

THE EFFECT OF THE FLIPPED CLASSROOM ON STUDENT ACHIEVEMENT  
AND STRESS

by

Cara A. Marlowe

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

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY  
Bozeman, Montana

July 2012

STATEMENT OF PERMISSION TO USE

In presenting this professional paper in partial fulfillment of the requirements for 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.

Cara A. Marlowe

July 2012

## ACKNOWLEDGEMENTS

I would like to thank several people for their support along the way. The administration of Dubai American Academy, particularly Denise Hardie and Dr. Jim Hardin, for giving thoughtful suggestions and Tony Mock for agreeing to let me try something novel. Carrie Brummer and Kerry Weinstein, for their assistance in editing. My MSU advisors, Dr. Genevieve Chabot and Dr. John Winnie, for answering my never ending questions and to Terrill Paterson for assisting me when I needed help recalling statistics. Tim Venhuis, who always helped and listened patiently when I needed help sorting out math issues. Tony DePrato, for helping me access past records and knowing when to remind me to walk away from the research/writing process for a few days. Finally, Phil Marlowe, for always listening and being my biggest supporter throughout the process.

## TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND .....	1
CONCEPTUAL FRAMEWORK .....	3
METHODOLOGY .....	9
DATA AND ANALYSIS .....	12
INTERPRETATION AND CONCLUSION .....	19
VALUE .....	21
REFERENCES CITED .....	25
APPENDICES .....	27
APPENDIX A: Independent Learning Checklist .....	28
APPENDIX B: Term Terminate .....	30
APPENDIX C: Five Minute Quiz .....	32
APPENDIX D: Student Interview Questions .....	34
APPENDIX E: Student Reflection .....	36
APPENDIX F: Student Self-reported Stress, Effort, and Completion levels .....	38

LIST OF TABLES

1. Data Triangulation Matrix .....	12
2. One-Way Repeated Measures ANOVA Results.....	15

## LIST OF FIGURES

1. Percent Change in Student Content Vocabulary Knowledge .....	13
2. Point Difference of Student Semester Grades .....	15
3. Semester Grades from Grades 9-12 .....	16
4. Percentage of Student Responses, Assignments .....	17
5. Percentage of Student Responses, Lab Reports .....	18
5. Student Reported Stress Levels .....	18

## ABSTRACT

In this investigation, the effect of the flipped classroom and associated differentiation was studied to measure the impact on student achievement and student stress levels. For the second semester of their senior year, students watched video lectures outside of class and completed assignments during class time. Students reported lower stress levels in this type of classroom environment compared to other classes. While semester grades showed improvement, exam grades did not show significant improvement. Overall, students displayed positive feelings towards the treatment and enjoyed the associated benefits of being able to choose their own assignments and explore concepts they found interesting more in-depth.

## INTRODUCTION AND BACKGROUND

### Project Background

Dubai American Academy is located in Dubai, United Arab Emirates and provides a college-preparatory program for students from pre-kindergarten to high school. The school is privately owned and managed by the GEMS Corporation. The whole school population is 2,253, with 552 students in the high school. Students are almost entirely expatriates, with over 90 nations represented. Countries with the most representation among the student body are the United States, Canada, India, the Netherlands, and the United Kingdom (M. Volk, personal communication, November 29, 2011). Many of the students are high academic achievers, as there are stringent testing requirements to enter the school, and the school makes limited accommodations for students with learning disabilities. However, there are some exceptions in the student population. Examples include students enrolled in the school prior to testing requirements, the fact that a few companies offer debentures to guarantee student acceptance, and the children of faculty are automatically accepted. Policy was recently changed to accept students with minor learning disabilities, but the school is direct with parents about the lack of resources to fully accommodate children who have more significant special needs, particularly in the high school where the International Baccalaureate Diploma Program provides the foundation of its academic program. In instances where students struggle academically or socially, teachers, counselors, parents, and administration coordinate and attempt to help these students achieve their goals (A. Mock, personal communication, December 4, 2011).



The study group was comprised of students in Year 2 of the International Baccalaureate (IB) Standard Level Environmental Systems and Societies (ESS) course. The course has 19 students, including 5 boys and 14 girls. The ESS course runs over a two-year cycle and students completed external exams in May 2012. In Year 1, the following topics are studied: Environmental value systems; Systems and models; Ecosystems; and Human population, carrying capacity and resource use. During Year 2, the following topics are studied: Pollution management; the Issue of global warming; and Conservation and biodiversity. Students who are International Baccalaureate Diploma candidates must take courses from the following subject areas: Group 1- Language 1, Group 2- Second language, Group 3- Individual and societies, Group 4- Experimental science, and Group 5- Mathematics and computer science. Students have the option of taking a course from Group 6- the Arts or another course from Groups 1-5. ESS is a unique course in the IB Diploma Program and can be used by students to satisfy Group 3 or Group 4 requirements. As a result, some students take the course to meet both requirements, while others will choose to have the course count as a Group 3 or Group 4, and others may take the course as an elective.

The idea for the study primarily came from student complaints. All levels of academic achievers frequently complain about the amount and level of work required by the program. Students often state they find little value in homework because they are forced to rely on peers when assistance is required because the content level exceeds their parents' knowledge. They also state classes tend to be tedious because they must sit through 85-minute lectures as most teachers rely on lecture since they feel pressure to complete the required syllabus by the exam dates in May. The ESS course has additional challenges because it mainly attracts two

types of students: a strong science student who sees little value in social science classes like history and economics or a strong social science student who previously experienced difficulty in experimental science classes. As a result, experimental science students are often bored during topics that require knowledge of biology, chemistry, or physics while social science students exceed their experimental science peers during history, psychology, and political aspects of the course.

### Focus Question

Interest in how to balance a classroom with various students strong in either social science or experimental science, along with the desire to meet individual student needs, led to the primary focus question: *To what extent do differentiation and independent learning, through the flipped classroom concept, lead to success in the IB classroom?* The following sub questions were developed: (1) Does the use of differentiation through the flipped classroom, in which students watch video lectures for homework and complete traditional homework assignments in class, allow for increased understanding of concepts? and (2) Does independent learning allow for students to complete work in class with teacher assistance, thereby reducing workload and stress in the IB classroom while still increasing content knowledge?

### CONCEPTUAL FRAMEWORK

Differentiation arises from the idea that students learn in different modalities and should be allowed to demonstrate competency in subject matter through a variety of ways. Gardner (1993) described these modalities and multiple

intelligences. He included such learning styles as visual, audio, naturalistic, logical-mathematical kinesthetic, musical, and interpersonal among others. As stated by Anderson (2007), differentiation allows for a classroom environment where students are valued for their unique learning styles. Additionally, students take responsibility for their learning, are encouraged to make their own decisions and demonstrate their abilities (Anderson, 2007). Differentiation is based in the constructivist theory, which emphasizes the importance of a student-centered and active classroom (Tomlinson & Allan, 2000).

Tomlinson and Allan (2000) define differentiation as “a teacher’s reacting responsibly to a learner’s needs” (p. 4). Teachers who effectively differentiate instruction recognize differences in students and seek to address the needs and learning styles of individual students, rather than applying homogenous methods to classroom learning and assessment. Teachers can differentiate on three levels: content, process, and products (Tomlinson, 2001). ‘Content’ addresses input and how students learn, ‘process’ addresses how students connect ideas and ‘products’ concern how students demonstrate learning. These areas are further differentiated by the student’s readiness and interest. As not every child is the same, some will be cognitively ready for material sooner than others and different interests lead students to pursue various forms of learning and knowledge.

In addition to recognizing student differences in learning, differentiation of content delivery is important. Studies by Borg and Shapiro (as cited by Lage, Platt and Treglia, 2000) report that students learn best when the teacher’s instructional methods match the student’s learning style, suggesting that students who learn best from lecture need to have a strong lecturer as a teacher. Reichmann and Grasha(1974) further contend there are three types of learners: dependent,

collaborative, and independent. Instead of trying to reach each style individually (potentially tripling learning time to meet all student needs) the flipped classroom potentially meets the wide-ranging learning styles of the modern classroom. In the flipped classroom, technology is used to switch lecture to homework. Students watch recorded video lectures through media such as YouTube prior to class. Then during class, students complete works that are usually given as homework- for example review questions, lab reports or worksheets. When using the flipped classroom, instructors allow students to investigate the concepts introduced during the video lecture in the way that makes them comfortable- for example group work or independent reading, while focusing on gaining content knowledge (Lage, Platt and Treglia, 2000). The flipped classroom was successfully introduced at the undergraduate level at the University of Miami- Ohio in an Introduction to Economics course in the late 1990's. In their study, students could access lecture and lecture material through PowerPoint slides and recorded audio lecture, or recorded video lectures. When the students entered class, the instructor asked and answered any questions raised. After, the class proceeded to run an economics experiment based on the material and finally students completed worksheets and review questions, which could be answered individually or in groups. Results suggested students preferred the flipped classroom to traditional lecture and instructors were similarly positive, stating they felt students were more motivated to learn. Both students and instructors commented they enjoyed the collaborative environment and the one-to-one support the flipped classroom allowed (Lage, Platt & Treglia, 2000).

Independent learning is an important dimension of differentiation and student growth. One method to achieve independent learning is through the use of the flipped classroom. According to Tomlinson (1993), goals of differentiation include

independent study, novel thoughts, and production. She outlines student's needs in order to achieve independent study as skill building, structured independence, shared independence, and self-guided independence (Tomlinson, 2001). In each of these stages, students work on developing the skills needed to make choices, complete tasks and follow directions to eventually develop the background knowledge and comfort needed to design, carry out, and produce their own work, asking the teacher for assistance when required (Tomlinson, 1993). Kapusnick and Hauslein (2001) also advocate for independent learning, stating it unites teachers and students in creating a common goal, helps students to develop plans, set benchmarks, and provide students with structure when required, which are all important life skills. Race (1996) suggests that most learning is independent in nature. For example, he notes most learning takes place outside of lecture, when students comprehend more when they participate actively in practical work and through collaboration with peers- more often than with direct contact with the instructor. Independent learning allows students the chance for enrichment and retention that would not normally occur in a typical classroom.

Educators value independent study because it allows students to operate autonomously and offers challenges not often met during regular classroom instruction (Powers, 2008). Pugh (1999) suggests independent study brings together student interests and readiness by providing critical thinking skills in the area of decision-making, investigation, inquiry, questioning and reflection.

To facilitate independent study, students must have background knowledge that they can apply to the information learned, and for them to have the organizational skills to complete independent study, which involves appropriate modeling from the teacher and peers. Fisher and Frey (2008) explain that

independent study is achieved through structured techniques and advocate for model of “I do it; we do it; you do it” (p. 3). In this learning and teaching style, called the gradual release of responsibility model, teachers provide the focus of the lesson in a short time frame that instructs students with the purpose of the lesson and models how information is processed, followed by the guided instruction phase, when teachers meet with small groups. In this stage, the initial differentiation can be introduced, as the small groups can be decided by pre-assessments, and allows for students to experience varied material, prompts, and questions. Working with small groups leads into collaborative learning, which provides students with peer support and allows for discussion before moving onto independent tasks (Fisher & Frey, 2008).

Formative assessment, through informal techniques such as discussion and questioning or formally with pre-assessment tests, is frequent in the differentiated and independent learning classroom. Pre-assessments are key to knowing what students already know, what they are interested in, and their learning style, which can assist in differentiating students and assignments (Rakow, 2007). Formative assessments can be integrated into instruction and activities. During the focus lesson, methods like “pair-share”, where students discuss concepts first in partners and then comments are projected for all to see, and “tickets out the door”, where students summarize the day’s lesson and hand the summary to the teacher on the way out of class, are both examples of how assessment can apply (Fisher & Frey, 2008). Guided writing through techniques like scaffolding and guided reading can provide opportunities for formative assessment in the guided learning phases. In these techniques, anecdotal notes and student writing samples allow formative assessment by the teacher, and can also be used in combination with a self-assessment rubric to

promote metacognition. Individual accountability within group work is essential for formative assessment in the collaborative learning phase. For example, a student working collaboratively will produce individual work such as a taking quiz or a writing lab report. In other cases one group project will be presented as a result of collaborative learning. However, by using techniques such as assigning students different color markers to use in poster presentation or ensuring individual participation in presentations, formative assessment can be applied to collaborative learning. During the final stage of independent learning, formative assessments are easily integrated. Methods used for independent learning, such as independent learning centers where students can explore concepts related to the subject according to their interests, engagement activities like writing prompts, and student-teacher conferences or progress reports can be used for formative assessment (Fisher & Frey, 2008).

Summative assessments, such as unit tests or end of course exams, are still valued as indicators of learning, but such assessments can take many different forms so students have the ability to demonstrate their knowledge in their own unique way (Tomlinson, 2001). Swearington argues that standard forms of assessment, like tests, essays and projects, may still be used as long as they are designed to incorporate the following conditions stated by: authenticity, variety, volume (being aware of testing overload), validity, and reliability (as cited in Fisher & Frey, 2008). Cumulative assessments fit best in the independent learning phase of the structured teaching model. By the end of independent learning, students have gained knowledge and had the opportunity to use and apply the new concepts.

Through the use of technology and the flipped classroom, differentiation and independent learning are possible. Differentiation is essential to meeting all student

needs. Through the gradual release of responsibility, students are introduced to independent study, which allows for metacognition in the learning process.

Independent learning allows for students to self-differentiate and select a variety of assignments to help students learn the material in the way most comfortable to them.

Assessment in the differentiated and independent learning classroom is varied, includes formative and cumulative assessment, and allows for students to produce work that shows their individuality and content knowledge.

## METHODOLOGY

The effect of the flipped classroom on student achievement and stress levels was tested on the 19 students (14 females, 5 males) in the Environmental Systems and Societies (ESS) course. In Year 1 (grade 11) and from September through December of Year 2 (grade 12) students were taught using traditional lecture methods. From December to March, students were taught using the flipped classroom approach. While a transition time period existed from November 2011 to mid- January 2012, this time period corresponds with a number of school holidays, revision for mock exams, a one week study break for mock exams, and two weeks of mock exams where students were not in class; accordingly, data was not collected during this time period. In the flipped classroom method, lecture videos were recorded and published to YouTube. Students were responsible for watching videos and submitting questions they had about concepts after watching the videos or a summary if they understood the lecture and had no questions. The questions or summaries were used to stimulate classroom discussions. The remaining classroom



time was devoted to working on projects, lab activities, readings, research and other assignments that may otherwise be assigned for homework.

Grades, including formative assessments, summative assessments and semester were compared between semesters and in some instances, across the student's high school careers. Additionally, students were interviewed and asked to reflect on their learning and stress levels throughout the process. 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.

### Treatment

The treatment of the flipped classroom took place during Topic 4: Conservation and biodiversity, which ran from the end of January to March 2012. Prior to the start of the treatment, students were asked to complete the Student Self-Reported Stress, Effort, and Completion Levels Survey (Appendix F). This survey asked about their assignment effort and competition levels, as well as stress in ESS, other science courses, and the IB program in general. Before Topic 4, students were given the Term Terminate pre-assessment on concept vocabulary (Appendix B). Students were then assigned to watch video lectures and asked to submit questions they had while watching the videos.

During classroom time, instead of listening to lecture and taking notes, students were able to focus on assignments that might otherwise be considered homework, such as writing lab reports, completing research assignments, answering questions from the textbook, and other assignments from the Independent Study Checklist (Appendix A). Prior to stating a sub-topic, students classified their

knowledge of words through Term Terminate (Appendix B). After the viewing of video lecture was due students would take a formative quiz, called the Five Minute Quiz (Appendix C). The average grades of the formative quizzes were compared to the summative topic test grade. Students who performed poorly on the Five Minute Quiz would need to partake in small, teacher-led group discussion; other students may opt into the discussion if they wished. The following class, nine students were randomly selected by pulling names out of a beaker for Student Interviews (Appendix D). The interview used the Five Minute Quiz to open discussion regarding student interest, difficulties in the new method, and levels of effort. Students were interviewed during class time and interviews were used to track student progress over time, as well as record stress levels and feelings towards the flipped classroom process. Additionally, at the end of each subtopic, students completed a Student Reflection Survey in order to qualitatively explore student attitudes and beliefs towards their learning process (Appendix E). The same Term Terminate was given as a post-assessment. The modes of Term Terminate were used to track student progress in content knowledge. Finally, students were asked to retake the Student Self-reported Stress, Effort, and Completion Levels Survey. The modes were used to calculate student completion, effort, and stress levels before and after the flipped classroom treatment. Additionally, statistical methods were used to investigate student semester grades. A paired *t*-test was used to investigate the relationship between Year 2, semester one grade and Year 2, semester two grade. Past semester grades were also collected for students who were enrolled at DAA prior to junior year. The past averages of semester grades were calculated and compared to the grades obtained during the use of the flipped classroom.

Table 1  
*Triangulation Matrix*

Focus Questions	Data Source 1	Data Source 2	Data Source 3
<i>Primary question:</i> To what extent do differentiation and independent learning, through the flipped classroom concept, lead to success in the IB classroom?	Comparison of Year 2 semester one final grade vs. Year 2 semester two final grade, t-test	Student interviews	Comparison of semester grades from years 9-12, ANOVA
<i>Secondary questions:</i> Does the use of differentiation through the flipped classroom allow for increased understanding of concepts?	Calculation of modes from Pre/Post Term Terminate	Five Minute Quizzes (formative) compared to summative test	Student Reflections
Does independent learning allow for students to complete work in class with teacher assistance, thereby reducing workload and stress in the IB classroom?	Student Interviews	Student Reflection	Calculation of modes from the Student Self-Reported Stress, Effort, and Completion Levels Survey

## DATA AND ANALYSIS

Throughout the treatment, students showed an increase in content knowledge. On average, students showed an average percent change of 58% in the content vocabulary ( $N=19$ ). While no change was evident in more common content vocabulary, such as extinct and natural selection, large gains were seen in more advanced terminology, such as geographic and reproductive isolation (Figure 1).

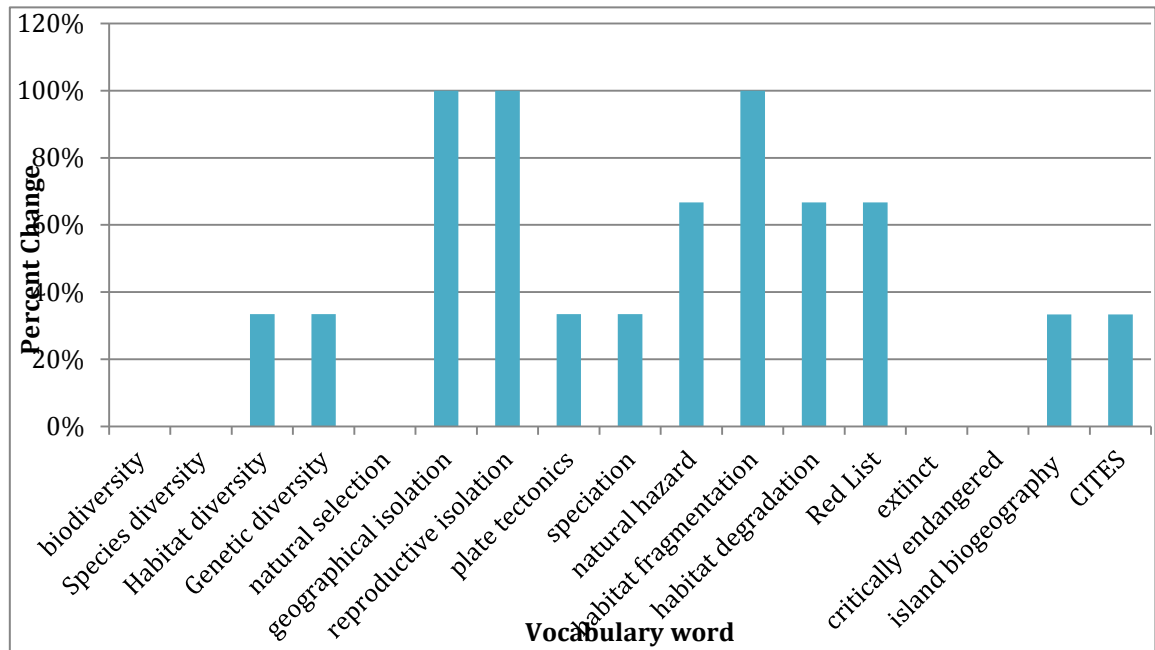


Figure 1. Percent change in student content vocabulary knowledge, as seen in Term Terminate formative assessment, ( $N=19$ ).

The increase in content knowledge was also seen on formative assessments compared to summative assessment. The class average of the two formative quizzes for Topic 4 was 85% compared with a 92% average on the Topic 4 summative test. On formative quizzes, the low was 70% while the low grade in the summative test was 77%. The high grades for both the formative and summative assessment was 100%. During one interview, a student commented on the increase in her quiz and test grades, stating that she enjoyed the flipped classroom method more because she was able to go back and re-visit the lectures before the test and quizzes in order to review and pause to take down notes she might otherwise miss in class. Students who did not perform as well as they expected most often said they felt like they needed to take notes on the video lectures rather than just listening; after the second quiz, the same students reported more positive feelings towards their grade and stated it was because they were taking notes to assist in their learning process.

The increase in grades was also evident in the change in semester one and semester two final grades. The two semester final grades were compared because the

material was of the same difficulty and the teaching hours were similar. Through the use of a paired  $t$ -test, which aids in the assessing if two means are different, the difference in semester grades was examined and a statistically significant difference was determined ( $N=19, p=0.02$ ). While the overall change in semester averages increased from an 82% to an 86% indicating a class average of a 3-point increase, some individuals experienced more dramatic increases in semester grades. As evident in Figure 2, one student increased her grade by 14-points, from a 68.6% to an 82.6%, while another student experienced a 13-point increase from a 70.1% to an 83.1%. However, not all students showed an increase in grades; six students had their semester grades decrease, while one student's semester grade was the same first and second semester. Those whose grade did decrease experienced an average decrease of two points and therefore had little impact on their corresponding letter grade and grade point average. Overall, more students experienced positive changes, with 63% of the class showed an increase in semester grades and 31% experienced a decrease

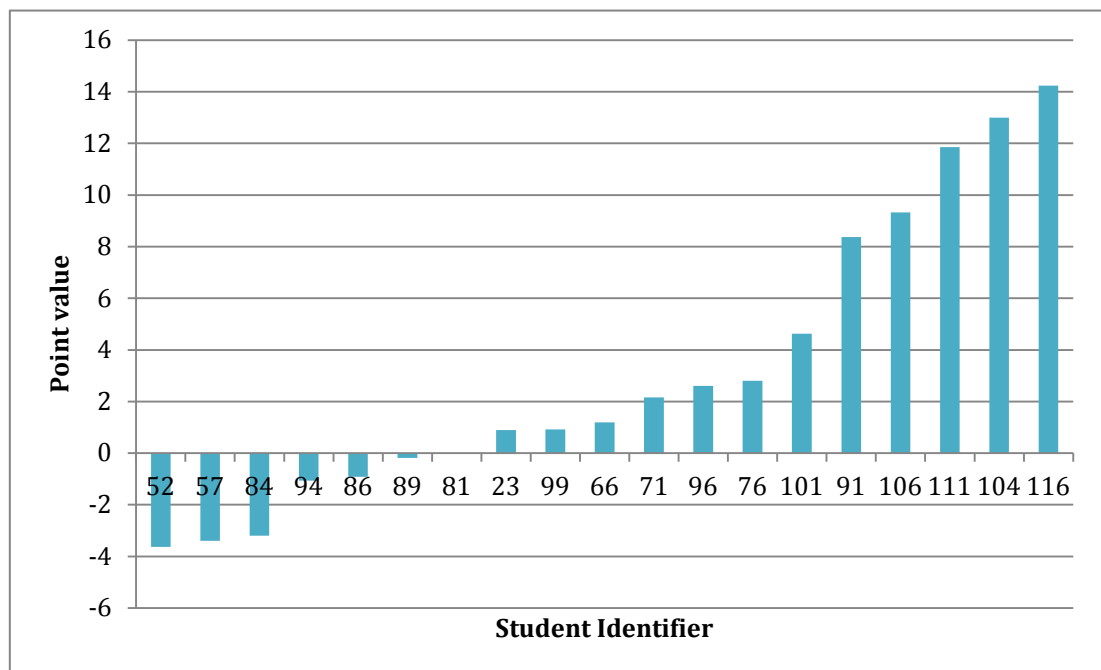
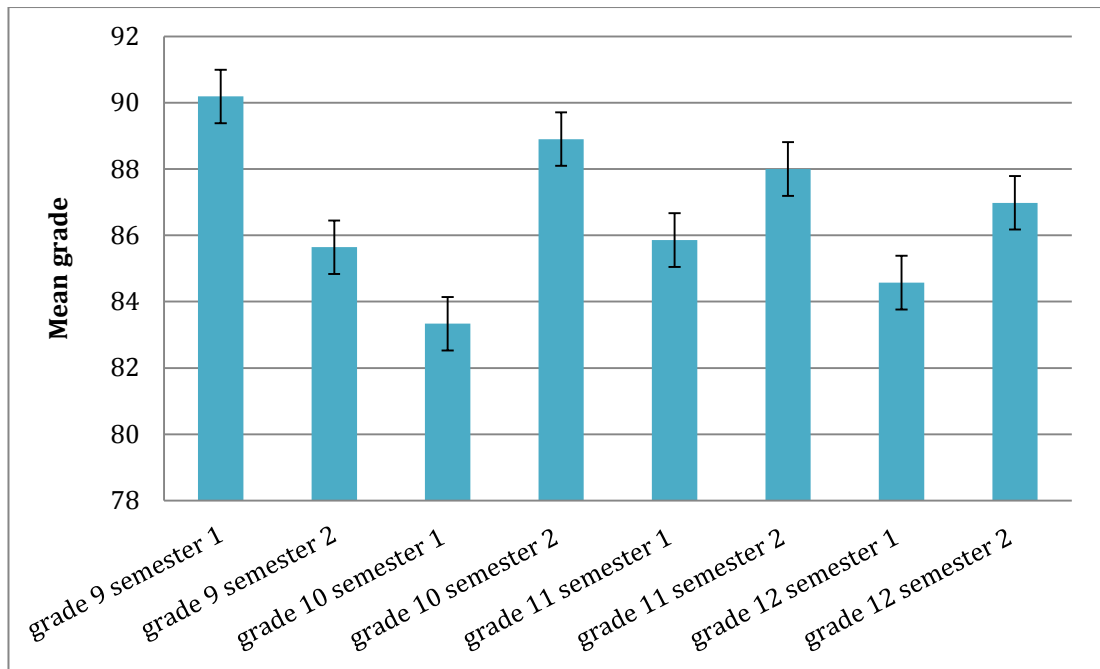


Figure 2. Point difference of student semester one and semester two grades, ( $N=19$ ).

The one-way repeated measure ANOVA was selected to investigate student semester grades over the course of the student's high school career. This test was chosen because the class represents a single group that has been measured several times in terms of final semester grades. The one-way repeated measures ANOVA was used to determine if student performance has changed overtime and what impact the flipped classroom may have had on student performance. Grades were collected for semester one and semester two for each of the 14 students who have been enrolled at DAA for their high school career, for a total of 8 measurements over the course of 4 years. No difference among semester grades from grade 9-12 was found ( $F_{(7,104)}=1.15, p=0.34$ ). There is no consistent pattern of average semester grades across the years. Average grades seem to increase for the second semester in each year, except for grade nine where the reverse is true (Figure 3). The full ANOVA results can be found in Table 2 and a graphical interpretation of the results can be seen in Figure 3.

Table 2  
*One-way Repeated Measures ANOVA Results of Semester 1 & 2 Grades from Grade 9-12, N=14*

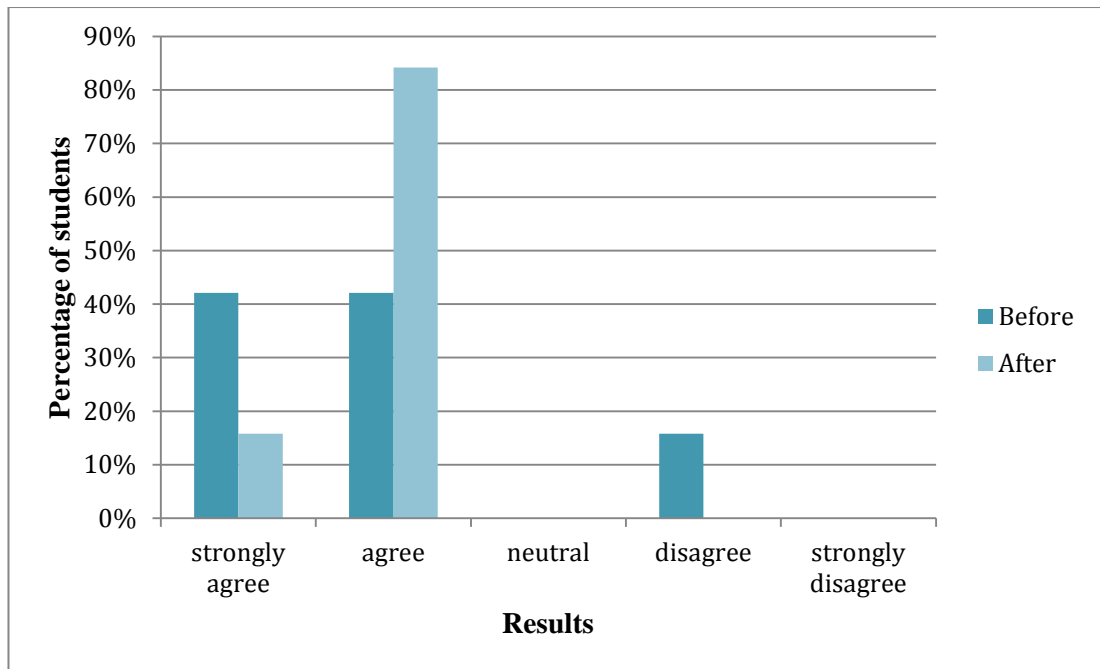
<b>ANOVA</b>						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>p-level</i>	<i>F crit</i>
Between Groups	510.28	7	72.90	1.15	0.34	2.10
Within Groups	6,620.10	104	63.65			
<i>Total</i>	7,130.39	111				



*Figure 3.* Semester grades from grades 9-12. Means  $\pm$  one standard error are shown for eight measurements over four years, ( $N=14$ ).

Prior to the start of the treatment, students were asked to complete a survey (Appendix F) to report their completion of and effort given to past assignments, lab reports (also called Internal Assessments or IAs) in the first year of the ESS course as well as past science courses. The survey also asked for their feelings towards common stressors in the IB program, as well as their overall stress level for the first year. At the end of the course, students completed the same survey.

Results from the pre- and post-survey indicated little change in the completion of assignments. Previously, 42% of students strongly agreed that they completed all assignments on all occasions, while after this number fell to 16%. However, previously 16% stated they did not complete homework on all occasions while after, this number fell to zero (Figure 4).



*Figure 4.* Percentage of student responses to, “I have completed ALL assignments on ALL occasions”, ( $N=19$ ).

When viewing completion rates for IAs, there was an increase in the number of students who completed all of these types of assignments. Before the flipped classroom, 89% of students responded they completed all IAs all of the time. At the end of the school year, 100% of students responded they completed all of these assignments (Figure 5).



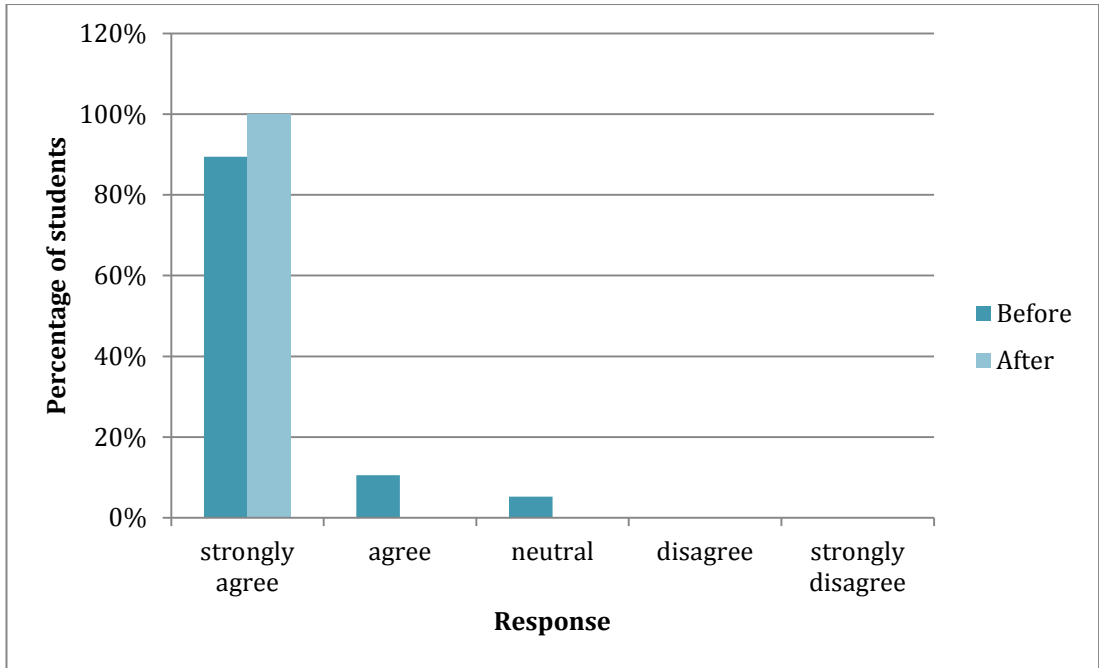


Figure 5. Percentage of student responses to I have completed ALL lab reports/write-ups on ALL occasions, (N=19).

A difference in stress level was seen between the flipped classroom of Environmental Systems and Societies and other traditional lecture based IB courses. The most reported level of stress in ESS was 2 out of 5, compared with 5 out of 5 in other courses (Figure 6).

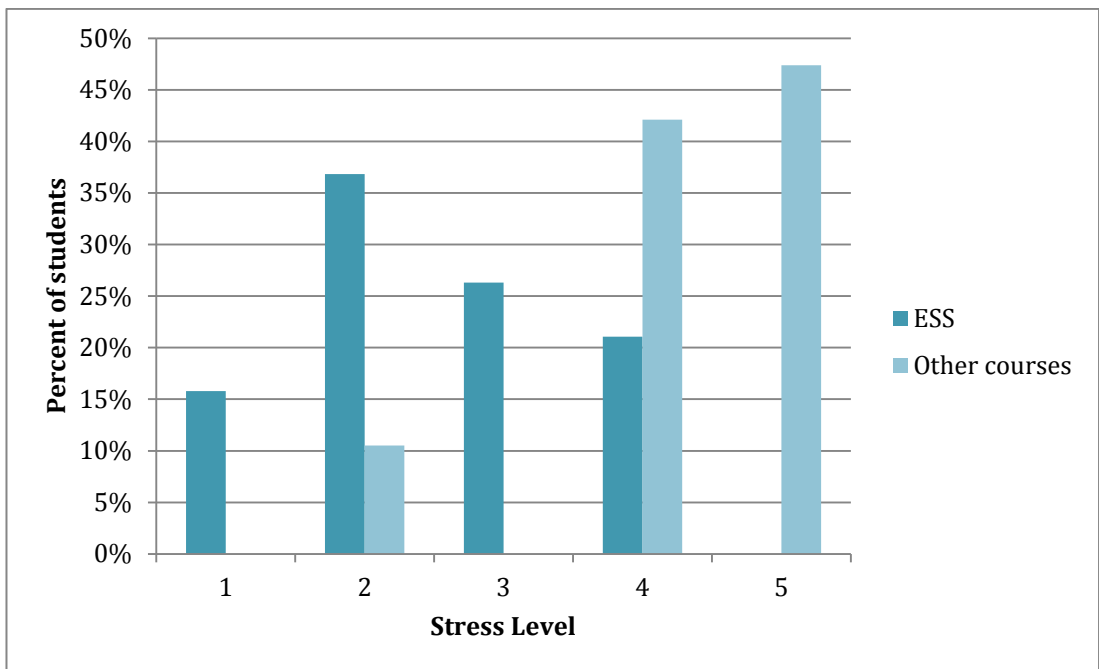


Figure 6. Student reported stress level, where 1 is low and 5 is high, (N=19).

## INTERPRETATION AND CONCLUSION

Results of the study indicated that use of differentiation and independent study, through the implementation of the flipped classroom model, was successful. The grades from semester one and semester two were significantly different, with the majority of students seeing an average increase of three points in semester grades. While different topics are covered in semester one compared to semester two, they are of a similar degree of difficulty and number of required teaching hours as dictated by the syllabus. However, the ANOVA results suggest there is no change in grades when comparing science grades over the course of students' high school career. There are several possible reasons why there was not change in the semester grades- difference in student ability, difference in teachers across the grades, student desire to perform well, preference of science courses, in addition to factors outside of school such as home-life. It is also possible that the flipped classroom has no impact on student grades. Lack of change may not be a negative conclusion, either. While grades may not have improved as previously thought, grades did not decrease compared to past years as well, which means student thoughts and feelings to the process must be considered as well.

The students who showed the greatest increase in semester grades were low performing students. This is because these students were given more opportunities for small group work and one-to-one contact with the teacher than would be possible in a traditional classroom. Lower performing students were required to take part in small group discussion after formative tests and had ample opportunity to ask questions during group and individual work. Instead of these students asking their

peers or parents for help on assignments, they were able to immediately ask me for clarification and assistance. Additionally, these students were able to select assignments that appealed to their multiple intelligences or cognitive level, rather than being forced to complete the same assignments as everyone else. Because lecture time was freed up for activities and assignments, I was able to be more creative with assignments and activities for students to select. For example, the student who said the largest increase in her semester grade also commented on her reflection, "I liked the optional assignment [to create and draw a protected rainforest reserve] and the PowerPoint on a protected area because it was more fun to research that way and make something with images rather than just answering questions.... I feel like I learn a lot more if I have to make a poster on something that interests me." Students who were traditionally top achievers also appreciated the opportunity to work at their own pace and to study the topic at more depth than would otherwise be available. One student commented, "I really liked the combination of podcasts, reading material and doing your own research. It helped me understand the different parts of the topics and the different arguments for some environmental issues.... I enjoyed linking what we were learning to current events, it just made everything more relevant."

By allowing students to complete work independently in class and with teacher assistance when required, student stress levels decreased. The majority of students, 37%, ranked their stress in ESS as a two, on a scale of 1-5, while in other courses stress level was ranked as a five by 47% of students. No students stated their stress level in ESS as higher than four. In order to further understand what was causing stress in other courses, students were asked to explain why they selected the stress rank. For other courses, students stated most often that there were too many

assignments given and not enough time to complete them. As one student commented, “There was a really heavy workload throughout the year.... Along with IB work and additional school work, there were college applications that increased stress levels.” University and college applications in addition to school work was a common stress trigger, with 26% students reporting college applications as a source and 68% reporting too many assignments as a source of stress. The most common reported reason for stress, 53%, in ESS was poor time management and the challenge of balancing other course workloads which prevented students from completing work in a timely fashion. Four students reported they felt either no stress or an adequate amount of stress; as one student explained, “We stayed on track at all times, all podcasts were posted on time and whatever was not understood was explained during class time. I did not feel any pressure from this class throughout the year.” Throughout the process of interviews and reflections, several students echoed similar sentiments.

## VALUE

The significant gains seen in lower achieving students and the appreciation all students had for the process raises the question of how and if the flipped classroom model can be applied to other grades and subjects. In addition to teaching grade 11 and 12, I also teach grade 9 students. Over the action research process, I have debated if a similar model would work with students who are less motivated and less mature than grade 12 students. While I think using the flipped classroom model with younger students would need more rules and accountability, I also think it is a positive model which can influence more students to succeed. I believe the top

achievers will be motivated and learn regardless of the teaching style, but if the flipped classroom model will help motivate middle and low achieving students to work harder and learn in a more efficient manner, than it is worth exploring.

The flipped classroom model is an appropriate method for differentiation and for creating an independent learner, with the help of a few practices. First, students still need to take notes on video lectures. When I first started, several students would watch the videos but would not retain much information because they were not actively engaged in the viewing and learning process. After discussions with students, it was decided that students would need to either submit questions they had about the lecture or a summary of the video. This helped facilitate class discussion and provided a way for me to check that students understood the concepts. In the future, I plan to have students either keep a notebook of just notes from the lectures or explore the option of a student kept blog or wiki. Another option I am considering for accountability is adding a mandatory formative quiz after watching the video, similar to the Five Minute Quiz used during class time. Additionally, classroom discussion still must take place. The number one complaint from interviews with students was that many of them missed the interaction with the whole class; these were students who typically answered all the questions and enjoyed engaging in debates and discussion during class time. To satisfy this desire, I began to schedule time for questions, debates and discussions at least two to three times per topic.

While the flipped classroom model works well in my international school, I do see some concerns that can arise in other settings. Overall, the population of our school is economically stable and it can be assumed that aside from the initial difficulty of setting up internet when moving to Dubai and the occasional internet failure, all students have access to the internet and computers at home; additionally

our campus library is open until 4:00pm during the week, giving students an additional 1 hour and 15 minutes of access to the internet and computers. In areas where socio-economic factors must be considered, other solutions such as burning the video lectures to DVD for watching at home would need to be explored.

Despite the difficulties that may arise from the flipped classroom model, I believe it is a valuable tool to reach all students. Several colleagues have asked if I feel disconnected from my students, as we no longer have the interaction during class time. On the contrary, I feel like I have more individual time with students and have come to understand their moods, learning styles, and needs better than I have in the past because the flipped classroom allows me to step away from the front of the room and to address their individual needs rather than the needs of the majority. Another interesting discovery came during a parent conference. One student was not performing as well as she and her mother would like; instead of offering vague examples of what the student could do to prepare better, I was able to give concrete evidence as to how the student was learning and what was lacking in her studies because I actually saw her preparation and understood her lack of motivation and frustration with the material. It was one of the first times in my teaching career where I felt like the parent meeting was productive, since instead of asking the parent what the child was doing at home to assist in learning, I was able to tell the parent what her daughter was or was not learning and why.

The feedback from the class was overwhelmingly positive. Throughout the process, students were open and honest about their feedback and provided great suggestions about how to improve the way the flipped classroom model was working. On several occasions, different students commented they wished other classes would operate in the same manner because they enjoyed the reduction in

stress and work level that came along with being able to interact with the teacher during the assignment rather than waiting until the assignment was due to discover it was incorrect. I found myself going back and adjusting assignments, allowing myself to be more creative and I experienced less stress in terms of grading because the only common assessments were the summative tests, quizzes and Internal Assessments. By allowing students to choose how to best show me their knowledge I had students who wrote summaries of news articles, created amazing posters raising awareness of endangered species, performed an optional lab activity on global warming impacts on species, while others choose to form a music group who made songs about biodiversity. By allowing them to choose assignments and design their own assessments, the class was less stressful for them and less stressful for me. Next year, I hope to expand the model to include grade nine students in the learning process and perhaps explore the concept of a mastery classroom in conjunction with the flipped classroom model. To this extent, I am also working on a Flipped Classroom Contract, in which guidelines and responsibilities, such as the student being responsibility for their learning by keeping up with work and understanding it is their responsibility to ask questions, are addressed.

## REFERENCES CITED

- Anderson, K. M. (2007). Tips for teaching: Differentiating Instruction to Include All Students. *Preventing School Failure*, 51(3), 49-54. Retrieved from EBSCOhost.
- Fisher, D & Frey, N. (2008). *Better learning through structured teaching: A framework for the gradual release of responsibility*. Alexandria, Virginia: ASCD.
- Gardner, H. (1993) *Multiple intelligences: The theory in practice*. New York: Basic Books.
- Kapusnick, R.A. & Hauslein, C.M. (2001) The 'silver cup' of differentiated instruction. *Kappa Delta Pi Record*, 37(4), 156-159.
- Lage, M.J., Platt, G.J., & Treglia, M. (2000) Inverting the classroom: A Gateway to creating an inclusive learning environment. *Journal of Economic Education*, 30-43.
- Powers, E A (Summer 2008). The use of independent study as a viable differentiation technique for gifted learners in the regular classroom. *Gifted Child Today* 31(3), 57 Retrieved February 19, 2011, from General OneFile via Gale:  
[http://find.galegroup.com.proxybz.lib.montana.edu/gtx/start.do?prodId=ITOF&userGroupName=mtlib\\_1\\_1123](http://find.galegroup.com.proxybz.lib.montana.edu/gtx/start.do?prodId=ITOF&userGroupName=mtlib_1_1123)
- Pugh, S. (1999). Developing a foundation for independent study. *Gifted Child Today*, 22(2), 26-33.
- Race, P. (1996). *A fresh look at independent learning*. Retrieved March 29, 2011 from  
<http://www.londonmet.ac.uk/deliberations/effective-learning/independent.cfm>
- Rakow, S. (2007) All means all: Classrooms that work for advanced learners. *Middle Ground, The Magazine of Middle Level Education*, 11(1), 10-12.
- Richards, M. & Omdal, S. N. (Spring 2007). Effects of tiered instruction on academic performance in a secondary science course. *Journal of Advanced Academics*, 18 (3), 424(30). Retrieved February 19, 2011, from Educator's Reference Complete via Gale:  
[http://find.galegroup.com.proxybz.lib.montana.edu/gtx/start.do?prodId=PROF&userGroupName=mtlib\\_1\\_1123](http://find.galegroup.com.proxybz.lib.montana.edu/gtx/start.do?prodId=PROF&userGroupName=mtlib_1_1123)
- Reichmann, S. & Grasha, A.F. 1974, A rational approach to developing and assessing the construct validity of a student learning scale instrument, *Journal of Psychology*, 87(2), 213-23.
- Tomlinson, C. A. (1993). Independent Study: A Flexible Tool for Encouraging



Academic and Personal Growth. *Middle School Journal*, 25(1), 55-59.

Tomlinson, C. A., (2001). *How to differentiate instruction in mixed-ability classrooms*. (2nd Ed.) Alexandria, Virginia: ASCD.

Tomlinson, C.A. & Allan, S.D. (2000) *Leadership for differentiation schools & classrooms*. Alexandria, Virginia: ASCD.

Tomlinson, C.A. & McTinghe, J. (2006) *Integrating differentiated instruction and understanding by design*. Alexandria, Virginia: ASCD.

APPENDICES

APPENDIX A

INDEPENDENT LEARNING CHECKLIST

Topic 4: Conservation and biodiversity, 15 hours

4.2 Evaluating biodiversity and vulnerability

Required?	Description	Due date
√	4.1 evaluation+ goal setting (edline link to google doc)	21-Feb
√	4.2 podcast +homework, part 1	23-Feb
√	4.2 podcast +homework, part 2	27-Feb
√	case study of a species	29-Feb
√	case history of a natural area	4-Mar
	read and summarize 2 current events articles on species diversity or natural areas	6-Mar
	design your own assessment	6-Mar
√	read/notes pg 91-98	21-Feb
√	read/notes 106-116	23-Feb
	questions pg 116	6-Mar
√	Natural Selection IA	9-Mar
	select 1 optional assignment	

APPENDIX B

TERM TERMINATE

Below is a screen shot from the Google Doc survey. The link can be accessed at <https://docs.google.com/spreadsheets/viewform?formkey=dG5PYUQwV3NuM1BnWGY0MDAwVVJkN3c6MQ#gid=0>

## Topic 4 Pre/post Vocab survey

Please be honest about your knowledge of the words below. You do NOT gain more points by saying you know all or none of the words. Complete the pre assessment by the due date, and complete the same form again at the end of the unit.

4= I know this word and I can define it

3= I think I know this word

2= I've seen this word, but can't define it

1= I've never seen this word before in my life

\* Required

Name \*

**biodiversity \***

1 2 3 4

**Species diversity \***

1 2 3 4

**Habitat diversity \***

1 2 3 4

APPENDIX C

FIVE MINUTE QUIZ

Name: \_\_\_\_\_

#### 4.1 Five Minute Quiz

1. State the three types of diversity. (1)
2. State two types of isolation. Explain how one of them can lead to the rise of a new species. (2)
3. Explain how natural selection can lead to new species. (2)



APPENDIX D

STUDENT INTERVIEW QUESTIONS

1. Think back to your last 5-minute quiz- did you perform to your satisfaction?  
What do you think you need in order to perform better/ why do you think you did well on the quiz?
2. Do you think you are attaining adequate progress in your learning? Why or why not?
3. Do you think you are putting in more or less effort than before independent study? Why or why not?
4. On a scale of 1-5, 1 being low and 5 being high, how motivated are you to complete work to the best of your ability?
5. On a scale of 1-5, 1 being all the time and 5 being never, how often do you complete your assignments to the best of your ability?
6. On a scale of 1-5, 1 being low and 5 being high, how would you rate your stress level in this class? In other classes? Why do you feel this way?
7. Is there anything else you would like to add?

APPENDIX E

STUDENT REFLECTION

1. Have you completed all required assignments? (1)
2. Have you completed the correct number of optional assignments? (1) Please list these assignments.
3. Have you completed the work to the best of your ability? Why/why not? (3)
4. Reflect on your learning process. Here are some ideas of questions to get you started- you can choose to answer some, all, or none of these. *Is there anything you need in order to be more successful? What is it? Were there some points where you learned better than others? Why was that? Do you think you are successfully meeting learning targets? Why or why not? Did you like any of the assignments in particular? Why?* (5)
5. Do you feel you worked at a good pace? If so, why? If not, why not/what can you do (or me as your teacher) to help stay on target? (2)
6. Create a goal for your next block of assignments. Is there anything I can do to help with this goal? (1)
7. Yes or no: I feel like the amount of work was appropriate for the time given. Please explain. (2)

APPENDIX F

STUDENT SELF-REPORTED STRESS, EFFORT, AND COMPLETION LEVELS  
SURVEY

Name: \_\_\_\_\_

Please be honest about your effort and completion of homework, projects, labs, and other assignments in high school. Circle the response that best fits.

Completion of work in past high school science courses

**1. I have completed ALL homework assignments on ALL occasions.**

Strongly agree    agree        neutral        disagree        strongly disagree

**2. I have completed ALL lab reports/write-ups on ALL occasions.**

Strongly agree    agree        neutral        disagree        strongly disagree

**3. I have completed ALL projects on ALL occasions.**

Strongly agree    agree        neutral        disagree        strongly disagree

Effort of work in past high school science courses

**4. I have ALWAYS completed my homework to the best of my ability.**

Strongly agree    agree        neutral        disagree        strongly disagree

**5. I have ALWAYS completed my lab reports/write-ups to the best of my ability.**

Strongly agree    agree        neutral        disagree        strongly disagree

**6. I have ALWAYS completed my projects to the best of my ability.**

Strongly agree    agree        neutral        disagree        strongly disagree

Completion of work in ESS Year 2

**7. I have completed ALL homework assignments on ALL occasions.**

Strongly agree    agree        neutral        disagree        strongly disagree

**8. I have completed ALL lab reports/write-ups on ALL occasions.**

Strongly agree    agree        neutral        disagree        strongly disagree

**9. I have completed ALL projects on ALL occasions.**

Strongly agree    agree        neutral        disagree        strongly disagree

Effort of work in ESS Year 1

**10. I have ALWAYS completed my homework to the best of my ability.**

Strongly agree    agree        neutral        disagree        strongly disagree

**11. I have ALWAYS completed my lab reports/write-ups to the best of my ability.**

Strongly agree    agree        neutral        disagree        strongly disagree

**12. I have ALWAYS completed my projects to the best of my ability.**

Strongly agree    agree        neutral        disagree        strongly disagree

IB Year 1 Stressors

**13. Overall, I felt that amount of homework/assignments I received in Year 1 was appropriate.**

Strongly agree    agree        neutral        disagree        strongly disagree

**14. I felt stressed trying to complete my homework/assignments on many occasions.**

Strongly agree    agree        neutral        disagree        strongly disagree

**15. I frequently did not complete assignments/homework in one course.**

Strongly agree    agree        neutral        disagree        strongly disagree

**16. I frequently did not complete assignments/homework in one course because I was receiving too much homework in another course.**

Strongly agree    agree        neutral        disagree        strongly disagree

**17. I felt that my teachers often assigned homework that was too confusing/frustrating to complete on my own.**

Strongly agree        agree        neutral        disagree        strongly disagree

**18. I relied on my peers to help me understand assignments.**

Strongly agree    agree        neutral        disagree        strongly disagree

**19. On a scale of 1-5, with 1 being low and 5 being high, rate your overall stress level for Year 1. Please explain why you selected this number.**