and animalia (Pre-treatment 2) units, and was administered on the four class periods simultaneously. The treatment for this study incorporated a flipped learning model in which students were assigned varied technologies, including teacher and non-teacher generated video lectures and virtual activities involving WebQuests, labs, interactives, tutorials, and animations. The treatment was conducted during the microbes, protista and fungi (Treatment 1), plantae (Treatment 2), and photosynthesis and cellular respiration (Treatment 3) units (Table 1).

Table 1
Summary of Pre-treatment and Treatment Units

Study Group	Unit 5 evolution	Unit 6 microbes, protista and fungi	Unit 7 animalia	Unit 8 plantae	Unit 9 photosynthesis & cellular respiration
Periods 2, 4, 6 & 8	Pre-treatment 1	Treatment 1	Pre-treatment 2	Treatment 2	Treatment 3

During treatment units, students were provided with a worksheet assignment, to be completed for homework, followed up with an accountability assessment in the form of a quiz or formative assessment, administered the next class meeting. In most cases, students were permitted to use their completed worksheet for the assessment as an incentive for having completed their homework. No formal in-class lectures were conducted during the treatment. Students were expected to come to class prepared, having completed the flipped assignment worksheet for homework. However, informal question-answer sessions and mini-lectures were conducted when students shared misconceptions, confusion, misunderstandings, or had challenges grasping difficult concepts from the flipped assignment. Furthermore, no specific framework was incorporated in this study. The study focused only on the effects of a flipped learning model, not on how to best implement the model.

A mixed-methods design utilizing both qualitative and quantitative data sources was used to answer the research questions (Table 2).

Table 2
Data Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
Primary questions:			
What are the effects of a flipped learning model utilizing varied technologies in a high school biology classroom?	Teacher-made tests/quizzes	Pre-and post formative assessments	Observance
Secondary questions:			
In what ways is the flipped model utilizing varied technologies more or less effective than the traditional classroom model?	Web-based student surveys	Individual student interviews	Observance
What are student attitudes toward the traditional learning model and flipped learning model using varied technologies?	Web-based student surveys	Individual student interviews	Observance

During the pre- and post-treatment phases of this study, the Student Surveys were administered (Appendix A). The Student Surveys are comprised of the Student Attitudes Survey Regarding This Class and Biology, the Student Attitudes Survey Regarding Varied Technology and The Flipped Learning Model, and the Student Perceptions Survey, which measured for the effects of the flipped learning model on student preference, motivation, engagement and interest, learning and comprehension, achievement, and preparedness. The surveys were administered at different times during the study (Table 3).

Table 3
Summary Table of Student Surveys

Survey Name	Student Attitudes Regarding this Class and Biology	Student Attitudes Regarding Varied Technologies and the Flipped Learning Model	Student Perceptions Survey
Administered	Before Pre-treatment 1 After Post-treatment 1 & 3	After Post-treatment 1 & 3	After Post-treatment 1 & 3

At the beginning of the school year, students completed a non-study related informational sheet containing questions about previous courses, their families, extracurricular activities, and their Internet accessibility, computer usage and experience. A small fraction of information from this sheet was considered in this study. In the rare event a student did not have Internet, the student was instructed to download or view the video or on-line portion of the assignment prior to leaving campus, during their free or study hall period. The Student Surveys utilized the Likert scale of *strongly agree* (SA), *agree* (A), *undecided* (U), *disagree* (D), *strongly disagree* (SD) and open student responses. The surveys were analyzed for common themes and trends. Likert scale categories were collapsed to *agree* (A), *undecided* (U), and *disagree* (D) when the category was less than 5. The pre- and post treatment surveys were also compared to identify significant changes in student responses.

The Student Knowledge Inventory was given to ascertain student misconceptions, preconceptions, and existing knowledge and was administered pre- and post-unit, with post-unit surveys administered on the same day, immediately following each unit exam (Appendix B). In total, five Student Knowledge Inventories were developed specific to each unit, presenting students with various levels of true and false statements and, often, one to five multiple-choice questions. The data collected were used to compare the effectiveness of the two models and the ways in which the model was more or less effective than another. Specifically, mean scores from the pre- and post treatment Student Knowledge Inventory were correlated to unit exam scores to identify patterns and trends. To determine if any of the observed correlations were due to student-favored units, a brief survey in which students voted their most favorite unit was administered in the semester two final exam.

At the end of each unit, teacher-generated unit exams were administered and analyzed for patterns, trends, and growth. Distributional comparison was done looking at quartiles to analyze median unit exam scores for differences between pre-treatment and treatment groups and to determine if the treatment had an effect.

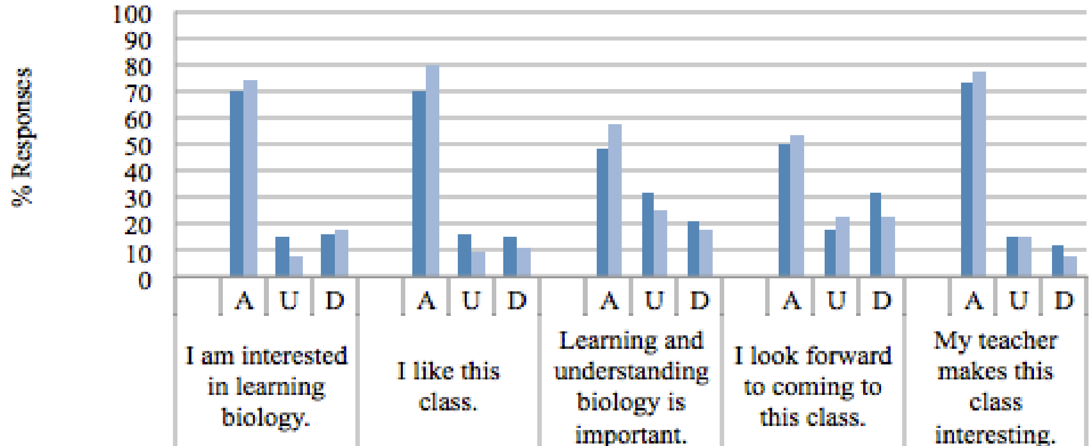
A variety of other methods were also used to determine the most effective model. As an active participant, I carried out observations using the Teacher Observations Sheet (Appendix C), which were analyzed for themes and patterns related to student and group similar behaviors, repeated behaviors, behavioral changes, desired and undesired behaviors, student expression of attitudes, and participation resulting from the traditional classroom model and the flipped learning model with varied technologies.

Additionally, the semi-structured Individual Student Interview was conducted in class (Appendix D). A total of twelve students, three from each class, were chosen at random to participate in the interviews. Student responses from questionnaires and interviews were also used to determine student preference and the effectiveness of varied technologies in the flipped learning model.

Throughout this research study, interim analyses were done to enhance data collection strategies based on unforeseen problems or questions. To draw conclusions from this study, the qualitative data were gathered and recorded in Microsoft Excel, were analyzed for themes and patterns, and were used to generate graphical displays. Using data analysis methods proposed by Hendricks (2013), the qualitative data were compiled, disassembled, reassembled into themes, and interpreted from which conclusions were drawn about the effectiveness of the two models with regard to student attitudes, preferences, interest, motivation, learning and comprehension, achievement, and preparedness. To ensure validity related to the accuracy of the results from this study, the multiple sources of data were also triangulated looking for corroboration between data sets. The results from the data analyses were used to inform teaching methodologies and future practices with regards to the traditional and flipped learning models.

DATA AND ANALYSIS

The results from the Student Attitudes Survey Regarding This Class and Biology showed an increase from 70% (Pre-treatment 1) to 80% (Post-treatment 3) in students who *agreed* they like this biology class (N = 86). Likewise, a 4% increase was found for student interest in learning biology, and a 10% increase *agreeing* learning and understanding biology is important. Furthermore, there was a 30% increase in students *agreeing* they would recommend this course to a friend and/or sibling. Also, 68% reported they *disagree* this class is a waste of their time compared to 77% at Post-treatment 3. One student shared, “This class is not a waste of time because it does indeed teach me a lot about how things in the world function, the study of life and all of the little things that make this world go round." Despite the increases in attitude, only 53% of students *agreed* they look forward to coming to this class despite a 4% increase (from 73% to 77%) in students *agreeing* I make the class interesting (Figure 1).



	I am interested in learning biology.			I like this class.			Learning and understanding biology is important.			I look forward to coming to this class.			My teacher makes this class interesting.		
	A	U	D	A	U	D	A	U	D	A	U	D	A	U	D
Pre-treatment 1	70	15	16	70	16	15	48	32	21	50	18	32	73	15	12
Post-treatment 3	74	8	18	80	9	11	57	25	18	53	23	23	77	15	8

Figure 1. Students' Attitudes about the Class and Biology, *(N*=86*).* D = *disagree*, U = *undecided, and* A = *agree.*

With regard to student attitudes concerning homework, the same survey found an 8% increase, from 42% to 50%, in students *agreeing* they enjoy doing the homework assigned in this class along with a 6% increase, from 74% to 80%, in students *agreeing* they always completing their homework on or before the due date. Likewise, following Post-treatment 3, 83% of student *agreed* the homework assigned helps them to learn and understand content, including difficult concepts, an increase from the Pre-treatment 1 survey findings of 80%.

Survey results from the Student Attitudes Survey Regarding Varied Technologies and The Flipped Learning Model revealed a decreasing trend in preference for varied technologies. For example, student preference for animations, WebQuests, virtual labs, and other digital resources to teacher-generated videos showed a 74% *agreement* at Post-treatment 3 compared to 76% at Post-treatment 1. At Post-treatment 3, there was 74% *agreement* by students of liking to watch video lectures and animations, a decrease from 77%. Still, 14% of students *agreed* for both treatments video lectures and animations were a waste of their time because they did not learn from them, although 71% *disagreed*. A student shared, "I really liked the flipped learning model! I feel like visual animations helped the material stick in my brain alot [sic] better then [sic] in class lectures where i [sic] would usually fall asleep. I suggest using the flipped learning model a lot [sic] more so that if anyone had any questions, they could come to class and ask them." A 6% decrease was also seen in students who *agreed* they prefer NOVA, PBS, or other online videos instead of animations and video lectures. Yet, there was an in increase of 12% in students who *agreed* they like doing WebQuests for homework (Figure 2).

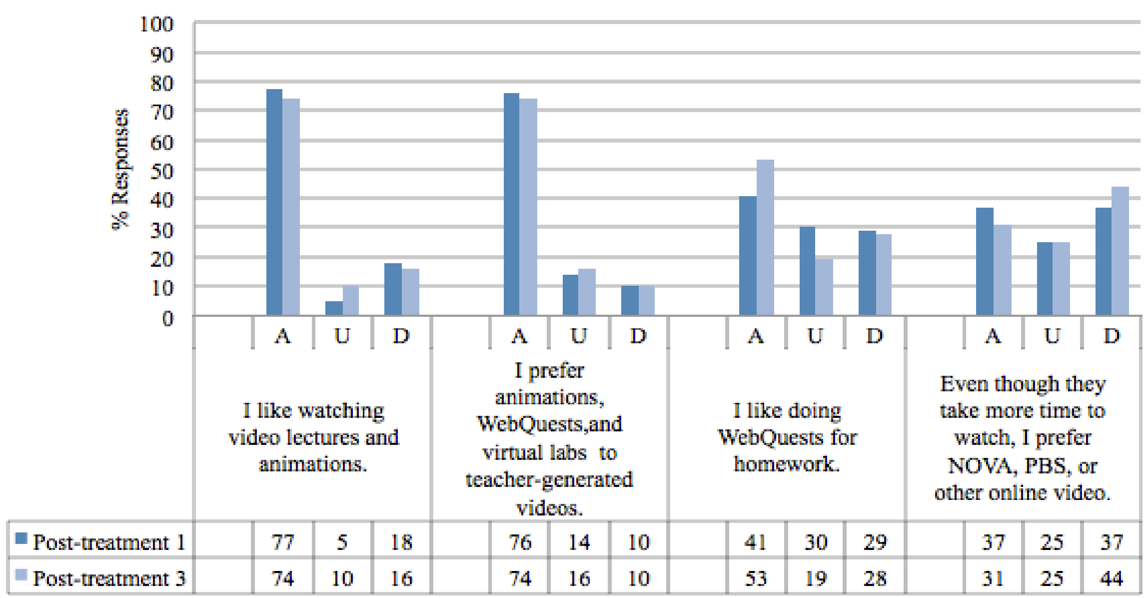
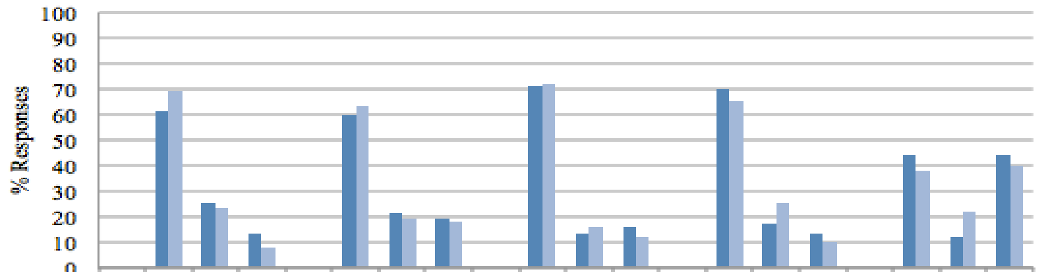


Figure 2. Students' Attitudes about Varied Technologies and the Flipped Learning Model, *(N*=86*)*. D = *disagree*, U = *undecided, and* A = *agree.*

With regard to student preference for the flipped verses traditional learning model, at Post-treatment 3, 69% of students *agreed* they would recommend a flipped learning model to a friend compared to 61% at Post-treatment 1. One student shared, "If this course continued to utilize the flipped learning method, I would definitely recommend it to anyone who was interested. The traditional learning method utilized in the begging [sic] of the year was not interesting or prompting at all." Furthermore, 49% *agreed* they wish all their teachers used the flipped learning model, an increase of 8% from Post-treatment 1 (41%). Seventy-four percent of students *agreed* they prefer the flipped learning model because they would rather watch lectures for homework than in class, an increase of 14% from Post-treatment 1. Seventy-two percent of students *agreed* in their preference for the flipped learning model because of the increase in time and opportunity to do labs and activities. While student preference for the flipped learning model was mostly due to the allowance for more class time to work in groups and learn from others (78%), 65% of students *agreed* in the preference for the flipped model because it helped them to better understand the concepts being taught. A student wrote, "The flipped learning model, in my opinion has helped me because I was able to get the lecture part of the unit out of the way at home rather than doing the lecture in class and having to take notes due to how fast the lecture is going. I like it because it gives us more time to do hands-on lab and it allows for me to take my time learning the new material." Another student also shared, "I think this is a good learning style because at least when we're at home watching the video we can do it on our own time, pause the video to make a note, [sic] its not like lectures where you can't pause the teacher to take a note or ask her to replay what she just said, as where videos can do that."

Preference for the traditional learning model was also evidenced. At Post-treatment 3, 38% of students *agreed* they prefer in-class lectures compared to 27% at Post-treatment 1, and 38% of students *agreed* in their preference for in-class lectures and note-taking opposed to at-home lectures and animations, a 6% decrease from Post-treatment 1(Figure 3). A student wrote, “we [sic] do too much labs. Well actually we dont [sic] do a lot but when we do, you assign too many questions and it just has made me hate doing labs because of the lab reports we need to do. I would rather just sit in class and have lectures than do labs if we have to write what we already know.” Some students (21%) were undecided about their preference. One student wrote,

> I feel like I don't learn much from this flipped-model…In traditional style…, I feel like there's a lot more content being taught especially since it is the teacher who created the lecture, in that we recieve [sic] her insight in the subject. And there's also more class discussion to provide clarification…Though the energy it takes to stay focus during a lecture is a pain. Flipped-model allows me to take my time, which is a huge advantage. But to me, it's about what I'm learning that matters. I'd say that the flipped-model captures my interest but the traditional-model allows greater understanding for me on the particular subject being taught.”

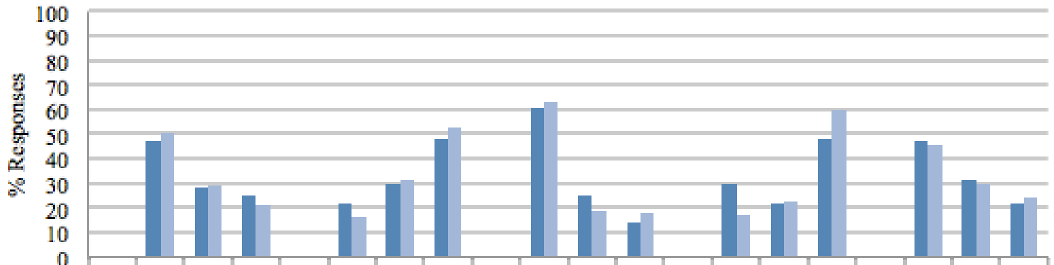


	I would recommend a flipped learning model to a friend.			I prefer the flipped learning model because I would rather watch lectures for homework.			I prefer the flipped learning model because there is more time in class for labs and activities.			I prefer the flipped learning model because it helps me to better understand the concepts being taught.			*I prefer in-class lectures opposed to at-home lectures and animations.		
	A	U	D	A	U	D	A	U	D	A	U	D	A	U	D
Post-treatment 1	61	25	13	60	21	19	71	13	16	70	17	13	44	12	44
Post-treatment 3	69	23	8	63	19	18	72	16	12	65	25	10	38	22	40

Figure 3. Students' Preferences for the Flipped and Traditional Learning Models, *(N*=86*).* D = *disagree*, U = *undecided, and* A = *agree.*

The effects of the flipped learning model on student interest, motivation, and engagement found a 5% increase, from Pre-treatment 1 to Post-treatment 3, in students who *agreed* their interest in learning biology had increased because of the flipped learning model. Likewise, 53% of students *disagreed* biology was more fun and interesting during the tradition model. A decrease of 9% was found in the number of students *agreeing* they watched every video and animation that was assigned occurred between Post-treatment 1 and end of study (84% and 75%, respectively). However, there was an increase of 5% in students *agreeing* that with the flipped learning model, they had been completing more of their homework (than during the traditional model). Sixty-three percent of students *agreed* they were more likely to do their homework with the flipped learning model. A decrease from 30% to 18% was reported in students *agreeing* they were more motivated to do homework during the traditional learning model. Finally, 46%

of students *agreed* they looked more forward to coming to class because of the flipped learning model, with 24% of students *disagreeing* (Figure 4).



	My interest in learning biology has increased because of the flipped learning model.			*Biology was more fun and interesting during the traditional learning model.			I am more likely to do my homework with the flipped learning model.			* I am more motivated to do homework during the traditional learning model.			I look more forward to coming to this class because of the flipped learning model.		
	A	U	D	A	U	D	A	U	D	A	U	D	A	U	D
Post-treatment 1	47	28	25	22	30	48	61	25	14	30	22	48	47	31	22
Post-treatment 3	50	29	21	16	31	53	63	19	18	17	23	60	46	30	24

Figure 4. Effects of the Flipped Learning Model on Student Interest, Motivation, and Engagement, *(N*=86*)*. D = *disagree*, U = *undecided*, *and* A = *agree*. **This question has reversed wording.*

The effects of the flipped learning model on student learning and comprehension showed 61% students *agreed* watching video lectures and animations at home and doing biology in class helped them to better understand biology concepts with 28% *agreeing* biology concepts were easier to understand when lectures were in class. Finally, a 9% increase from Post-treatment 1 to Post-treatment 3 was seen in students (65%) who *agreed*, in comparison to other science classes they have taken, they had learned more in this class because of the flipped learning model, with 45% of students *agreeing* they learned more during the traditional model (Figure 5). A student shared, “I am learning way more than I did in my previous science class. I enjoy sharing the interesting information to my family.”

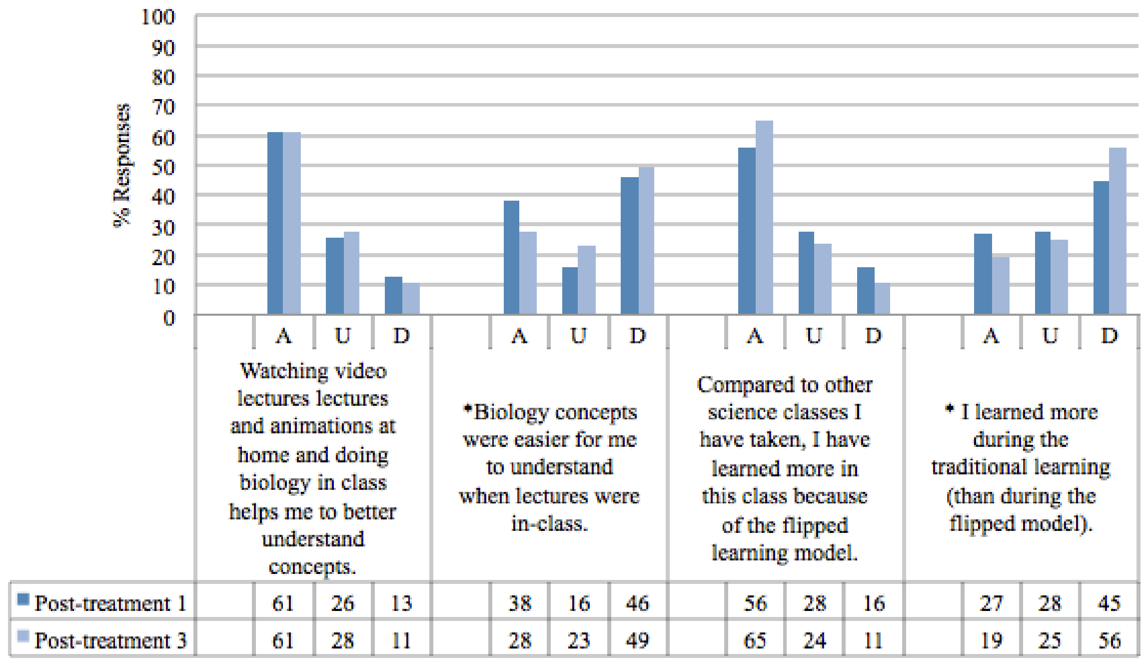


Figure 5. Effects of the Flipped Learning Model on Student Comprehension and Learning, *(N*=86*)*. D = *disagree*, U = *undecided, and* A = *agree*. **This question has reversed wording.*

Survey results for student achievement found a 15% increase between Post-treatment 1 and Post-treatment 3 in students who *agreed* their exam and quiz grades had improved, with 53% *agreeing* their overall grade had improved because of the flipped model. Likewise, 62% of students *agreed* their grade had improved because of the increase in in-class labs and activities. Only 26% of students *agreed* their grade was higher for units that used the traditional learning model. A student shared, “If I were to come straight out and say it I would say I dont [sic] like the flipped learning but for some reason its [sic] getting me a better grade! So I guess I like it but dislike it as well.” As for learning, at Post-treatment 1, 27% *agreed* they learned more during the traditional learning model than during the flipped. By Post-treatment 2, 19% *agreed* (Figure 6).

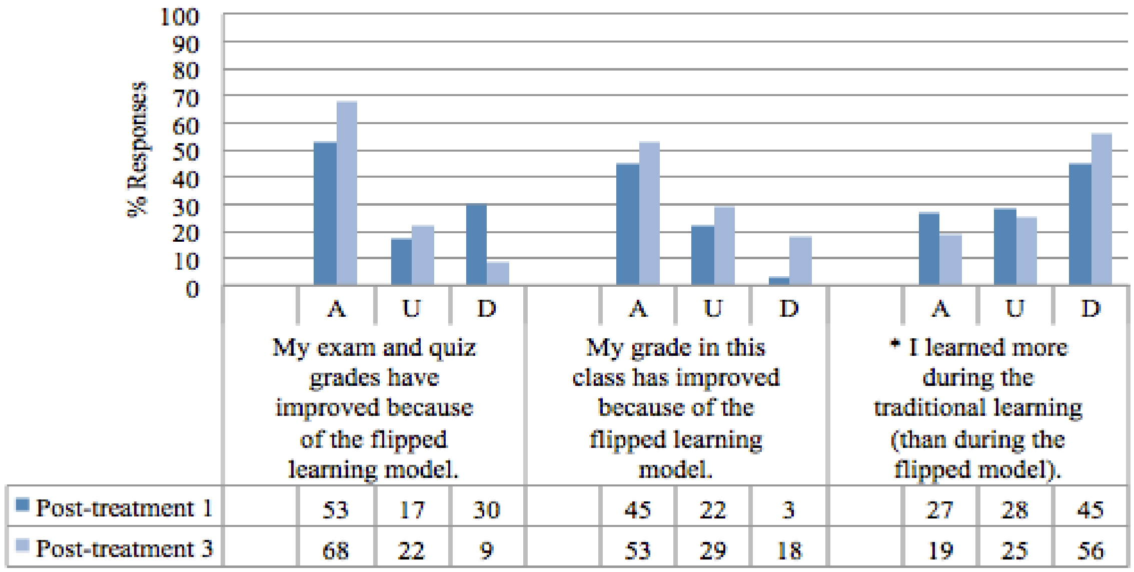
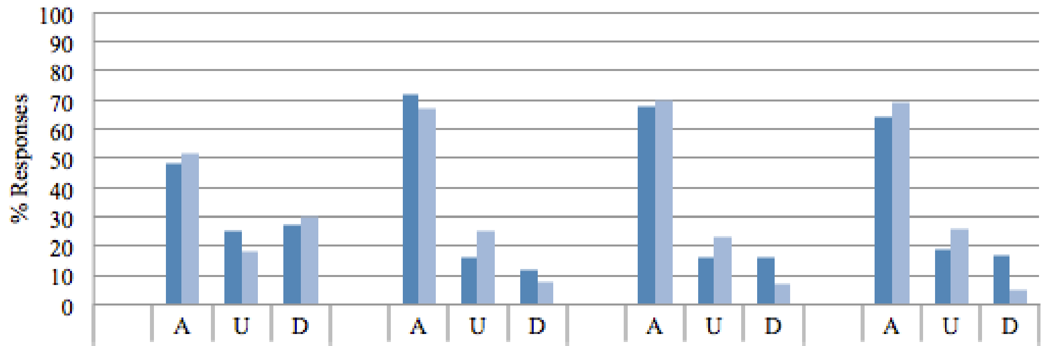


Figure 6. Effects of the Flipped Learning Model on Student Achievement, *(N*=86*)*. D = *disagree,* U = *undecided, and* A = *agree. *This question has reversed wording.*

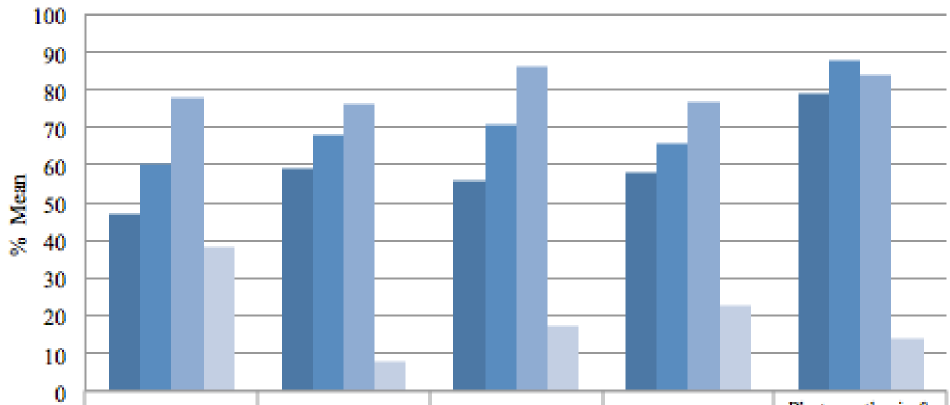
The student preparedness results disclosed 52% of students *agreed* and 30% *disagreed* in-class lectures better prepared them for quizzes and exams, an increase of 4% between Post-treatment 1 and Post-treatment 3. A student shared, “i [sic] think that the flipped learning models are sometimes good because it helps us to learn better and also do better on the quizzes and exams. i [sic] think the flipped learning model is a good thing and should be used for other classes.” On the flip side, 70% of students *agreed* watching video lectures helped prepare them for quizzes and exams, and 67% *agreed* watching video lectures helped prepare them for in class labs, activities, and discussion. Finally, 69% of students *agreed* the flipped learning model helped them to not fall behind when absent from school, a 5% increase from Post-treatment 1 (Figure 7).



	*In class lectures better prepare me for quizzes and exams.			Watching video lectures helps prepare me for in class labs, activities, and discussions.			Watching video lectures helps prepare me for quizzes and exams.			The flipped learning model helped me to not fall behind when I was absent from school.		
	A	U	D	A	U	D	A	U	D	A	U	D
Post-treatment 1	48	25	27	72	16	12	68	16	16	64	19	17
Post-treatment 3	52	18	30	67	25	8	70	23	7	69	26	5

Figure 7. Effects of the Flipped Learning Model on Student Preparedness, *(N*=86*)*. D = *disagree*, U = *undecided, and A = agree. *This question has reversed wording.*

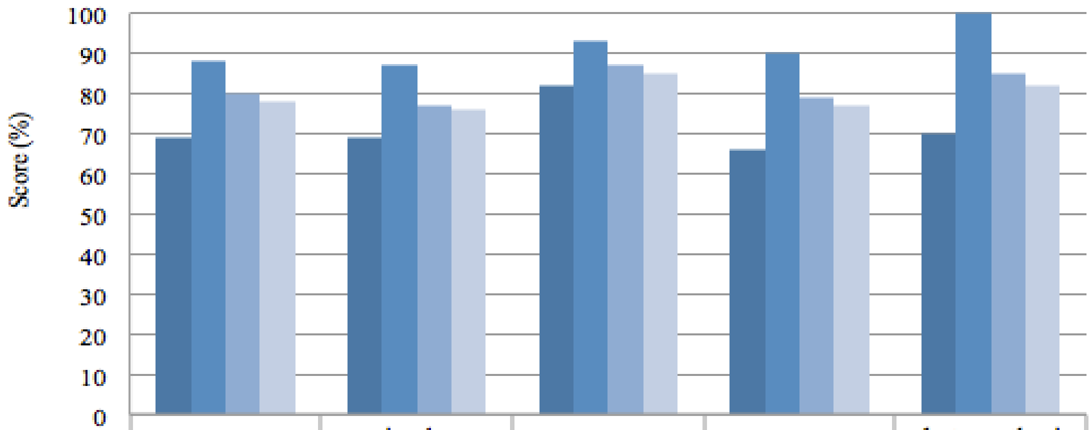
Student achievement was measured using pre- and post- unit student knowledge surveys and exams. A brief survey conducted during the semester two final exam revealed the most favored unit by students was evolution (38%), followed by plantae (23%), animalia (17%), photosynthesis and cellular respiration (14%), and the least favored unit - microbes, protista, and fungi (8%). For all of the units, pre- and post- student knowledge surveys showed an increase in mean percentages. The unit with the greatest difference (17%) was evolution (the most favored unit) and the least difference was in plantae (8%), the second-most favored unit. A Spearman correlation test ($r(84) = 0.1052$) revealed little evidence of a linear association between mean exam scores and percent votes for most favorite unit (Figure 8).



	Evolution (Pre-treatment 1)	Microbes, protista and fungi (Treatment 1)	Animalia (Pre-treatment 2)	Plantae (Treatment 2)	Photosynthesis & Cellular Respiration (Treatment 3)
Pre-Survey Mean (%)	47	59	56	58	79
Post-Survey Mean (%)	60	68	71	66	88
Exam Mean (%)	78	76	86	77	84
Votes for most Favorite (%)	38	8	17	23	14

Figure 8. Comparisons of Pre- and Post-knowledge Survey Means, Exam Means and Most Favored Unit, *(N*=86*)*.

Data from unit exams showed students had greatest achievement on animalia (86%), a pre-treatment unit, followed by photosynthesis and cellular respiration (84%), a treatment unit, then evolution (78%), a pre-treatment unit, followed by plantae (77%) a treatment unit, and microbes, protista, and fungi (76%), a treatment unit. Exam scores revealed a slight right skew when comparing means and medians, in that, the mean for all exam scores was 1 – 3% lower than the median. When looking at the 25% quartile, little change was seen when comparing the pre-treatment to treatment units with the exception of animalia (82%), which was 12 – 16% greater than the 25% percentile for all other units. However, there was an increase in the 75% quartile, with the greatest increase seen comparing evolution (88%), the first pre-treatment unit, to photosynthesis and cellular respiration (100%), the last treatment unit (Figure 9).



	evolution (pre-treatment)	microbes, protista, and fungi (treatment)	animalia (pre-treatment)	plantae (treatment)	photosynthesis and cellular respiration (treatment)
25% quartile	69	69	82	66	70
75% quartile	88	87	93	90	100
Median	80	77	87	79	85
Mean	78	76	85	77	82

Figure 9. Pre-treatment and Treatment Unit Exam Score Summary, (*N*=86).

The Teacher Observation Sheet showed students were most engaged and attentive during the flipped learning units, especially while working on labs and during class discussions. I also observed high levels of engagement when students were working on homework, in that, students were seldom off task and were often observed interacting and collaborating with their peers regarding the assignment. A substitute teacher, also the former vice-principal for grades 9 and 10 at my school, made similar observations. He shared with me whatever I was doing with the students was amazing and that he seldom experienced classes in which all the students in all of the classes were so focused, on-task, and engaged in a worksheet. On that particular day, students were working on a flipped assignment using varied technologies, including a virtual lab, to complete a worksheet on the relationships between photosynthesis and cellular respiration. In the units where the traditional model was instituted, students showed high levels of motivation in taking notes and asking questions. This was particularly true when I took extra time to ensure the lecture was interesting and would provoke discussions. While most students were attentive and showed interest during the traditional learning model, on many lecture days, there was always one or two students per class observed struggling to stay awake. This was also dependent on time of day. Class periods that met after lunch had the least attentive students who were, often times, struggling to stay awake. There was also decreased attention and effort on note taking. Another noteworthy observation I made during the flipped learning model was higher achieving students were more likely to complete the flipped assignments opposed to lower achieving students. Because students were expected to come to class prepared following the flipped assignment, and to hold students accountable, I administered an open-note quiz at the beginning of each class period following the flipped assignment. For students who had either not completed the assignment or had copied from a classmate, their achievement on the quiz was markedly lower than the students who had completed the assignment on their own. Two of the students I interviewed typically scored below average. I asked them how it was they scored low given the quiz was open-note, with questions coming directly from the worksheet. One student admitted he did not always complete the assignments because, "I'm just lazy and do not always do my homework." The other student who has variable scores, sometimes scoring high and, at other times, scoring low, admitted that she often copied the work from another student and shared that when she completed the assignment on her own, her quiz scores were much higher. She stated, "I learn a lot more from the flipped assignments when I do the work myself, especially since I learn so well from watching the videos and doing the online labs by myself. It makes sure I understand what I'm learning." Another observation I took note of was with respect to student achievement on the evolution and cellular respiration units – often considered the most difficult units for students. I surveyed all my classes asking why they thought their exam scores were higher for these two units compared to the other units this semester. The majority of students shared they studied more for these units because they knew the exams would be harder because the concepts were harder to understand. They also shared when units were easy, like animalia, they would study less. And, if they did not like a unit, the amount of time they studied depended on how much time they had available between other homework.

The Individual Student Interviews revealed valuable information. I learned while 10 of the 12 students interviewed preferred the flipped learning model, they also appreciated having lectures, especially when content was difficult or challenging and the varied technologies were not sufficient in ensuring student understanding of content. One student shared he preferred the traditional learning model because he just wants to be told what he needs to know. His learning style is auditory. This same student also reported he did not always complete homework even though, during the flipped units, the homework served as the lecture and he found the flipped assignments interesting. Another student shared his excitement about my teaching chemistry next year because of his preference for the flipped learning model. He shared his math teacher also flips instruction but he does not think the flipped model would be work well in English. Students who shared their preference for the flipped model indicated they really liked coming to class to do labs and activities. They also liked when I give them class time to get started on their flipped assignment, which motivated them to complete it for homework. Students also shared a dislike for teacher-generated video lessons mainly due to the lack of accessibility to closed-captioning, a feature available with most animations, YouTube videos, and virtual labs. Students admitted that seeing the words that were being spoken on the screen really helped them with spelling, word recognition, and meaning. They also disliked teacher-generated videos because they are not as interactive as animations and virtual labs, resulting in them losing focus and, often, having to review portions of the video multiple times. Three students shared they found the lecture videos really boring and, sometimes, confusing.

INTERPRETATION AND CONCLUSION

Since its inception, educators and administers have been asking whether, or not, the flipped model works. My purpose and interest for studying the effects of a flipped learning model originated from claims found in various literature about how this pedagogical method has been shown to increase homework completion rates, to improve student attitudes toward homework, simplify the protocol for missed material by students who are absent, and the fostering of independent learners who are in charge of their learning with the ability to learn at their own pace. Further claims are the model increases student engagement, since lectures become homework, allowing class time to for collaboration between students as well as labs and activities. Data collected from my research project support these claims. Specifically, the qualitative data support a flipped learning model using varied technologies, showing it had positive effects on student attitudes about biology, it increased student interest, motivation, and engagement, and better prepared students for in-class activities, including labs and discussions.

On the flip side, skeptics claim the model may not have any impact on learning, with some claiming the benefits are dubious, lacking empirical evidence with respect to student achievement. While I am an optimist of the flipped learning model, and while students' perceptions were the flipped model had positive effects on their comprehension and learning, quantitative data from analyses of student exam scores and pre- and post-student knowledge surveys lack convincing evidence this learning model increased overall student achievement, although evidence was found the model may improve achievement for the upper 75% quartile of students. In fact, data show more support for the traditional learning model in terms of student achievement, a favored model by a small minority of my students but appreciated by most. Another concern by skeptics is students feel disconnected from the classroom and teacher since they are not participating in traditional lectures. I personally felt more connected to my students during the treatment because I had more time and opportunity for one-on-one interaction with my students. My interactions were more personal opposed to me standing in front of the class lecturing to the class as a whole.

No major transformations in the data were observed during this study yet small transformations were found. The greatest transformation was seen in the increase (10%) of students who liked this class and the 9% increase in students who found learning and understanding biology was important. However, these findings were not necessarily due to the flipped learning model and may have resulted from student interest in the content because of its relevancy. Another worthwhile transformation was with regard to student preference for the flipped model, which increased from Treatment to Treatment 3. However, I found where the data contradicted itself. While student preferences for the flipped learning model showed an increase, student agreement about liking to watch video lecture and animations and their preferences for varied technologies actually decreased, but only by a margin of 3 to 4%. Regardless, I found this compelling since student open responses were in great favor of the varied technologies, including animations and WebQuests.

Despite the corroborations and contradictions in data, I found my study and its results to be mostly valid. However, to improve its validity, the flipped learning model should be studied over multiple years in multiple classrooms by multiple teachers, comparing individual student grades and achievement, as well as overall grades. Unit grades as well as semester grades should be also included in the analyses. Finally, units, lessons, and unit exams should be carefully created to ensure they are equivalent in terms of difficulty. One of the reasons my students may have shown higher achievement on the animalia exam is the unit was considered to be easier by most students. The ease of the animalia exam compared to other units is further evidenced when comparing the 25% and 75% quartiles of all other exams to animalia. If exam and quiz scores are being used to assess the effectiveness of one model over another, and to draw valid conclusions from data analyses, they must be equivalent in level of difficulty, the number of questions asked, and the timing of administration.

VALUE

The most value gained from this research project was using student feedback to modify teaching practices in the best interest of my students. In doing so, I noticed a tremendous change in student attitudes and in the relationships between myself and individual students, and myself and entire classes. Students gained the sense that I genuinely cared about them, and valued their perceptions about biology and this class, and their learning experiences and success. This research project also gained the respect and trust of my students. I strive to build my classroom culture on respect and trust to not only establish an environment conducive of learning, but also so students will be comfortable with providing me continual and honest feedback enabling me to continue improving their experience. In the future, I also want to inform my practice using feedback from parents, colleagues, administrators, counselors, and dorm advisors.

Furthermore, the action research has forever changed me as a teacher. The process has inspired me to be continually reflective of my practice. I have always understood the importance and value of self-reflection, but it is not something I have put into practice in an ongoing manner, mainly due to lack of time. Becoming an accomplished, effective, master educator is not possible without reflection. Growth is not possible without reflection. I also firmly believe exercising self-reflection demonstrates to my students how they can become more successful students through their own self-reflective practices. Furthermore, the action research process has opened my eyes to its important role and place in education. It is my opinion all teachers should partake in action research on a yearly basis, at a minimum, to inform their practice for making changes and improving the educational experiences of their students. I will never arbitrarily change my teaching practices without first putting into place the action research process – to inform the change. While several questions surface regarding my best practices, my experiences with this research project have raised the question as to how the flipped learning model used in this study can be changed to have greater impact on student learning and comprehension, to include my high and lower level achievers?

Another question is what can be done to change students' dislike for biology? One of the most disheartening and frustrating experiences as a teacher who is passionate for the subject, no matter what I do, some students will always have a dislike for biology. One student shared, "I will always hate biology, no matter what anyone does, I will always hate biology. Even if you gave me 10 million dollars and a new Ferrari... I will always hate biology….Ms. Tully is a great and awesome and nice and dedicated teacher, but too bad she teaches such a boring subject like Biology [sic]." While this constitutes a small minority of my students, I still believe the problem needs to be addressed (studied). There must be *something* I can do to change students' dislike for biology. Right?

REFERENCES CITED

Atteberry, E. (2013, October 13). 'flipped classrooms' may not have any impact on learning. *USA Today*. Retrieved November 26, 2013, from http://www.usatoday.com/story/news/nation/2013/10/22/flipped-classrooms-effectiveness/3148447/

Bennett, B. (2011). Video is not the answer. Retrieved November 28, 2013, from http://www.brianbennett.org/blog/video-is-not-the-answer/

Bergmann, J., & Sams, A. (2012a). Before you flip, consider this. *Phi Delta Kappan, 94*(2):25.

Bergmann, J., & Sams, A. (2012b). Flip your classroom: reach every student in every class every day. *International Society for Technology in Education.*

Bergmann, J., & Waddell, D. (2012). To flip or not to flip? *Learning & Leading with Technology: International Society for Technology in Education (ISTE). 39*(8), 6-7. Retrieved November 27, 2013 from http://www.learningandleading-digital.com/learning_leading/20120607#pg8

Brame, C.J. (2013). Flipping the classroom? *The Center for Teaching. Vanderbilt University.* Retrieved April 12, 2013 from: http://cft.vanderbilt.edu/teaching-guides/teaching-activities/flipping-the-classroom/

Brunsell, E., Horejsi, M. (2013). A flipped classroom in action. *Science 2.0: using web tools to support learning.* The Science Teacher, *(80)*2, 8.

Camel, C. (2011). An evaluation of the flipped classroom. Retrieved November 28, 2013 from http://camelportfolio.files.wordpress.com/2012/03/camel-c-final-epd-for-the-flipped-classroom.pdf

Gerstein, J. (2011). The flipped classroom model: a full picture. Retrieved September 24, 2013, from http://usergeneratededucation.wordpress.com/tag/flipped-classroom/

Goodwin, B., Miller., K. (2013). Research says evidence on flipped classrooms is still coming in. Education Leadership. Retrieved September 26, 2013, from http://www.educationalleadershipdigital.com/educationalleadership/201303/?pg=80#pg80

Green, G. (2012). The flipped classroom and school approach: Clintondale high school. Presented at the annual Building Learning Communities Education Conference, Boston, MA. Retrieved September 19, 2013, from http://2012.blcconference.com/documents/flipped-classroom-school-approach.pdf

Hamdan, N., McKnight, P., McKnight, K., Arfstrom, K. (2013). A review of flipped learning. *Flipped Learning Network.* Retrieved September 29, 2013, from http://www.flippedlearning.org/cms/lib07/VA01923112/Centricity/Domain/41/LitReview_FlippedLearning.pdf

Hendricks, C. (2009). Improving schools through action research: A comprehensive guide for educators. Upper Saddle River, N.J: Pearson.

Hill, P. (2013). A response to USA Today article on flipped classroom research. Retrieved November 26, 2013, from: http://mfeldstein.com/response-usa-today-article-flipped-classroom-research/

Johnson, G.B. (2013). Student perceptions of the flipped classroom. Unpublished professional paper. The University of British Columbia – Okanagan.

Johnson, L.W. & Renner, J.D. (2012). Effect of the flipped classroom on a secondary computer applications course: student and teacher perceptions, questions and student achievement. Retrieved September 19, 2013, from http://theflippedclassroom.files.wordpress.com/2012/04/johnson-renner-2012.pdf

Kamehameha Schools – Research and Evaluation Division. (2010). 21st century skills for students and teachers. Retrieved from: www.ksbe.edu/spi/PDFS/21%20**century**%20**skills**%20full.pdf

"Kamehameha Schools - Kapālama." (22 May 2013). *GreatSchools*. Retrieved November 27, 2013, from http://www.greatschools.org/hawaii/honolulu/380-Kamehameha-Schools-Kapalama-Campus/

Kamehameha Schools. (2014). Kamehameha schools campuses. Retrieved June 16, 2013, from http://www.ksbe.edu/campuses.php

Kamehameha Schools. (2013a). About Kamehameha Schools. Retrieved April 19, 2013, from http://www.ksbe.edu/about/

Kamehameha Schools. (2013b). About Kamehameha Schools. Retrieved April 20, 2013, from http://apps.ksbe.edu/admissions/about-kamehameha-schools

MacDonald, W. T. (2013). *The classroom flip strategy: a review of current literature..* Informally published manuscript, Technology and the Curriculum, Ontario Institute of Technology, Ontario, Canada.

Marlowe, C.A. (2012). The effect of the flipped classroom on student achievement and stress. Unpublished professional paper. Montana State University – Bozeman.

McIntosh, M. (2011). Mastery learning and the flipped class: A resource guide. Retrieved from http://mistermcintoshsays.org/2011/03/10/mastery-learning-and-the-flipped-class-a-resource-guide/

Partnership for 21st Century Learning. (2012). P21 framework definitions. Retrieved April 21, 2013, from http://www.p21.org/storage/documents/P21_Framework_Definitions.pdf

Petrinjak, L. (2012). Have you flipped? National Science Teachers Association (NSTA) Reports, WebNews Digest. Retrieved February 28, 2013, from http://www.nsta.org/publications/news/story.aspx?id=59253

Strayer, J.F. (2007). The effects of the classroom flip on the learning environment: a comparison of learning activity in a traditional classroom and a flip classroom that used an intelligent tutoring system (Doctoral dissertation, The Ohio State University).

Zappe, S., Leicht, R., Messner, J., Litzinger, T., & Lee, H.W. (2009). "Flipping" the classroom to explore active learning in a large undergraduate course. In *Proceedings, American Society for Engineering Education Annual Conference & Exhibition*. Austin, TX.

APPENDICES

APPENDIX A

STUDENT SURVEYS

**Please note: This survey is completely voluntary and your responses will in no way affect your grade or class standing.

	1 Strongly disagree	2 Disagree	3 Somewhat disagree	4 Undecided	5 Somewhat agree	6 Agree	7 Strongly agree
STUDENT ATTITUDES SURVEY REGARDING THIS CLASS AND BIOLOGY							
Administered pre-treatment (before evolution) and at end-of-study after photosynthesis and cellular respiration.							
Q1. I am interested in learning biology.	○	○	○	○	○	○	○
Q2. I always complete my homework on or before the due date.	○	○	○	○	○	○	○
Q3. I enjoy doing the homework that is assigned in this class.	○	○	○	○	○	○	○
Q4. The homework assigned in this class helps me to learn and understand content, including difficult concepts.	○	○	○	○	○	○	○
Q5. *This class bores me to tears. I just want to come to class and sleep.	○	○	○	○	○	○	○
Q6. I like this class.	○	○	○	○	○	○	○
Q7. In comparison to previous science classes, I am learning more in this class than the previous class(es).	○	○	○	○	○	○	○
Q8. Biology is easy.	○	○	○	○	○	○	○
Q9. I take good and thorough notes in this class.	○	○	○	○	○	○	○
Q10. Learning and understanding biology is important in my life now and in my future.	○	○	○	○	○	○	○
Q11. I am satisfied with the number of labs and activities we do in this class.	○	○	○	○	○	○	○
Q12. My teacher does a good job of answering student questions.	○	○	○	○	○	○	○
Q13. I would recommend this course to a friend and/or sibling.	○	○	○	○	○	○	○
Q14. I would recommend this teacher to a friend and/or sibling.	○	○	○	○	○	○	○
Q15. I plan on pursuing a career in biology or a biology-related field.	○	○	○	○	○	○	○
Q16. *This class is a waste of my time.	○	○	○	○	○	○	○
Q17. I look forward to coming to this	○	○	○	○	○	○	○

class.							
Q18. My teacher makes this class interesting.	○	○	○	○	○	○	○
Q19. I always complete my homework.	○	○	○	○	○	○	○
STUDENT ATTITUDES SURVEY REGARDING VARIED TECHNOLOGIES AND THE FLIPPED LEARNING MODEL							
Administered post-treatment, at end of units for microbes, protista and fungi (unit 6); plantae (unit 8); and, photosynthesis and cellular respiration (unit 9)							
Q1. I like watching video lectures.	○	○	○	○	○	○	○
Q2. *I do not learn from watching video lectures.	○	○	○	○	○	○	○
Q3. *The video lectures are a waste of my time. I do not learn from them.	○	○	○	○	○	○	○
Q4. I prefer video lectures plus WebQuests, Virtual Labs and other videos to teacher-generated video lectures.	○	○	○	○	○	○	○
Q5. I prefer animations (Adaptive Curriculum, YouTube, other educational), WebQuests, virtual labs, and other digital resources to teacher-generation videos.	○	○	○	○	○	○	○
Q6. Even though they take more time to watch, I prefer NOVA, PBS, or other online videos (instead of lecture videos).	○	○	○	○	○	○	○
Q7. I like doing WebQuests for homework.	○	○	○	○	○	○	○
Q8. *I prefer video lectures and animations only (not WebQuests and virtual labs).	○	○	○	○	○	○	○
Q9. *I do not like doing virtual labs for homework.	○	○	○	○	○	○	○
STUDENT PERCEPTIONS SURVEY							
STUDENT PREFERENCE FOR FLIPPED VS. TRADITIONAL LEARNING MODEL							
Administered post-treatment, at end of units for microbes, protista and fungi (unit 6); plantae (unit 8); and, photosynthesis and cellular respiration (unit 9)							
Q1. I would recommend a flipped learning model to a friend.	○	○	○	○	○	○	○
Q1. I wish all my teachers used the flipped learning model.	○	○	○	○	○	○	○
Q3. I took more meaningful notes from the video lectures compared to in-class lectures.	○	○	○	○	○	○	○
Q4. I like how the flipped learning model allows me to work with and learn from other students.	○	○	○	○	○	○	○
Q5. I like that we do more in-class, hands on labs and activities during the flipped learning model.	○	○	○	○	○	○	○
Q6. The flipped learning model allows for more class time to work in groups and learn from other students.	○	○	○	○	○	○	○
Q7. *I prefer in-class lectures (and note-taking) opposed to at-home lectures	○	○	○	○	○	○	○

and animations (with note-taking).							
Q8. I prefer the flipped learning model because there is more time and opportunity during class to do labs and activities.	o	o	o	o	o	o	o
Q9. *I prefer the traditional learning model (in class lectures and notes) because I do not enjoy hands-on activities and labs.	o	o	o	o	o	o	o
Q10. I prefer the flipped learning model because it helps me to better understand the concepts being taught.	o	o	o	o	o	o	o
Q11. *I prefer the traditional learning model because I would rather do traditional homework at home (worksheets, etc.) and come to class for lectures and notes.	o	o	o	o	o	o	o
Q12. I prefer the flipped learning model (above the traditional learning model) because I would rather watch lectures for homework (than listen to lectures in class).	o	o	o	o	o	o	o
MOTIVATION, ENGAGEMENT, INTEREST AND THE FLIPPED LEARNING MODEL							
	1 Strongly disagree	2 Disagree	3 Somewhat disagree	4 Undecided	5 Somewhat agree	6 Agree	7 Strongly agree
Q13. I watch every video that is assigned to me.	o	o	o	o	o	o	o
Q14. With the flipped learning model, I have been completing more of my homework (than with the traditional learning model).	o	o	o	o	o	o	o
Q15. My interest in learning biology has increased because of the flipped learning model.	o	o	o	o	o	o	o
Q16. *I am more attentive (awake) during in-class lectures than when I watch video lectures.	o	o	o	o	o	o	o
Q17. I always write down questions I have while watching the video and ask them the next day in class.	o	o	o	o	o	o	o
Q18. *Biology was more fun and interesting during the traditional learning model than the flipped learning model.	o	o	o	o	o	o	o
Q19. I look forward to coming to class because of the flipped learning model.	o	o	o	o	o	o	o
Q20. I am more likely to do my homework with the flipped learning model.	o	o	o	o	o	o	o
Q21. I never rush and carefully watch videos so I can take notes while watching.	o	o	o	o	o	o	o
Q22. *I am more motivated to do homework during the traditional learning model.	o	o	o	o	o	o	o
Q23. *I am less motivated to learn biology during the flipped learning model.	o	o	o	o	o	o	o

LEARNING, COMPREHENSION AND THE FLIPPED LEARNING MODEL							
Q24. *The flipped learning model makes it harder for me to understand biology concepts.	○	○	○	○	○	○	○
Q25. Compared to other science classes I have taken, I have learned more in this class because of the flipped learning model.	○	○	○	○	○	○	○
Q26. *I learned more during the traditional learning model (than during the flipped learning model).	○	○	○	○	○	○	○
Q27. *Biology concepts were easier for me to understand when lectures were in-class (opposed to video lectures).	○	○	○	○	○	○	○
Q28. Watching video lectures at home and doing biology in class helps me to better understand biology concepts.	○	○	○	○	○	○	○
ACHIEVEMENT AND THE FLIPPED LEARNING MODEL							
	1 Strongly disagree	2 Disagree	3 Somewhat disagree	4 Undecided	5 Somewhat agree	6 Agree	7 Strongly agree
Q29. *My grade in this class was higher for units that used the traditional learning model (like chemistry and cells).	○	○	○	○	○	○	○
Q30. My grade in this class has improved because of the flipped learning model (like microbes and plantae).	○	○	○	○	○	○	○
Q31. My exam grades have improved because of the flipped learning model.	○	○	○	○	○	○	○
Q32. My grade in this class has improved because we do more in-class labs and activities during the flipped learning model.	○	○	○	○	○	○	○
STUDENT PREPAREDNESS AND THE FLIPPED LEARNING MODEL							
Q33. Watching video lectures help prepare me for in-class labs and activities.	○	○	○	○	○	○	○
Q34. Watching video lectures help prepare me for quizzes and exams.	○	○	○	○	○	○	○
Q35. The flipped model enabled me to not fall behind when I was absent from school.	○	○	○	○	○	○	○
Q36. *Video lectures do not prepare me to do well in this class.	○	○	○	○	○	○	○
Q37. *In-class lectures better prepare me for quizzes and exams.	○	○	○	○	○	○	○

**These questions have reversed wording.*

APPENDIX B

STUDENT KNOWLEDGE INVENTORY

**Please note: This survey is completely voluntary and your responses will in no way affect your grade or class standing.

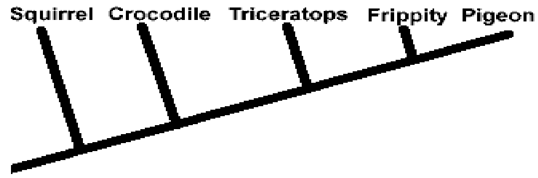
Units 5 & 6: Evolution: Pre- and Post-Survey

Read each of the following statements and CHECK those that you believe are TRUE.

- ☐ Evolution is the process by which different kinds of living organisms are thought to have developed and diversified from earlier life.
- ☐ Evolution is a theory that tries to explain the origins of life (when, where, how life on Earth began).
- ☐ Evolution only occurs over a really long time periods of time (millions – billions of years).
- ☐ Evolutionary theory proposes that all life on earth today shares a common ancestor.
- ☐ Evolution has never been observed which is why it is considered a theory.
- ☐ Evolution is a theory, not a fact.
- ☐ Individual organisms can evolve during their lifetime.
- ☐ Evolution is like climbing a ladder – organisms evolve to become better.
- ☐ Evolution is a random process and occurs by chance.
- ☐ The only evidence for evolution is in fossils and rock formations.
- ☐ Human beings are currently not evolving.
- ☐ The theory of evolution proposes that human beings originated (evolved) from chimpanzees.
- ☐ Evolution, and the theory of evolution), were discovered by Charles Darwin.
- ☐ The theory of evolution denies the existence of God since it is based on science, not faith.
- ☐ The fittest organism in a population is one that is the strongest, fastest, healthiest and/or largest.
- ☐ Natural selection produces organisms that are perfectly adapted to survive in their environment.
- ☐ Natural selection leads to more complex organisms.
- ☐ There is much evidence that disproves evolution.
- ☐ The most complex organisms on earth are those the evolved most recently.
- ☐ The more complex an organism is, the greater advantage the organism has for survival.
- ☐ Evolution happened in the past and is no longer happening today.
- ☐ Evolution always moves from simple to complex.

- ☐ Earth is approximately 4.5 million years old.

1. Examine the diagram below and read the statements that follow. CHECK those that you believe are TRUE.



- ☐ Crocodiles are more closely related to squirrels than to frippities.
- ☐ Frippities share a more recent ancestor with Triceratops than with Pigeons.
- ☐ Frippities probably laid eggs.
- ☐ All of these animals share the same ancestor.
- ☐ Squirrels evolved before crocodiles, and pigeons.
- ☐ Pigeons are the most complex and squirrels are the least complex.
- ☐ Crocodiles evolved earlier in geologic time than did pigeons.

2. A ship that had been used for many years in arctic exploration was sold and moved to a harbor in the warm waters of the Caribbean. Worms that had lived on the ship bottom crawled off in the warm waters and attempted to attach to other ships in this tropical area where there were no similar worms. Some of the worms were able to survive and reproduce. What would you expect to happen to this group of worms over many generations in this new environment?
   a. The worms will mate and produce offspring just as they did in their previous environment, and the group’s traits will likely remain unchanged after many generations.
   b. The worms will gain new, more complex traits through natural selection that will help them better adapt to the warmer waters because natural selection leads to more complex and better adapted organisms.
   c. Worms possessing genetic variations that help them to survive and thrive in the new environment will leave more offspring than others lacking those traits. Over time, the proportion of the worm population with these adaptive traits will likely increase.
   d. The mutation rate will increase in this group of worms in order to promote evolution.
3. A chef sprays antimicrobial cleaner on her counter top. At the first, the bacteria population declines significantly. However, even though she continues to spray in following weeks, the number of bacteria begins to increase again. Why did this happen?
   a. Some bacteria had traits that allowed them to survive the initial antimicrobial application. They produced offspring also carrying those traits.
   b. After the application of antimicrobial spray, the bacteria needed to adapt by developing antimicrobial spray-resistant traits.
   c. The antimicrobial compound caused a mutation for resistance to it. This trait increased in the population over time.
   d. The bacteria that tried hardest to become resistant left more offspring, who were also resistant.

**Please note: This survey is completely voluntary and your responses will in no way affect your grade or class standing.

Unit 7: Biodiversity: Pre- and Post-Survey

Read each of the following statements and CHECK those that you believe are TRUE.

- ☐ All of Earth's species have been discovered.
- ☐ Species have always been going extinct so we do not need to worry about a few animals and plant disappearing.
- ☐ Most of the organisms on Earth today are plants.
- ☐ There is great species diversity near the equator than near the poles.
- ☐ The biodiversity on our planet Earth is rising (increasing).
- ☐ High biodiversity is an indicator of a healthy ecosystem.
- ☐ Extinction is not a natural phenomenon
- ☐ Biodiversity of other species is not important to humans.
- ☐ Dinosaurs went extinct because of humans.
- ☐ Bacteria and other microorganisms are not important to Earth's biodiversity.
- ☐ Global warming is the greatest reason for a loss of biodiversity.
- ☐ It is impossible for scientists to estimate the number of species on Earth.
- ☐ Biodiversity loss on Earth is unavoidable.
- ☐ Biodiversity is beneficial to human health.
- ☐ The loss of biodiversity on Earth's land is far more critical than the loss of biodiversity of Earth's oceans.
- ☐ Animals are the most important organisms on Earth. As long as Earth has high diversity of animals, the health of our planet will be fine.
- ☐ The source of Earth's biodiversity is genetic variation.
- ☐ Scientists have been successful in developing a definition for the term species.
- ☐ Biodiversity and genetic diversity are basically the same thing.
- ☐ To order Earth's biodiversity, organisms are classified into groupings based on external characteristics only.
- ☐ Each species identified by scientists has a unique and universal scientific name that is used and recognized by all scientists all over the world.
- ☐ Organisms classified at the kingdom level will have more traits in common than organisms classified at the species level.
- ☐ The broadest level of classification is domain.
- ☐ There are currently 8.7 million species on Earth today.

- ▢ The ocean contains the greatest number of species.
- ▢ The term, indigenous, means that the species is only occurs in one particular area on Earth.
- ▢ Planet Earth is in its sixth mass extinction event.
- ▢ Hawai'i is considered a biodiversity hotspot.

Observe the following graphic and choose from the following statements those that you AGREE with.

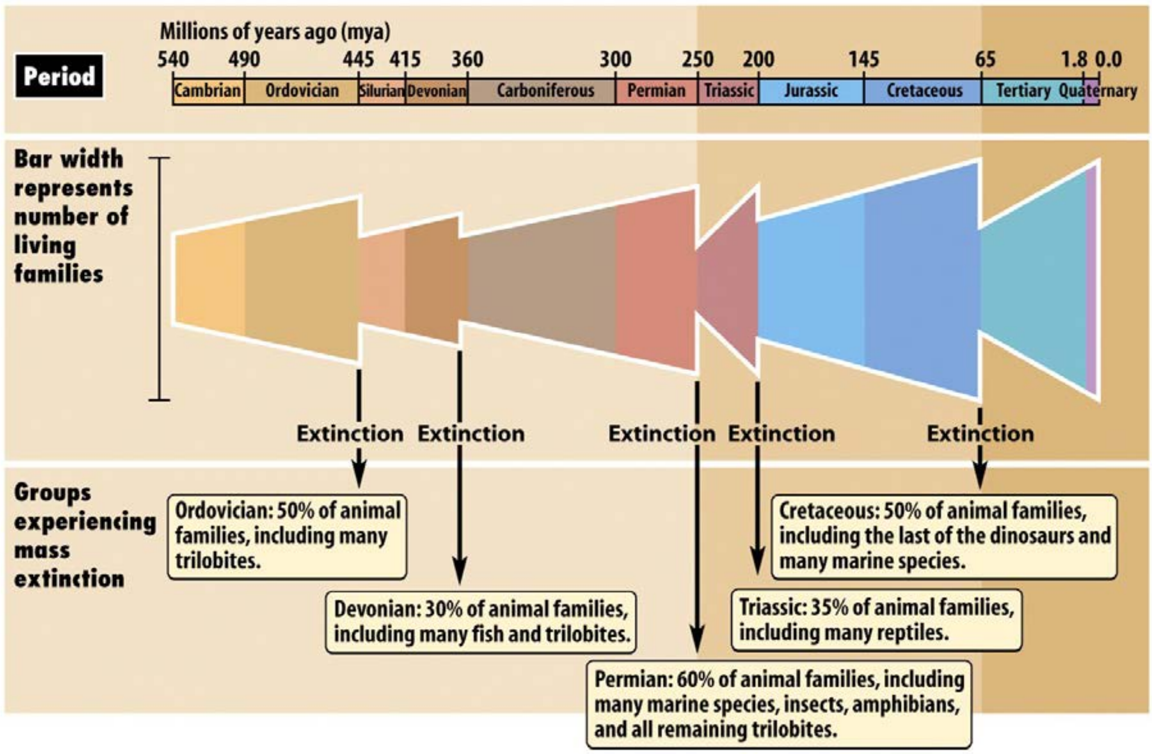


Figure 19-8 Discover Biology 3/e

a. We should not worry so much that species are going extinct. This is something that has happened repeatedly over the past 540 million years.
b. Our planet, Earth, is undergoing an extinction event.
c. Animals have been most affected by historic species extinctions.
d. Based on the graphic, it can be inferred that animals in the current period, Quaternary, will likely experience the greatest extinctions.
e. The extinction rate occurring in the Tertiary/Quaternary periods is greater than any other

**Please note: This survey is completely voluntary and your responses will in no way affect your grade or class standing.

Unit 8: Microbes: Pre- and Post-Survey

Read each of the following statements and CHECK those that you believe are TRUE.

- ☐ Microbes include microorganisms such as bacteria, protists, and fungi.
- ☐ All microbes, such as bacteria and viruses, are bad.
- ☐ If I catch a cold, the doctor should treat it using antibiotics.
- ☐ Vaccines are given to people infected with bacterial infections.
- ☐ All microbes, including viruses, are classified as living organisms.
- ☐ My body contains more microbial cells than somatic (body) cells.
- ☐ All microbes need oxygen in order to survive.
- ☐ Viruses and bacteria have similar cellular structure.
- ☐ There are bacteria species that help protect people against obesity.
- ☐ There are more microbes living on planet Earth today than all other organisms combined.
- ☐ Yeast are classified as bacteria.
- ☐ All protists are considered microbes.
- ☐ Microbes are important to ecosystems because they cycle nutrients.
- ☐ All microbes are prokaryotic organisms.
- ☐ Bacteria are the smallest of all living organisms.
- ☐ Bacteria help digest food and destroy harmful organisms in the gut of other organisms.
- ☐ Fungi and algae are considered autotrophic producers.
- ☐ All microorganisms are immobile (cannot move).
- ☐ Pathogens are all disease causing.
- ☐ Most microbes are heterotrophic.
- ☐ All microbes contain DNA.

Microbes with cells but no nucleus are:

a. Viruses
b. Fungi
c. Bacteria
d. Protists

Which statement is true of all microorganisms?:

a. All microorganisms have a protective cell wall.
b. All microorganisms are unicellular (single-celled).
c. Microorganisms live mostly in wet habitats.
d. Microorganisms inhabit more areas on earth than any other organisms.

**Please note: This survey is completely voluntary and your responses will in no way affect your grade or class standing.

Unit 9: Plants: Pre- and Post-Survey

Read each of the following statements and CHECK those that you believe are TRUE.

- ☐ All plants are photosynthetic.
- ☐ Plants containing chlorophyll are considered photosynthetic.
- ☐ Plants do not require oxygen for survival since they are autotrophic and manufacture their own food energy.
- ☐ Seeds and fruits are non-livings.
- ☐ Nuts are a type of fruit.
- ☐ Plants conduct photosynthesis only during sunlight hours.
- ☐ Plants obtain energy they need for growth from the minerals and nutrients found in soil.
- ☐ Plants can reproduce both asexually and sexually.
- ☐ Plants only have 3 organs: roots, stems, and leaves.
- ☐ Plants take in water from the atmosphere through their leaves.
- ☐ Land plants are the primary source on Earth for oxygen gas.
- ☐ Mosses are not classified as plants.
- ☐ Flowers are non-living.
- ☐ All plants reproduce using flowers.
- ☐ All plants require water for reproduction.
- ☐ Green peppers, zucchini, squash, and tomatoes are considered vegetables.
- ☐ A fruit is a ripened ovary.
- ☐ All plants have roots and leaves.
- ☐ Plants undergo photosynthesis while animals undergo cellular respiration to acquire their energy to carry out life-sustaining processes.
- ☐ All plants are autotrophic.
- ☐ Algae are classified as plants.
- ☐ Plants require fertilizer in order to grow and produce fruits.
- ☐ A person carves the words, “Jack and Jill Forever” at the base of a tree and that same person returns to the tree 20 years later, he/she will not be able to see those words without requiring a ladder.
- ☐ The bark of a tree is considered dead tissue.

The oldest part of a tree is:

e. the leaves at the very top of the tree
f. the tips of the roots underground
g. the bark of the tree
h. the inner-most part of the tree trunk, or stem.

**Please note: This survey is completely voluntary and your responses will in no way affect your grade or class standing.

Unit 10: Animals: Pre- and Post-Survey

Read each of the following statements and **CHECK** those that you believe are TRUE.

- ☐ All animals are mobile (can move).
- ☐ All animals reproduce by sexual reproduction only.
- ☐ All animals produce gametes - eggs and sperm.
- ☐ All animals have reproductive organs.
- ☐ Larger animals have larger cells.
- ☐ All animals have lungs that are used for breathing.
- ☐ All animals have a head and tail region.
- ☐ All animals are heterotrophs.
- ☐ All animals are eukaryotic.
- ☐ All animals are classified as invertebrates or vertebrates.
- ☐ All animals have a heart that pumps blood.
- ☐ Most of the animals on Earth are aquatic (live in water).
- ☐ All animals require oxygen in order to survive.
- ☐ All animals have an internal skeleton to support their bodies.
- ☐ All animals have a brain.
- ☐ All animals have a nervous system.
- ☐ All animals are endotherms.
- ☐ Birds, fish, and insects are not animals.
- ☐ All animals have eyes.
- ☐ All reptiles lay eggs.
- ☐ Most animals are vertebrates.
- ☐ All fish have bony skeletons.
- ☐ All animal cells have nuclei.

Identify from the following the organisms that are classified as animals:

a. Humans
b. Sponges and jellyfish
c. Corals

d. Worms
e. Spiders and insects
f. Amphibians and lizards
g. Sharks
h. Shrimp, lobsters, and crabs
i. Birds and reptiles
j. Starfish, sea urchins, and sea cucumbers

APPENDIX C

TEACHER OBSERVATIONS SHEET

Classroom Observation Sheet

Date: ____________________Period: _____

Unit: ________Activity: __________________________________

For each question, provide evidence for the observation.

1. Are students paying attention?
2. Are students engaged?
3. Are any students off task?
4. Are students actively participating?
5. Are students asking questions?
6. What level of questions are students asking?
7. Are students working collaboratively?
8. Do students appear interested in the activity?
9. Are students enjoying the activity?
10. Do students appear to be learning from the activity?
11. Do students appear in control of their learning?

APPENDIX D

INDIVIDUAL STUDENT INTERVIEW

**Please note: This survey is completely voluntary and your responses will in no way affect your grade or class standing.

Date: ________ Period:___ Unit: ____ Student Name: ____________________________

1. Do you prefer the traditional classroom model or the flipped classroom model?
2. Tell me your thoughts about the traditional classroom model? What did you like and dislike about this model?
3. Tell me your thoughts about the flipped classroom model? What did you like and dislike about this model?
4. For this class, do you enjoy the type of homework assigned during the traditional model or flipped model best? Explain.
5. Do you prefer coming to class and taking notes or participating in an activity?
6. Do you learn most from coming to class and taking notes or participating in an activity?
7. What activities did you most enjoy in this unit?
8. During which model did you complete the most homework? Explain.
9. Do you consider yourself a good student? Explain.
10. During which model do you feel you were able to learn most from your peers?
11. During which model were you most excited about coming to class?
12. During which model were you most motivated to complete homework?
13. During which model do you feel you learned the most and understood what you were learning?

14. Rank in order your preference for varied technologies: teacher-generated video lectures, non-teacher created videos (NOVA, PBS, etc.), digital readings, discussion boards, virtual labs, WebQuests, and games.
15. How could this class be improved? Explain.
16. How could the teacher-generated video lectures be improved?
17. How could the homework be improved?