A STUDY OF A HYBRID COURSE IN NON-MAJORS BIOLOGY: AN ASSESSMENT OF CHANGES IN STUDENT ATTITUDES AND LEVELS OF ENGAGEMENT

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This paper is dedicated to my loving parents without whose belief and support I could have never made it this far. I am forever grateful and I will love you both always.

I would also like to thank my thesis committee whose help was invaluable in completing this research project.

INTRODUCTION

The renowned educator Horace Mann once said that, "Education, then, beyond all other devices of human origin, is the great equalizer of the conditions of men, the balance-wheel of the social machinery" (Mann, 1848). Biology is a fundamental part of a well-rounded education. Proper instruction in the field of biology should stimulate curiosity about the natural world, develop life-long learning competencies and stimulate deep thinking about scientific concepts (Bauerle et al., 2011). The mysteries of the history of the planet Earth are unlocked through the study of biology and its sister fields giving students perspective on how we have arrived where we are today. The study of biology allows students to observe and understand the physical changes occurring over time to the human body and the Earth (Aplet et al., 1992). A knowledge of biological processes and principles allows students to understand and engage with current political debates such as global warming, coal mining and burning as a power source, clean energy, and fetal and adult stem cell research (Masters, 2001). In fact, one can say that without biology there is an inability to understand the intricacies of the interactions between the living and non-living world (Iran-Nejad et al., 1992; Sears, 1976). Biology teaches students how the world they live in works, as well as how their actions affect the delicate balances that exist on planet Earth (Bauerle et al., 2011).

The pedagogy used to teach biology has developed over time. The most classic method of education involves face to face and instruction by lecture styles. These methods allow students to interact with an expert in the field and develop a personal attachment to the material through the faculty while creating accountability for material taught (Ross, 1992). A key problem with the way most biology classes are taught using this method is that most of the students' in-class time is spent on identification of terms, concepts, facts and figures from a textbook instead of engaging the mind of the student. This lecture method of classroom instruction does not

captivate the minds of students nor does it stimulate deep thinking about how biology interacts with the other sciences or how it affects them personally on a day to day basis (Bersin, 2004).

Information technology has become an important tool used in the teaching of science (Sun et al., 2008). With the advancements in Web 2.0 and associated computer technologies online learning was born (Bower et al., 2010; Harasim, 2000). By the academic year 2006/2007, 61% of two-year and four-year institutions were offering online courses (Parsad and Lewis, 2008). This method lets students engage the material at their own pace and on their own time schedule. In solving a few of the problems that were indicated with the face to face teaching methods, online education brought forth a new set of problems. Some of the problems with online learning begin with the ease in which the students disconnect from the material. Additional problems occur as people who are fully employed attempt to add online coursework to their busy lives; this results in diminished mental focus and an incomplete understanding of the material. The lack of accountability is a major factor for this disconnect (Bersin, 2004). Bersin (2004) mentions that in the beginning stages of corporate e-learning there was a 60% drop out rate. This drop was due to a lack of engagement and created a general overarching negative attitude towards online education. One way recommended to fix some of these problems is to allow the students to develop questions themselves to ask other students. By making the students think through scientific principles to the point where they are able to write questions on the material helps to cement material covered in class (Pittenger and Lounsbery, 2011). It has been suggested that working in groups provides a good setting for students to engage the previously mentioned self-developed questions (Sadler, 2002). This method of group discussion is one of the foundational tenets of blended learning (Akkoyunlu and Soylu, 2008; Santandreu Calonge et al., 2011; Swan, 2002).

In 1987, Chickering and Gamson described seven principles for good practice in undergraduate education: (1) encourages contacts between students and faculty; (2) develops reciprocity and cooperation among students; (3) uses active learning techniques; (4) gives prompt feedback; (5) emphasizes time on task; (6) communicates high expectations; and (**7**) respects diverse talents and ways of learning (Chickering et al., 1987). It is because of the inability of current teaching methods to fulfill such a basic set of principles as these that changes must be made to our current methods of educating our students. In 2010, revised in 2011, the American Association for the Advancement of Science (AAAS) with the support of the National Science Foundation (NSF) published *Vision and Change in Undergraduate Biology: A Call to Action.* This report addresses the need for changes in the way biology is taught. One of the major focuses of the report is on moving away from teaching only the content of biology towards teaching the core concepts and processes of science. Students moving into more advanced levels of biology appear to be unprepared for the critical thinking that is required for proper application in biological fields and civic interaction (Moore, 2012). The report suggests a four-pronged approach for implanting the change (Table 1).

Table 1 – Vision and Change's goals for the reforming of biology education

1. Integrate Core Concepts and Competencies throughout the Curriculum
    a. Introduce the scientific process to students early, and integrate it into all undergraduate biology courses.
    b. Define learning goals so that they focus on teaching students the core concepts, and align assessments so that they assess the students' understanding of these concepts.
    c. Relate abstract concepts in biology to real-world examples on a regular basis, and make biology content relevant by presenting problems in a real-life context.
    d. Develop lifelong science-learning competencies.
    e. Introduce fewer concepts, but present them in greater depth. Less really is more.
    f. Stimulate the curiosity students have for learning about the natural world.
    g. Demonstrate both the passion scientists have for their discipline and their delight in sharing their understanding of the world with students.
2. Focus on Student-Centered Learning
    a. Engage students as active participants, not passive recipients, in all undergraduate biology courses.
    b. Use multiple modes of instruction in addition to the traditional lecture.
    c. Ensure that undergraduate biology courses are active, outcome oriented, inquiry driven, and relevant.
    d. Facilitate student learning within a cooperative context.
    e. Introduce research experiences as an integral component of biology education for all students, regardless of their major.
    f. Integrate multiple forms of assessment to track student learning.
    g. Give students ongoing, frequent and multiple forms of feedback on their progress.
    h. View the assessment of course success as similar to scientific research, centered on the students involved, and apply the assessment data to improve and enhance the learning environment.
3. Promote a Campuswide Commitment to Change
    a. Mobilize all stakeholders, from students to administrators, to commit to improving the quality of undergraduate biology education.
    b. Support the development of a true community of scholars dedicated to advancing the life sciences and the science of teaching.
    c. Advocate for increased status, recognition, and rewards for innovation in teaching, student success, and other educational outcomes.
    d. Require graduate students on training grants in the biological sciences to participate in training in how to teach biology.
    e. Provide teaching support and training for all faculty, but especially postdoctoral fellows and early-career faculty, who are in their formative years as teachers.
4. Engage the Biology Community in the Implementation of Change
    a. Promote more concept-oriented undergraduate biology courses, and help all students learn how to integrate facts into larger conceptual contexts.
    b. Ensure that all undergraduates have authentic opportunities to experience the processes, nature, and limits of science.
    c. Provide all biology faculty with access to the teaching and learning research referenced throughout this report, and encourage its application when developing courses.
    d. Create active-learning environments for all students, even those in first-year biology courses.

e. Encourage all biologists to move beyond the "depth versus breadth" debate. Less really is more. (Bauerle et al., 2011)

An important concept brought to light in the previous list is the concept of active learning. Traditionally classes are taught using passive learning meaning that students come to class, sit at their desks and hear a lecture (McClanahan and McClanahan, 2002). One of the main reason that this is the prevailing method is that traditionally professors have tried to fit as many concepts and principles into a semester as possible. Imparting such great volumes of information is only possible if the professor lectures continuously while the students scribble notes furiously at their desks. All that this cramming of information into a semester has managed to accomplish is to encourage the memorization mentality (Michael, 2006). This method does not cause the student to be actively engaged with the material thereby making it harder for the information to be cemented in the mind of the student. An alternative to this cramming of information is to pare down the number of concepts to those necessary for basic daily interaction (such as basic ecology and the scientific method), which is especially important in a general survey course after which many students may not have the opportunity to or want to take another science class (McClanahan and McClanahan, 2002; Michael, 2006; Rutledge, 2008).

At the heart of this debate on educational methods are academicians' views of students' epistemology (Deniz, 2011). The two viewpoints on the students' ways of knowing are the more traditional transmissive view versus a constructionist view which utilizes active learning. The major difference in these methods is that the constructivist model uses previously learned knowledge when teaching new concepts. Learning in this manor helps the students relate bodies of knowledge to one another thereby creating a more complete picture of the interconnectedness of science. The more traditional absorption model proposes that students gain knowledge as it is imparted with no background or context necessary (Bevevino et al., 1999).

One of the suggested ways to solve the combined problems raised by the face to face teaching method and online learning is through the method of blended learning (Bauerle et al., 2011). Blended classes, also known as hybrid classes, can be defined as courses that have reduced "face time" that is replaced by time spent outside the classroom or to put it more simply a blending of e-learning and traditional learning techniques (Abdalla Jr et al., 2012; Caulfield, 2011). Online video lectures, quizzes and group projects (via forums) are just a few of the ways the traditional face to face teaching method may be supplemented by online material. There is room for more field trips and experimentation when using a blended learning method as the students need to spend less time in lecture because they have already engaged the material beforehand (Akkoyunlu and Soylu, 2008; Uğur et al., 2011).

The benefits of the blending learning method are that students are able deal with part of the material on their own time and at their own pace, but there is the accountability and presence of an expert that comes with face to face instruction. This also allows teachers to pick important topics out of the text and zero in on them for greater understanding through non-lecture techniques such as videos, field trips and in-class group discussion since there is no need to lecture during class. The students do not need to have a lecture because the online video lectures and lessons cover what would have normally been lectured on during the class period. The interaction with the material before class allows the teacher to instead answer questions about specific sections or principles that the students have questions on using examples, discussion and/or practice problems since the students have already been introduced to the material. Using this method of instruction, the teacher becomes more of a facilitator of learning rather than simply regurgitating information. This method also facilitates metacognitive development and self regulatory development thus moving the responsibility of learning from squarely on the

shoulders of the instructor to the students taking the course thereby helping the students take more responsibility for their own education (Li-Ling and Suh-Ing, 2011). In addition to the blended learning, the method of flipping the classroom also presents a new way of approaching the blending of online and face to face learning (Akkoyunlu and Soylu, 2008; Heinze and Procter, 2004; Uğur et al., 2011).

What makes a blended class also a flipped class is that the students deal with the traditional lecture material (terms, concepts, facts and figures) in the online format. Because the lecture material is online now the teacher can use the class time to discuss the implications of these concepts in real life situations. Discussing these implications helps make the connection to the material more visceral for the student (2011). Also the class time interactions with an instructor allows for meaningful learning with diminished misconceptions. Flipping the classroom allows students to take ownership and responsibility for their learning. Students in a flipped class can no longer passively receive information in class, but are now responsible for gaining most of the knowledge outside of class (Berrett, 2012). Caulfield states that this is part of the process of switching from a pedagogical educational approach to an androgogical educational approach (Caulfield, 2011). Table 2 from Caulfield (2011) outlines the major differences between these two types:

Table 2 – Pedagogical Principles Compared to Androgogical Principles

Pedagogical Principles	Androgogical Principles
Learners learn what the teacher tells them they need to know.	Learners need to know why information is important to learn.
Learning is the primary responsibility of the teacher.	Learning is the primary responsibility of the student.
Transferring information is the most frequently used method of teaching, and learners experience is minimized.	Drawing on the individual's personal experience and relating that experience to information from the discipline is the most frequently used method of teaching.

Readiness to learn is determined by the teacher, and uniformly applies to the entire class.	Applying scaffolding techniques, such as group interaction, simulation, and case analysis is frequently used to enhance each individual's readiness to learn.
Content to be learned is determined by the logic of the discipline.	Information is best learned when applied to real-life situations that are relevant to the learner.
External motivators (grades, monetary rewards) are considered primary motivators of learning.	Intrinsic motivators (self-esteem, need to achieve) are more important than extrinsic motivators.

(Caulfield, 2011)

In Heinze and Procter's (2004) opinion, one of the hurdles to overcome when attempting to teach a blended learning course is that neither teacher nor their students have much experience with these types of learning so there is a huge learning curve. Students surveyed in Uğur and Akkoyunlu's (2011) study said that they benefited from the ability to deal with the text beforehand. The approach allowed them to "easily understand the lesson" and "establish a firmer connection between the topics and look from a wider perspective" (p.15, 16). Akkoyunlu and Soylu (2008) surveyed students who liked the face to face part of the course because it allowed them to "understand the topics which we had not been able to understand on the web" (p. 188). The surveyed students also liked the online portion because "We can learn by being free of time and place limitations in accordance with our own learning speed" (Akkoyunlu and Soylu, 2008) (p.183). There are many different ideas about blended learning, but very few statistical analyses that give evidence to the effects of this blended learning on the students.

THE PROBLEM

Ball State's Biology 100 class, Biology for a Modern Society, is a non-majors class that can be taken to fulfill a general elective credit. This class has within the past two years been converted from a traditional method of instruction to a blended, flipped method. The problem with this change is that there is a lack of empirical data on the effectiveness of blended classes in

engaging the students or on the attitudes of the students towards blended learning. It is for this purpose that this project is proposed.

THE HYPOTHESES

1) This educational method will show a difference between the pretest and posttest in regards to attitude amongst gender, class rank or expected grade.

2) This educational method will show a difference between the pretest and posttest in regards to levels of engagement amongst gender, class rank or expected grade.

Literature Review

The declining numbers of students choosing science as a pursuit for study has been shown to have a direct correlation to their attitudes about science (Osborne et al., 2003). Research has shown that attitude levels are an important predictor of academic performance (Otunuku and Brown, 2007). Memory retention of learned subject matter also has been researched and shown to be directly affected by attitudes towards the subject in question (Holbrook et al., 2005). The attitudes of students towards their classes have been shown to have a direct correlation with the student's satisfaction with the class, level of control of the learning process and study motivation for learning (Katz, 2002). Students who experience science workshops where active engagement and correlation with everyday situations were stressed exhibited a positive change in attitude towards science studies (Rukavina et al., 2012). A key method used to cause students to engage with class material is active learning. Active learning, just as it sounds, forces the students to interact with science principles and crosslink them to other knowledge during class time (Michael, 2006). As mentioned previously, the constructivist model of education is an active learning model that builds upon previously gained knowledge. Current research shows that the constructivist model of learning is more beneficial for understanding science than the transmissive model (Bevevino et al., 1999; Chang and Bell, 2002; Rizk et al., 2012). Research has shown that the constructivist educational model is effective at promoting changes in conceptual knowledge as well as committing the gained knowledge into long-term memory (Çalik et al., 2010). It has also been shown that the constructivist educational model is better than traditional models at motivating students, generating interest in subject matter, and improving problem solving skills (Lotfi et al., 2012).

Studies have shown that the more engaged a student is in his or her coursework, the more information he or she tend to retain, the attitudes of the students about the class is more positive, and the more satisfied the students are with their education (Koljatic, 2001; Umbach and Wawrzynski, 2005). Several sources suggest that there is a direct correlation between lack of engagement and burnout (Alarcon et al., 2011; Giacobbi, 2009). There has also been research that shows engagement levels are even more important in first year undergraduate students (Cruce et al., 2006; Kuh, 2007; Kuh et al., 2008). Research has shown that the amount of engagement has a positive correlation with the amount of money a student makes early on in his or her career (Hu, 2010). The level at which one engages with a class has also been shown to have a direct relationship with the mental health of a student and indirectly on the physical health as well (Steele and Fullagar, 2009). Students have indicated that these levels of engagement are highest in class rooms where teachers utilize active and collaborative learning techniques, engage students in experiences, emphasize higher-order cognitive activities in the classroom, interact with students, challenge students academically, and value enriching educational experiences (Umbach and Wawrzynski, 2005). With engagement being such an important educational rule of measure one would expect to see levels increase after the call for change in undergraduate education went out in the 1980's. However, research has shown that there has been little to no change whatsoever (Koljatic, 2001).

Recently, there has been a call for change in the way that we approach undergraduate education especially in the area of biology (Bauerle et al., 2011). The nature of the problem lies in the fact that students more and more are feeling that the current method of education is focused on the end result of the course, such as high test scores or amount of information covered, without any concern for the journey along the way to get there (Bauerle et al., 2011;

Butenko, 2001). Some of the other factors driving this need for change are workforce shortages, heightened regulatory requirements as well as increased community expectation and scrutiny (Hillis, 2009). This call has been issued by businesses, medical schools, government and educational reformers (Marsh, 2012). The current dominant method of outcomes based education encourages students to merely participate at the level of memorization in education instead of engage in it. There is evidence that shows that although calls for change have been ringing out since the 1930's and a large number of professors are aware of this fact, few do little to change their method of delivery or style of teaching (Agius et al., 2008; Greenberg, 1994). The responsibility for creating change falls squarely on the shoulders of department chairs and key faculty members. Not only will this change improve student's levels of engagement and attitudes towards science education, but the change will also make institutions more competitive with other institutions as well as attract top students to their programs (Greenberg, 1994; Hillis, 2009).

As the number of people going back to school later in career or life rises as well as the amount of students with full time jobs is also on the rise, the need to create a flexible alternative to the traditional method of in-class instruction became apparent (Schopf and Flytkjaer, 2011). One method created to solve this ever growing problem was online learning. This method allows for the students to go to a website and view lectures, video, submit assignments, read textbooks and interact through email with their fellow classmates and instructors (Oeffner et al., 2011; Schopf and Flytkjaer, 2011). In 1981, the first online class was offered (Harasim, 2000). There are some key aspects that need to be considered regarding online learning. First and foremost is immediacy and amount of teacher interaction with the class strongly effects the student's attitudes and participation in the class. Another factor to take into account is the online community. The level of activity between the students in the class has a great effect on the

amount of satisfaction in the class (Ruey, 2010; Wallace, 2003). There is a certain level of flexibility that students enjoy who used this format meaning they can work on it whenever they have time available to do so. This is of particular interest to those already entrenched in a profession where they are busy during "normal" class hours. Usually not living in a large, urban setting is a limiting factor to education as there is limited access to journals or textbooks. However, this is a problem that can be solved with online learning as access to these types of literature may be found online (Aggarwal et al., 2011; Karaman, 2011; Ruey, 2010). Online labs are yet another area to consider when thinking about online learning. There are many positive attributes to this type of learning when applied to laboratories. One of the highest rated attributes is the ability to engage the material at one's own pace. Another advantage to this type of learning is the reduction in cost per student to offer a class. A major problem in doing laboratories face to face is the issue of repeatability and this issue is addressed superbly by online labs as the same results can be achieved repeatedly without having to worry about such problems as optimization or amounts of reagents needed (Venneman and Knowles, 2005). Another problem corrected for by online learning in the laboratory online is the ability to accommodate various learning styles while allowing for a high level of repeatability of the experiments which is essential for the building of scientific concepts (Mawn et al., 2011; Pelayo et al., 2011; Schopf and Flytkjaer, 2011; Sun et al., 2008; Venneman and Knowles, 2005). The ability for people with differing levels of knowledge of the subject matter to learn and gain insight at their respective levels speaks to the ease of use which is an important benefit of this educational method (Feudner et al., 2009; Oeffner et al., 2011). A benefit for the professors of these online classes is a redirection for in-class preparation and execution. Instead of having to spend time every semester giving basically the same lectures over and over again, the instructors can record their lectures once for

online viewing and update them as new information becomes available. This change of focus allows the professor to use the class time to be able to focus on new applications of class material and projects to engage the students (Oeffner et al., 2011). This method of science education does have its limitations. Probably the most obvious limitation to this type of education is the requirement for internet access which, even though it is becoming more commonplace, is not in every household or every country yet (Aggarwal et al., 2011; Lonsdale et al., 2006). One of the problems for students who take classes taught online is that many online classes simply provide recorded instructor lectures, which only reinforces the negative effects of passive non-participatory learning (Wang et al., 2009).

A student's desire to do well in the class is a function of how much interaction the student has with the instructor as well as other students within the class. There is a direct correlation between the amount of time the students spent working on the class and the amount of satisfaction they got from the class making it apparent that this type of class more than any other requires more work for similar rewards as gained in other instructional methods. Only students who exhibit high levels of self-motivation will tend to excel with this type of educational method (Karaman, 2011; Pelayo et al., 2011; Swan, 2002). There seems to be a varying difference of opinion on online learning based on age. This could be a variation that could disappear in the future as students are exposed to online technology at progressively younger ages and are therefore more comfortable with online course work (Karaman, 2011). Several groups of students that have been surveyed were not satisfied with the entire course being online. Some of the concerns that were expressed by these students were lack of immediate responses and a lack of face to face communication from both the instructor and classmates.

Students in these classes suggested a blend of both face to face and online learning (Aggarwal et al., 2011; Aspden and Helm, 2004; Oeffner et al., 2011; Thompson and Heng-Yu, 2005).

Blended learning is fusion of online learning and traditional face to face instruction methods (Abdalla Jr et al., 2012). Studies have suggested that students with different learning styles all tend to perform the same where this method of instructions is utilized therefore making this method more suitable over other methods which favor specific learning styles (Akkoyunlu and Soylu, 2008; Cornelius, 2009). Allowing for collaboration among students in their own time over multiple locations has been shown by research to be a highly desired quality that is present in the blended learning method (Cooner, 2011; Horzum, 2011; Jefferies and Hyde, 2010). Research has shown computer illiteracy is a common problem even in today's advanced society. One of the ways to combat this problem of illiteracy is through high levels of support such as provided by a blended learning environment (Allan and Lukoseviciute-Noreikiene, 2008). One of the keys to the success of this style of teaching has been shown through research to be the level of engagement between both the student and the material as well as between the student and the instructor (Aspden and Helm, 2004). Past research done at Ball State University has shown that there is no difference in levels of engagement or attachment between blended learning courses and traditional face to face teaching methods thereby showing that blended learning is a suitable substitution for more traditional education methods (George-Palilonis and Filak, 2009). As shown in studies, one way to make this transition easier for faculty is through the designing of a quality online curriculum (Bai and Smith, 2010). Research has shown that the anonymity that can be created by utilizing a blended method of education, via the use of gender-free pseudonyms in online forums or chat rooms, allows students who would not usually participate in class to participate. These students in this anonymous environment feel that it is

purely the quality of their work that they are now being judged on and not who they are as a person (Miyazoe and Anderson, 2011). A few of the areas in which students have been shown to excel using blended learning over more traditional learning styles are reading comprehension, oral communication skills, repeatability of experiments virtually instead of waiting for patients to practice on, in-class participation, pre-class preparation and understanding of the material (Behjat et al., 2012; Gibbard and Salajan, 2009; Kenney and Newcombe, 2011; Kirkgoz, 2011). To be able to click on subjects that a student is interested in, while reading the online text, and be able to easily find more information about that subject is an important benefit of blended learning (Behjat et al., 2012). This ability to easily find information online promotes discovery and has been shown to cause the student to want to read more than was assigned (Behjat et al., 2012). One of the main reasons that teachers are reluctant to teach this method is because it is not how the teachers themselves were taught (Igwebuike et al., 2011). Research has shown that no matter how much data is presented to teachers on the effectiveness of a new educational method, teachers are more likely to teach they way that they are most familiar with and that most often is how they themselves were taught (Alesandrini and Larson, 2002; Chang and Bell, 2002; Distler, 2007). Research has shown that apprehension in the application of this method is that it will be too time consuming to develop and the concern over the location of legitimate material since the web is not always a reliable source (Benson et al., 2011). It has also been shown that the level of familiarity of an instructor as well as the students with web-based technology has a direct correlation to how comfortable they are with the concept and implication of blended learning (Benson et al., 2011; Gulbahar and Madran, 2009). Another hurdle mentioned in the implication of blended learning is the lack of support for the teachers who are trying to use it in their classrooms showing that where there is adequate support the blended learning model is widely

accepted then when the teacher has to try to figure it out on his or her own (Boitshwarelo, 2009; Fetters and Duby, 2011; Kenney and Newcombe, 2011; Santandreu Calonge et al., 2011). Research has also shown the importance of the face to face half of blended learning method in that if assignments in both the online classes and the online portion of the blended learning classes excluding any in-class interactions are compared there is a similar lack of online class participation. This lack of online participation shows the need for the classroom and its ability to create an engaging environment that will entice the students to participate in the subject matter (Brooks and Bippus, 2012; Delialioğlu, 2012).

Using the flipped classroom method in the blended learning format is a logical step forward in blended learning technique. This method has been shown to have great appeal to teachers, students and parents as well. For students, the advantage of being able to look at any lecture at any time is very useful, and for parents who are involved in their student's lives, it allows them to be able to see what their student is learning in class (Alvarez, 2012). Research has shown that this method of instruction of watching video lectures and interacting with the material during class time is preferable among students because of the increased one on one time with the professors in class which would have otherwise been used for lecture (Brunsell and Horejsi, 2011). It has been shown to be of great benefit to the student in that working on problems in class allows for the teacher to clear up misconceptions and improper lines of thinking instead of using the class time to lecture over new material (2011). Not only have studies shown that there is a migration from passive to active learning in a flipped classroom but also a general increase in the amount learned overall (Berrett, 2012).

Material and Methods

PARTICIPANTS

During the fall of 2012, a survey testing for student attitudes and levels of engagement was administered to Ball State's BIO 100 classes. Two-hundred and fifteen students were surveyed between two different sections of the BIO 100 class. These students are non-biology majors and contained a large portion of freshman (67%) while having very few upper classmen.

DATA SOURCES

In order to evaluate the change in attitudes and engagement levels over the course of the semester, pre-class and post-class questionnaires were developed (Appendix A). The questionnaire is a combination of two different, published surveys and a few questions tailored to my specific research desires. The first survey used, Science Opinion Survey, was developed out of the necessity to test student's opinions on engaging, inquiry based curricula. The survey was created under the assumption that better science education would improve the quality of education which would in turn increase the student's interest levels in science as shown by more positive attitudes about science (Gibson and Chase, 2002). The survey was recommended by Dr. Tom McConnell for use in science educational research. The second survey used was taken from the National Survey of Student Engagement (NSSE) which is used by permission from Indiana University. The NSSE has been shown to be an accurate measure for the self-reporting of student interactions with faculty, measure of the level of academic challenge, supportiveness of the campus environment, participation in active and collaborative learning and enriching educational experiences (Popkess and McDaniel, 2011). This survey has been widely used and is considered to be a standard for engagement testing in the classroom (Carle et al., 2009).

DESIRED CATEGORIES FOR ANALYSIS

I considered many different identity groups during the course of this study in order to try to look for similarities and differences between these identity groups. The different identity groups that I examined for my research are age, gender, class rank, expected grade. Differences amongst student ages, genders, grade level and expected grade have been shown to be good measures for study. These groupings exhibit a wide range of responses between individual groups, i.e. students age 20 versus students age 18, which makes them a good rubric for study (Ewing, 2012; Graham, 1998; Koohang, 1986; Maas et al., 2007; Novak, 1992; Pettijohn et al., 2010). Finally, I also assessed whether there is a correlation between increased levels of engagement and positive attitudes towards science.

EXPERIMENTAL PROCEDURE

After obtaining IRB approval for the research, the following experimental procedures were carried out. During the first week of classes, the instructor introduced the study to his BIO 100 classes, a class for which I am the graduate assistant responsible for grading many of their homework assignments. The students were then made aware of the informed consent form on the back of their questionnaires (Appendix B). It was explained to the students that there would be a pre-class questionnaire administered during the first week of class as well as a post-class questionnaire that would be administered during the final week of classes. Because I wished to compare pre-class to post-class questionnaires, at the request of the professor the students came up with a code name which they would use instead of their real names. A master code name sheet was created for the students who wished to record their code names on in case they thought that they would forgot it by the end of the semester. The master blank master sheet was left on the desk for the students to fill out after they had turned in their completed questionnaires while

the instructor was out of the room. This master sheet was kept in a locked cabinet in a third party's office where it was kept, inaccessible to either the instructor or the principal investigator in order to preserve impartiality. The professor explained to his class that completing the questionnaire was optional and that in order to preserve impartiality, after administering the questionnaires he would leave the room so as not to know who did or did not do the surveys. The students were then instructed that after they had completed the questionnaires they were to be turned into an impartial third party after which time they would be returned to me for data entry. During the final week of the semester the professor, at the beginning of class, reminded the students about the pre-class questionnaire that they had previously taken and then informed them that they would now be taking the post-class questionnaire. Again to preserve impartiality, after administering the questionnaires, the instructor left the room and the students returned completed questionnaires to a neutral third party who then returned them to the principal investigator. In case the students forgot their code names, the master list was left on the front desk for the students to use once the professor had left the room.

ANALYSIS METHODS

The completed questionnaires were returned to me and I entered the data into Microsoft© Excel™ for further processing. The results of the questionnaires were analyzed in several different ways. Firstly, I analyzed the results of the entire survey separately by age, gender, class rank, and expected grade in order to see if the specific groups have different results or if they are the same across the spectrum. Next, I looked at each question individually by age, gender, class rank, and expected grade to look for differences and similarities amongst these three groups. Thirdly, I looked for differences between the pre-questionnaires and the post-questionnaires on two sets of questions. The first set of questions deals with engagement, on the pre-test these are

question numbers 7 though 12 and on the post-test they are question numbers 1 through 6. The second set of questions deals with attitudes, on the pre-test these are questions number 13 through 21 and on the post-test they are questions number 10 though 18. The entered data was statistically tested for significance in changes in attitudes and engagement in multiple categories. First the total changes in attitudes and engagement for the whole data set was calculated. Next the data was separated into several categories and tested for significant change in attitudes and engagement: age, gender, class rank, previous experience with biology, and AP or No AP Biology. Additionally I tested for changes in engagement levels in relation to attitudes in order to see if there is a correlation between students whose engagement levels with science increase over the course of the semester and more positive attitudes about science. Finally I tested each question couplet in the engagement and attitude sections to see if any of the individual couplets exhibited change. These couplets were tested for overall change and then the means were tested via one-way ANOVA to look for statistically significant inconsistencies between the ways that the different classes of students answered the questions (gender, class rank, age, expected grade, whether or not they took AP biology, and whether the student's previous experience with Biology had been positive or not).

In order to analyze the results of the pre and post questionnaires, point values were assigned to the answer choices as follows: from the pre-test questions numbers 1 through 6 (Yes = 2 and No = 1), for pre-test questions number 7, 8 and 10 through 12 and post-test questions number 1 and 3 though 9 (VO = 4, O = 3, S = 2, and N = 1), for pre-test question 9 and post-test question 2 (VO = 1, O = 2, S = 3, and N = 4), for pre-test questions 13, 15, 16, and 19 though 21 and post-test questions 10, 12, 13, and 16 though 21 (SA = 5, A = 4, NS = 3, D = 2, and SD = 1),

for pre-test questions 14, 17, and 18 and post- test questions 11, 14, and 15 (SA = 1, A = 2, NS = 3, D = 4, and SD = 5).7

At the recommendation of statistician Dr. Kianre Eouanzoui from the Research and Academic Effectiveness office as well as other sited literature, t-tests were run on the questions where there are only two variables (gender, previous experience with biology, and AP or No AP) and a repeated measure ANOVA test on the other categories with multiple variables (age, expected grade, grade level, and class rank) (Dimitrov and Rumrill, 2003; Jahan and Khan, 2012; Thomas and Zumbo, 2012; Zimmerman, 2012). The goal of the study is to test for statistical significance looking at within subject correlation, between subject correlation, and overall significance (Bland and Altman, 1995; Hu and Lin, 2012). The desired four general categories for study are listed in the table below and defined as to what each category tested specifically:

Table 3 - Statistical Analysis Categories

1) General Analysis
    a. Age
    b. Gender
    c. Class Rank
    d. Expected Grade
2) For each question
    a. Age
    b. Gender
    c. Class Rank
    d. Expected Grade
3) Groups of questions to analyze together and then also against age, gender, class rank and expected grade.
    a. Pre-engagement to Post-engagement as follows:

Couplet Number	Pre-Engagement Question Number	Post-Engagement Question Number
1	7	1
2	8	6
3	9	2
4	10	3
5	11	4
6	12	5

    b. Pre-attitude to Post-attitude as follows:

Couplet Number	Pre-Attitude Question Number	Post-Attitude Question Number
7	13	10
8	14	11
9	15	12
10	16	13
11	17	14
12	18	15
13	19	16
14	20	17
15	21	18

    c. Students' attitudes about hybrid class: post-test #19-21
4) When there is a change in the students' level of engagement (3a) is there also a change in students' attitude about science (3b)

Results

During the first week of class, two BIO 100 classes here at Ball State University were surveyed. The classes were given IRB approved pre-questionnaires that contained confidentiality statements. The students were instructed to fill out the questionnaires and then return them to an impartial third party. After all the questionnaires had been completed and handed in, the completed questionnaires were then placed in a locked cabinet until they could be entered into a database for further processing. During the final week of class, the IRB approved post-questionnaires were handed out following the same protocol as the pre-questionnaires and then they were also put into a locked cabinet for further processing at a later date.

After the questionnaires had been entered into Excel™ and returned to their locked cabinet, the entered data were processed using the SPSS™ software package. The data were tested for gain score in attitude and levels of engagement using several different categorizations of information. First, an over-all change was tested for, then the data were divided up by gender, age, class rank, expected grade, whether or not students took AP biology, and whether the student's previous experience with Biology had been positive or not. Since the number of students of each age varied greatly, the students were divided up into age groups. These age groups are as follows: Group 1 - 17 and 18 (28 students), Group 2 - 19 (22 students), Group 3 - 20 (14 students), and Group 4 - 21 to 24 (18 students). Since no students expected to get an F in the class, the range of expected grades was A to D. Finally the questions were tested one couplet at a time to see if any of the individual engagement or attitude questions had yielded any positive results.

There was no statistically significant change detected in attitudes or engagement amongst any of the categories that were tested. Question 9 on the post-questionnaire tested the ability of

the class to challenge the students by making them think differently than they had previously thought.

Table 4 – Data for tracking changes in levels of engagement (first) and attitudes (second). Categories studied include: age, expected grade, gender, class rank, previous experience with biology, and whether or not the student had taken an Advanced Placement (AP) biology class in high school. Data listed includes (from left to right): number of students responding to the surveys (N), mean pre-questionnaire score (PrMS), PrMS standard deviation (PrSD), mean post-questionnaire score (PoMS), PoMS standard deviation (PoSD),and the difference between the two means (Diff).

		N	PrMS	PrSD	PoMS	PoSD	Diff.
Engagement	Age Categorized						
	17 and 18	28	2.40	0.51	2.36	0.65	-0.04
	19	22	2.25	0.84	2.05	0.94	-0.20
	20	14	1.98	0.66	1.94	0.76	-0.04
	21+	18	2.38	0.54	2.37	0.86	-0.01
	Expected Grade						
	A	17	2.40	0.56	2.26	0.86	-0.14
	B	22	2.31	0.61	2.34	0.77	0.03
	C	11	2.36	0.66	2.09	0.83	-0.27
	D	4	1.64	1.05	1.51	1.05	-0.13
	Gender						
	Male	39	2.43	0.70	2.32	0.95	-0.11
	Female	43	2.15	0.58	2.11	0.64	-0.04
	Class Rank						
	Freshman	37	2.45	0.60	2.43	0.67	-0.02
	Sophomore	25	2.00	0.76	1.78	0.88	-0.22
	Junior	9	2.21	0.47	2.19	0.77	-0.02
	Senior	10	2.38	0.53	2.41	0.78	0.03
	Previous Experience						
	Positive	70	1.71	0.69	1.66	0.87	-0.05
	Negative	12	2.38	0.60	2.30	0.76	-0.08
	AP or No AP						
	No AP	65	2.32	0.62	2.21	0.74	-0.11
	AP	17	2.14	0.77	2.20	1.05	0.06
	Totals	82	2.29	0.07	2.21	0.09	-0.08
Attitude	Age Categorized						
	17 and 18	28	2.40	0.51	2.36	0.65	-0.04
	19	22	2.25	0.84	2.05	0.94	-0.20
	20	14	1.98	0.66	1.94	0.76	-0.04
	21+	18	2.38	0.54	2.37	0.86	-0.01
	Expected Grade						
	A	17	2.40	0.56	2.26	0.86	-0.14
	B	22	2.31	0.61	2.34	0.77	0.03
	C	11	2.36	0.66	2.09	0.83	-0.27
	D	4	1.64	1.05	1.51	1.05	-0.13
	Gender						
	Male	39	2.43	0.70	2.32	0.95	-0.11

	Female	43	2.15	0.58	2.11	0.64	-0.04
	Class Rank						
	Freshman	37	2.45	0.60	2.43	0.67	-0.02
	Sophomore	25	2.00	0.76	1.78	0.88	-0.22
	Junior	9	2.21	0.47	2.19	0.77	-0.02
	Senior	10	2.38	0.53	2.41	0.78	0.03
	Previous Experience						
	Positive	70	1.71	0.69	1.66	0.87	-0.05
	Negative	12	2.38	0.60	2.30	0.76	-0.08
	AP or No AP						
	No AP	65	2.32	0.62	2.21	0.74	-0.11
	AP	17	2.14	0.77	2.20	1.05	0.06
	Totals	82	2.25	0.07	2.18	0.09	-0.07

The questions for engagement and attitude were tested individually for gain score to see if any of the questions had yielded any positive results. All but one engagement question couplet showed significant levels of changes less than the 0.05 level of significance. Of those questions that exhibited significant change, two were negative changes observed in couplets 2 and 6. Only half of the attitude questions showed significant levels of changes less than the 0.05 level of significance. Couplet 15 exhibited a significant negative change in attitude (table 5).

Table 5 – Shows which question couplets were tested from the pre- and post- questionnaires from the engagement and attitude sections and their T-tested levels of significance for gain score. The question couplets are first classified by major category (either engagement or attitude), followed by the couplet number (CN), the pre-questionnaire number (PrQ), the post-questionnaire number (PoQ), the mean difference (MD), and finally the calculated level of significance (p Value). Those couplets that show significant positive change are 1, 4, 5, 6, 7, 9, 11, and 12. Couplets 2, 6, and 15 exhibit a significant negative difference between the pre- and the post- questionnaires.

	CN	PrQ	PoQ	MD	p Value
Engagement	1	7	1	0.44	0.00
	2	8	6	-1.05	0.00
	3	9	2	0.04	0.75
	4	10	3	0.38	0.01
	5	11	4	0.96	0.00
	6	12	5	-0.37	0.00
Attitude	7	13	10	0.38	0.00
	8	14	11	-0.07	0.49
	9	15	12	0.33	0.00
	10	16	13	0.04	0.74
	11	17	14	0.39	0.00
	12	18	15	0.30	0.03
	13	19	16	-0.20	0.10
	14	20	17	-0.21	0.08
	15	21	18	-0.27	0.03

The questions were then tested using a one-way ANOVA looking for significant with-in subject variation. Most of the questions did not exhibit different results among the tested groups; however, there were a few that exhibited differences (figure 1).

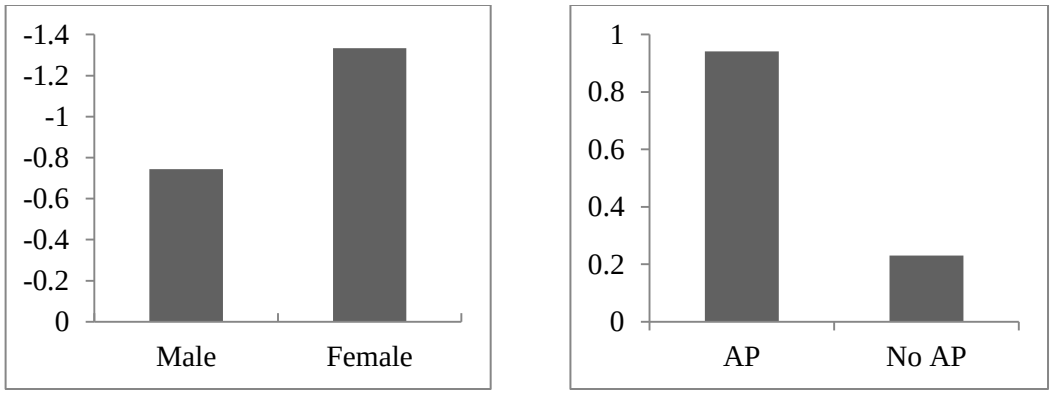
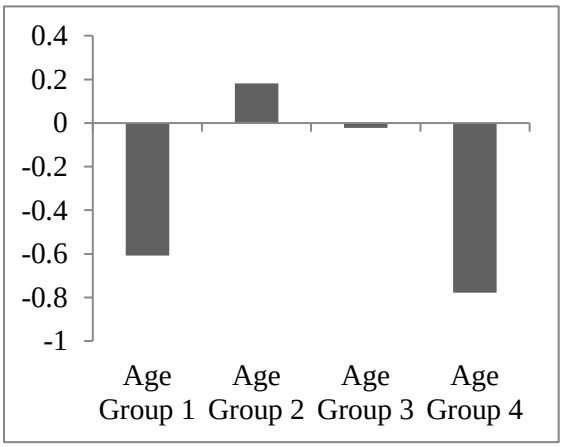
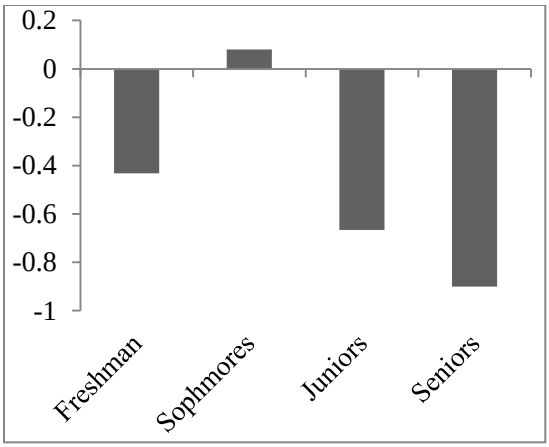


Figure 1.1 - Differences between tested categories in different couplets. The chart on the left is from couplet 2 showing a negative significant change over the course of the semester in the used online materials for class (NOT including projects or reports). The difference here is between the way males and females with females exhibiting a much stronger lack of use then the their male counterparts. The chart of the right is from couplet 4 showing a postive significant change over the course of the semester in the likelyhood for students to work with classmates outside of class to prepare class assignments. The difference here is between students who had taken AP biology in high school (AP) and those that had not taken AP in high school (No AP).





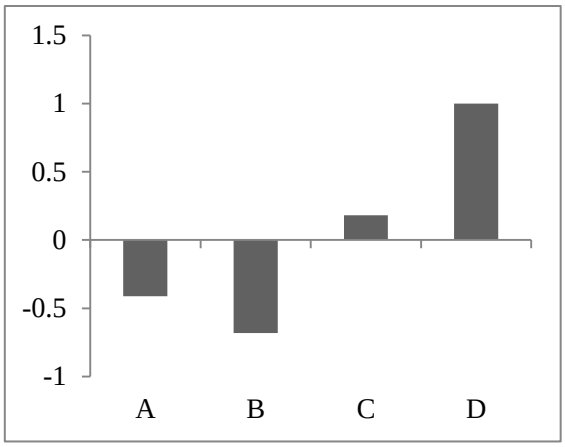
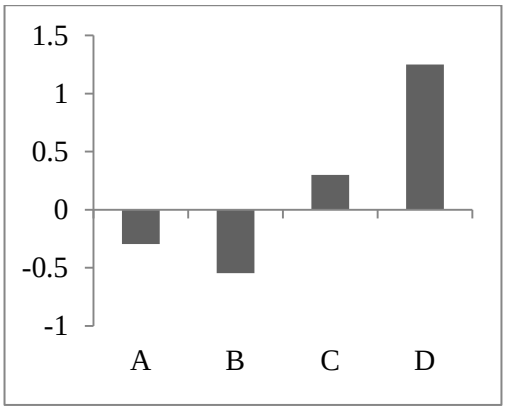


Figure 1.2 - Differences between tested categories in different couplets. These charts are from couplet 6 showing the negative significant change over the course of the semester in the likelyhood that students would discuss biological concepts outside of class with non-classmates (parents, neighbors, friends, ect.). The differences here are between students of different age groups (age group 1: 17 & 18, age group 2: 19, age group 3: 20, age group 4: 21 and over), students of different class rank (Freshmen, Sophomores, Juniors, and Seniors) and students with different expected grades (A, B, C, and D).



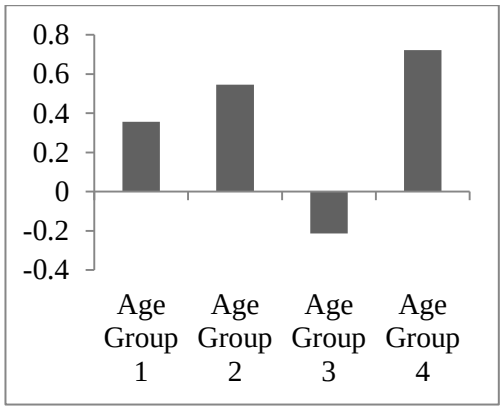


Figure 1.3 - Differences between tested categories in different couplets. The chart on the left is from couplet 11 showing a positive significant change over the course of the semester in the belief that the students do not need to learn more about biology. The difference here is between students of different ages (age group 1: 17 & 18, age group 2: 19, age group 3: 20, age group 4: 21 and over). The chart of the right is from couplet 15 showing the negotive significant change over the course of the semester in how comforatable the studentes feel with talking about biological topics outside of class. The difference here is between students with different expected grades (A, B, C, and D) feel comfortable.

The students were tested by asking how often they felt their ideas were changed whether it was very often, often, sometimes, or never. Here out of 139 student responses, 29% said their ideas were changed very often, 39% said their ideas were changed often, 27% said their ideas were changed sometimes, and 5% said their ideas were never changed. Students were asked if they strongly agreed, agreed, were not sure, disagreed, or strongly disagreed with the statement "I would like to see this method of using online materials to supplement classroom activities implemented in courses that I will take or have taken" (question 20 on the post-questionnaire). One-hundred thirty-nine students responded to that question and of those 64% would like to see this method used again while 15% would not like to see this method used again and 21% were not sure either way (Table 7). Questions 19, 20, and 21 (appendix A) were designed to gauge the students' attitudes towards this method of education. The results for these questions were 64% positive, 16% negative, and 20% not sure (table 7 and figure 2).

Table 7 – Student answers to questions (QN) 19, 20, and 21 on the post-questionnaire (appendix A). The scores were first classified by number if respondents (N) and then level of agreement: strongly agree (SA), agree (A), not sure (NS), disagree (D), and strongly disagree (SD). The scores are then further classified as either positive, consisting of strongly agree plus agree, (NPR) or negative responses, consisting of disagree plus strongly disagree, (NNR).

QN	N	SA	A	NS	D	SD	NPR	NNR
19	139	24	68	29	13	5	92	18
20	139	25	64	29	13	8	89	21
21	139	29	58	24	22	6	87	28
Totals	417	78	190	82	48	19	268	67

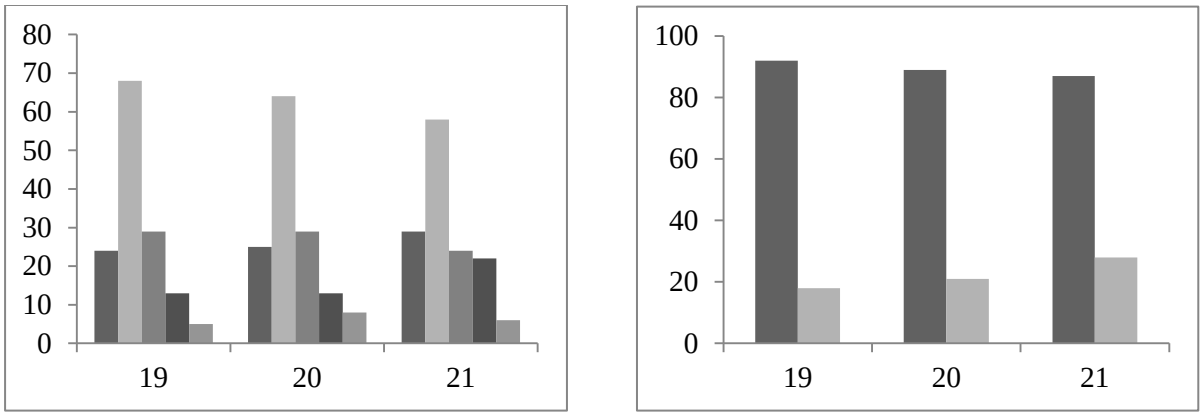


Figure 2 – Chats of the totals from table 7of student answers to questions 19, 20, and 21 on the post-questionnaire. The scores are categorized in the chart on the left as either being (from left to right) strongly agree, agree, unsure, disagree, or strongly disagree. The scores are next separated into two different categories in the chart on the right as either positive, being composed of strongly agree plus agree, being the left, darker bar or negative responses, composed of disagree plus strongly disagree, being the right, lighter bar while disregarding the unsure responses.

Discussion and Conclusions

DISCUSSION

Ball State's Biology 100 class, Biology for a Modern Society, is a non-majors class that can be taken to fulfill a general elective credit. This class has within the past two years been converted from a traditional method of instruction to a blended, flipped instructional method. The problem with this change is that there is a lack of empirical data on the effectiveness of blended classes in engaging the students or on the attitudes of the students towards blended learning. For these reasons, this study is testing for statistical significant changes in attitudes and levels of engagement over the course of the semester. The hypotheses state that this educational method will show a statistically significant difference between the pretest and posttest values in regards to attitude and levels of engagement.

In order to discover if this method is effective or not surveys were administered to two different sections of Biology for a Modern Society. A pre-questionnaire was administered during the first week of class and a post-questionnaire was administered during the week before finals. The results from the questionnaires were analyzed looking for changes in two categories: overall change as well as change in individual question couplets. The results were further analyzed looking for possible variations between the changes of different people groups. These groups were as follows: age groups (group 1: 17&18 years old, group 2: 19 years old, group 3: 20 years, and group 4: 21+ year olds), gender (male or female), class rank (freshman, sophomore, junior, or senior), expected grade (A, B, C, or D), previous experience with biology (positive or negative), and whether or not the students had taken AP biology in high school or not.

Upon statistical analysis of the data, the following results were discovered. There was no overall statistically significant change in attitudes and levels of engagement. Question couplets 1, 2, 4, 5, 6, 7, 9, 11, 12, and 15 all exhibit statistically significant changes when tested

individually. There were statistically significant inconsistencies in the way different groups of people answered the question couplets. For couplet 2, men and women answered differently. In couplet 4, students who took AP answered differently than those who did not take it. Couplet 6 had differences amongst students of different ages, students of different class ranks, and students with different expected grades. In couplet 11, there were statistically significant differences among students of different ages. Finally there were statistically significant differences between students with different expected grades in couplet 15.

Currently, there is world-wide growth in the practice of blended and online learning which benefit student achievement and learning (Dabner et al., 2012). This research has shown that there were no overall significant changes in attitudes and levels of engagement. Even though this is not the original intended result of the study, it is significant none the less in that students exhibited similar attitudes and levels of engagement in this blended class as they had in previous classes which utilized other educational methods. This lack of a decrease in attitudes and engagement levels suggests that blended learning is a viable substitute for other, more traditional methods. Previous studies have also suggested that the blended learning model is a viable substitute for more traditional methods (George-Palilonis and Filak, 2009).

In addition, a majority of students exhibited positive attitudes towards specific aspects of this class in particular. These aspects are they would like to see this method applied on a boarder scale, that the method relieved stress about attending class, and also that the method helped them understand biology better. The results showing that the students would enjoy seeing the method used again in other classes they will take in the future or hand taken in the is supported in other studies (Akkoyunlu and Soylu, 2008; Uğur et al., 2011). The reason that the students found this method to be stress relieving is unclear and requires further testing. This stress relief could

potentially be to the fact that the students are able to engage the material at their own pace. This suggestion has been supported by both this study, post-questionnaire question 19, as well as previous research (Akkoyunlu and Soylu, 2008).

The individual couplets yielded some promising results with 5 out of 6 of the engagement couplets and 5 out of the 9 attitude couplets showing statistically significant changes. However, out of the 5 engagement questions that exhibited significant change, 2 of them were a negative change (couplets 2 and 6). Couplet 15 in the attitudes section also exhibited significantly negative change from pre- to post-questionnaire. Since the questions that did not yield statistically significant changes were answered uniformly across all groups considered, it may be possible that these questions need to be thrown out and new ones that are more specifically tailored to the students who are being surveyed.

The results from the questionnaires show that students overwhelmingly didn't like using the online technology. Couplet 2 was about using the online technology outside of projects and reports. Basically this question couplet was trying to test if the students have used the lecture videos and online text book. It is interesting to note that although this change was negative, the 64% of the student surveyed would like to see this method of education used again (post-questionnaire question 20).

There is a high probability that the technology is new and unfamiliar enough to discourage students (Benson et al., 2011). Students historically have not used the web for these two activities it stands to reason that this new format would be stress and anxiety inducing. While working with some of the female students in this class during a study session, the question was asked "Why can't he (Dr. Rogers) just teach us?" This question suggests that the student has either not adapted to the new method yet, since the time at which this question was asked was at

the end of the first unit this choice seems most likely, or that she didn't like the method. During conversations with Drs. McDowell and McConnell, it became apparent to Dr. McDowell that women in her classes had a more difficult time with this method then did the male students which also validated her own personal experience with the method. Dr. McConnell added that is his case he that while he enjoyed the idea of this method from the start, he had no idea how to do it (McDowell and McConnell, 2013). In addition most of the students surveyed in this class are underclassmen, it is quite possible that this is the students' first ever experience with using online class material, which would be a question to consider asking in future studies. This first time experience could negatively affect how they perceived the class since, for them, the learning curve would be great. Research has suggested that two of the biggest problems for gaining benefit from blended learning are the heavy work-loads and the technical barriers (Delialioğlu, 2012; McNaught et al., 2012).

The insignificant questions deal with topics from completing homework before class to attitudes about Biology lessons (are they boring or are they fun) and finally whether or not the students would consider a job in a biological field (either general biologist or laboratory scientist). It could be argued that since this class is a general education class for non-majors that students notoriously do not spend enough time reading and preparing for class as they should. Yet another reason could be that since most of these students in the class are freshman (46% of the students surveyed were freshman) they have not yet adjusted to the rigors of college education and do not yet understand the importance of preparing for class (Owen, 2010; Smith and Zhang, 2009). Finally, since this is a general education class and not majoring in a Biological field, most likely the students are not considering a career in biology to begin with so

perhaps asking questions about jobs in the field of Biology are not appropriate (Walczak and Walczak, 2009).

Two of the couplets, 6 and 15, that had negative changes were questions about talking about Biology outside of the classroom, in fact they were the only two questions in the questionnaires that dealt with relating to non-class participants (student, instructor, or otherwise) (see appendix A). Couplet 6, which talks about being comfortable about talking about Biology outside of class, yielded negative statistically significant changes and was answered differently by different groups of students: students of different ages, different class rankings, and different expected grades. Since this is a general non-majors course, an increase in wanting to talk about biology outside of class to non-classmates is not anticipated; however a significant decrease is present in this study. It is unclear why students are less likely to talk about Biology outside of class with non-classmates. More research needs to be done to discover what exactly is happening.

One of the main problems that occurred within the study was that a number of responses could not be correlated from the second set of questionnaires. Only 82 out of the original 234 surveys, a 35% return, were useable. One way to fix this problem as suggested by Dr. Tom McConnell would be to have the students combine their birth day, birth month, and last 4 numbers of their social security number and use the resulting number as their code name thus making it both an easily remembered number for them and unknowable to the surveyor.

The number of students answering the expected grade question was very low. In order to combat this low result in future research, choices should be provided and directions for the students to select only one of the choices (A, B, C, or D). Providing choices for the students in this manor should help alleviate confusion for the students, allow more students to answer the

question, and eliminate the observed self-reporting errors of plusses and minuses or choosing more than one grade if the student believes that he or she is on the border between two grade levels.

Yet another problem could be that we administered the final questionnaire the week before finals. Although this did yield a positive result for questions 9 and 19-21 on the post test, there is a possibility that stress felt by the students at that point in time changed the way they answered the questions thereby potentially skewing the results (Eouanzoui, 2013). The week before finals is notoriously the most stressful week of the semester and therefore one would expect attitudes to be less positive during this time.

There is always self-reporter error to take into account when using surveys. Research has confirmed that there is some error to be expected when dealing with self-reported surveys. High performing students tend to undervalue themselves while under performing students tend to over value themselves (Karnilowicz, 2012). In our surveys this could account for the differences in ways students of different expected grades answered the survey questions.

CONCLUSIONS AND RECOMMENDATIONS

A majority of the students desired to see blended learning used again in other classes they either had taken or will take in the future (post-questionnaire question 20). The fact that the students found this method stress relieving (post-questionnaire question 21) and helps them to understand Biology better (post-questionnaire question 19) is encouraging. There is still, however, a long way to go to be able to determine the true benefits of this method.

This study exhibited mixed results when considering the outcomes of blended learning. When considered as groups of engagement and attitude questions, there were no overall statistically significant changes observed between the pre- and post- questionnaires. There were,

however, statistically significant changes observed between the individual question couplets. Some of these couplet changes were negative and some were positive. Since a majority of the questions were answered either positively or with ne change at all it can be concluded that this blended learning method of education can be a valid substitute for more traditional educational methods.

The lack of overall changes could also suggest that some of the questions used in these questionnaires should be replaced by more respondent appropriate questions. Questions that deal more with general application of Biology to every-day life should replace questions that are geared more for majors in the subject area (Walczak and Walczak, 2009). One of the reported main advantages to blended learning is allowing the student to take control of his or her learning experience thereby allowing the individual to learn more about what he or she is interested in (Delialioğlu, 2012).

The technology used in this method is so new and there is a learning curve associated with being able to effectively utilize the online portion of the class, students may not be comfortable with using it (Benson et al., 2011). Because of this learning curve, it is imperative that students be given the proper training in order to best utilize this method. Ball State University, as well as other schools, is looking to use this method in a wide variety of 100 level classes with the potential for expanding into higher level courses depending on the results from the lower level courses. Every new student at Ball State has the opportunity to go through new student orientation. It is the purpose of this orientation to help prepare the students for their time at Ball State. In future it may be beneficial to present this method in one of the orientation forums so that the students may be able to ask questions and be sufficiently informed before the semester begins. During this training, special attention needs to be given to make sure that both

men and women receive adequate coaching depending on their specific needs since, as observed by Drs. McConnell and McDowell, different aspects of this method are more challenging than others depending on the student.

This lack of familiarity with the material may be contributing to the overall lack of change in attitudes and engagement levels. Because of this, questions that test the ability of a blended learning course to stimulate the curiosity and allow the students to take control of their learning should be considered in future research. More research should also be conducted into why the different groups of students answered couplet 6 differently. There was a lack of post-questionnaires that could be used to compare with the pre-questionnaires. Two alterations have been mentioned to fix this lack of data. Firstly, that the method of coding responses should be made easier for the students to remember via the method recommended by Dr. Tom McConnell of using a combination of birth day, birth month, and last four numbers of social security number. Secondly, to increase the number of responses for expected grade, it is recommended that choices be provided in order to alleviate confusion for the students. Since students are under a great amount of stress during the week before finals, it has been recommended by Dr. Eouanzoui that in future studies the post-questionnaire be given earlier on in the semester. If these question and distribution changes are implemented it is quite possible that future research could show significant positive changes in attitudes and engagement levels. Research has shown that students who use the online material the most gain the most self-perceived learning benefits (Behjat et al., 2012; McNaught et al., 2012). Because of this research, future research should track the amount of time students spend using the online materials. Future research should not only contain quantitative but qualitative data as well. Doing interviews with students would allow for more in-depth analysis of the effectiveness and shortcomings of implementing blended

learning in a non-majors biology class as well as bringing to light more areas that could be quantitatively tested as well (McNaught et al., 2012; Pombo et al., 2010). Future research should also, for accurate comparison, contain a control group(s) if at all possible. The ideal study would use one traditional face-to-face lecture course and one purely online course as the two controls and then compare them to the blended model. It is known that most educational research is quasi-experimental in nature because it is virtually impossible to re-create the exact same experimental conditions in more than one class. The small amount of research available has shown that when able to make comparisons between these three educational methods, blended learning has been shown to be the better method (Delialioğlu, 2012).

In conclusions we note that no significant overall change has been observed and that there is some evidence that attitudes and levels of engagement have changed as a result of using the blended method of education. These two facts taken in conjunction indicate that this method is a viable alternative to more traditional method. It is with that knowledge that research should move forward and continue to make this method more beneficial for every student individually. In the future as the blended method is honed and refined, as students become more acquainted with the technology, as educators become more effective at utilizing the materials, and as better methods for evaluating the method's effectiveness are developed, surely this method will become a hallmark of modern education.

APPENDIX A

Pre-Class Survey

Code Name (***make sure*** you right this down because you will ***use it again at the end of the semester***):
_____

Age: _____ Sex (please circle answer): Male Female

Class (please circle answer): Freshman Sophomore Junior Senior

Please circle either yes or no for each of the following questions.

1) Did you take a biology course in high school? YES NO
2) Did you take an advanced placement (AP) biology class in high school? YES NO
3) Have you taken any other college level biology courses? YES NO
4) Was your previous experience with biology positive? YES NO
5) Does any member of your immediate family teach or use biology at a professional level? YES NO
6) Did your previous biology class have a lab section? YES NO

For the following questions please circle either the answer very often (VO), often (O), sometimes (S) or never (N) in regards to your previous experience in biology classes (high school or otherwise).

7) Asked questions in class or contributed to class discussions VO O S N
8) Used online materials for class (**NOT** including projects or reports) VO O S N
9) Came to class without completing readings or assignments VO O S N
10) Worked with classmates **outside of class** to prepare class assignments VO O S N
11) Discussed grades or assignments with a teacher VO O S N
12) Discussed biological concepts **outside of class** with non-classmates (parents, neighbors, friends, ect.) VO O S N

For the following questions please circle either the answer I strongly agree (SA), I agree (A), I am not sure (NS), I disagree (D) or I strongly disagree (SD) in regards to your previous experience in biology classes (high school or otherwise).

13) I would like to learn more about biology SA A NS D SD
14) Biology lessons bore me SA A NS D SD
15) I look forward to biology lessons SA A NS D SD
16) Biology lessons are fun SA A NS D SD
17) I do not need to learn more about biology SA A NS D SD
18) I don't want to take any more biology classes SA A NS D SD
19) A job as a biologist would be interesting SA A NS D SD
20) Working in a biology laboratory would be an interesting way earn a living SA A NS D SD
21) I feel comfortable talking about biological topics outside of class SA A NS D SD

Post-Class Survey

Code Name (***make sure*** you use the same name you used ***at the beginning of the semester***):

_____

Age: _____ Sex (please circle answer): Male Female

Class (please circle answer): Freshman Sophomore Junior Senior Expected Grade: _____

For the following questions please circle either the answer very often (VO), often (O), sometimes (S) or never (N) in regards to your experience in the BIO 100 class.

1)	Asked questions in class or contributed to class discussions	VO	O	S	N
2)	Came to class without completing readings or assignments	VO	O	S	N
3)	Worked with classmates **outside of class** to prepare class assignments	VO	O	S	N
4)	Discussed grades or assignments with a teacher	VO	O	S	N
5)	Discussed biological concepts **outside of class** with non-classmates (parents, neighbors, friends, ect.)	VO	O	S	N
6)	Used online supplemental material to prepare for class	VO	O	S	N
7)	Spent time online reading the textbook	VO	O	S	N
8)	Answered the in-class iClicker questions	VO	O	S	N
9)	Learned something during this course that changed the way you understand an issue or concept	VO	O	S	N

For the following questions please circle either the answer I strongly agree (SA), I agree (A), I am not sure (NS), I disagree (D) or I strongly disagree (SD) in regards to your experience in the BIO 100 class.

10)	I would like to learn more about biology	SA	A	NS	D	SD
11)	Biology lessons bore me	SA	A	NS	D	SD
12)	I look forward to biology lessons	SA	A	NS	D	SD
13)	Biology lessons are fun	SA	A	NS	D	SD
14)	I do not need to learn more about biology	SA	A	NS	D	SD
15)	I don't want to take any more biology classes	SA	A	NS	D	SD
16)	A job as a biologist would be interesting	SA	A	NS	D	SD
17)	Working in a biology laboratory would be an interesting way earn a living	SA	A	NS	D	SD
18)	I feel comfortable talking about biological topics outside of class	SA	A	NS	D	SD
19)	Being able to learn the online supplemental material at my own pace helps me understand biology better	SA	A	NS	D	SD
20)	I would like to see this method of using online materials to supplement classroom activities implemented in courses I will take or have taken	SA	A	NS	D	SD
21)	The online supplemental material makes going to biology class less stressful	SA	A	NS	D	SD

APPENDIX B

INFORMED CONSENT FOR SOCIAL SCIENCE RESEARCH

Study Title A Hybrid Course in Non-Majors Biology: An assessment of changes in student attitudes and levels of engagement. Michael E. Moore, principal investigator.

Study Purpose and Rationale

The purpose of this study is to assess the effect that a hybrid biology course has on student's attitudes and levels of engagement with biology. The data derived from this research will help quantify the effectiveness of these delivery systems in the areas of attitudes and levels of engagement. This quantification will help with the refinement of this type of delivery system for more effective education.

Inclusion/Exclusion Criteria

To be eligible to participate in this study, you must be 18 years of age or older and be currently enrolled in Ball State's BIO 100 course.

Participation Procedures and Duration

For this project, you will be asked to complete two surveys; one will be administered at the beginning of the semester and the other one will be administered at the end of the semester. The survey at the beginning of the semester will ask questions pertaining to your previous experience(s) in biology classes. The survey at the end of the semester will ask questions pertaining to your experience in Ball State's BIO 100 class. Both surveys are 21 questions long and should take no more than 10 minutes each to complete.

Data Confidentiality

All data will be maintained as confidential and no identifying information such as names will appear in any publication or presentation of the data.

Storage of Data

The data will also be entered into a software program and stored on the researcher's password-protected computer for three years and then deleted. Only Michael Moore and Dr. Rogers will have access to the data.

Who to Contact Should You Experience Any Negative Effects from Participating in this Study

Should you experience any feelings of anxiety, there are counseling services available to you through the Ball State Counseling Center in Muncie, (765) 285-1736.

Benefits

There is no immediate or long-term personal benefit to participating in this study.

Voluntary Participation

Your participation in this study is completely voluntary and you are free to withdraw your permission at anytime for any reason without penalty or prejudice from the investigator. Please feel free to ask any questions of the investigator before signing this form and at any time during the study.

IRB Contact Information

For one's rights as a research subject, you may contact the following: For questions about your rights as a research subject, please contact the Director, Office of Research Integrity, Ball State University, Muncie, IN 47306, (765) 285-5070 or at irb@bsu.edu.

Study Title A Hybrid Course in Non-Majors Biology: An assessment of changes in student attitudes and levels of engagement. Michael E. Moore, principal investigator.

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