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Active Learning in the Science Classroom

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What are the effects of active learning in a science lecture hall
on student's attitude and achievement?

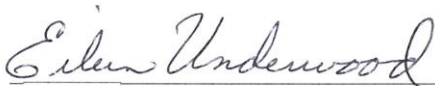
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HONORS PROJECT

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Abstract

This study focused on active learning and how it affects student attitude and achievement in college level biology courses. A Biology Attitude Survey was administered at the beginning and middle of the semester to determine if student's attitude towards biology improved from the active learning setting. The student's attitude was also assessed from a classroom format survey containing questions about the benefits of undergraduate Learning Assistants and the active learning classroom format. These attitudinal measures were then compared with student's achievement in biology by looking at their midterm grade, pre-test and post-test assessment scores. The ANOVA revealed that students with a high achievement in the course had a higher attitude towards biology.

Keywords: Active learning, inquiry, achievement, science, Learning Assistants, lecture hall

What are the effects of active learning utilizing undergraduate Learning Assistants in a science lecture hall on student's achievement and attitude?

Active Learning is widely discussed topic in the education field today. Many teachers know that it is important and it is effective but many do not know what exactly active learning is or how to incorporate it into their classroom. Active learning is considered a teaching method that is not the traditional lecture format seen in many classrooms today of passively listening to an instructor (Paulson & Faust, 2012). While lecture is a very efficient way to present a lot of material in a short amount of time, it does not do any good to go through any amount of material if students are not able to apply what is presented. To incorporate active learning into the classroom teachers can have discussions, activities, group exercises, problems, etc. It allows students to apply the information they are learning to real-life situations. It is important to find a method that works for your students and use a variety of methods to meet all students learning needs. The active learning style of teaching will allow you to be a more effective teacher and in turn impact your students in very positive ways.

My interest in this topic stems from my position as a Learning Assistant in Biology 1040, Introduction to Biology, and 2050, Concepts in Biology II, courses at the collegiate level. As a learning assistant I facilitate group discussions, answer any questions students may have, and serve as a bridge between the professor and the students. I have seen many positive outcomes from this active learning setting including group work and discussions. Students are more engaged while in class, they are more motivated to learn and their overall attitude towards science seems to improve. I have also noticed an improvement in student achievement because the small groups allow them to make connections and build resources with their peers so they now have people to study with and to ask questions.

I am also interested in researching the correlation between active learning and students attitudes and achievement because I have noticed that I personally feel like I benefit much more from active learning and small group discussions than from the traditional format. From taking several education

classes I have learned about metacognition and a variety of different learning styles. It is very important to be cognizant about the way that one is learning and how he or she can improve their learning by trying different methods that may work better for that individual. I have also noticed in many of my classes throughout high school and college how unengaged my peers are in class. Many students are on their phones, Facebook and other social media and have no idea what is going on in class or what the professor is talking about. This is a serious problem and I do not want to be the teacher that is in front of a class full of students and no one is paying attention or learning any of the key concepts. Through researching and learning about different teaching strategies such as active learning I can hope to be a much better teacher for my students.

The effects of an active learning style classroom were analyzed by looking at correlations between the data at the beginning of the semester and half way through the semester on students' attitudes toward science, content knowledge and achievement in the class. Surveys were also administered to students to evaluate how effective the students thought the active learning style classroom was and if they liked it. This allowed me to see the effect the active learning and small groups can have on the students learning outcomes and attitude towards science.

This is very important topic in education today because it is essential to engage students and find a way to effectively teach science content. Active learning appeals to many different learning styles and allows students to be more engaged in the learning process, increasing understanding and memory of topics learned. Many students lose interest in science or become intimidated by the subject often as early as middle school inhibiting them from reaching their full potential in science classrooms. By engaging students and helping them to better understand the content they can discover the true excitement and real life applications that science brings. As Lotto (2012) quoted Plutarch, who said, "The mind is not a vessel that needs filling but wood that needs igniting." I think that it is essential for

the future of education to head in a much more active format rather than the traditional lecture style format. Students will be more engaged, and value and enjoy what they are learning. They will have an opportunity to find value in the science that they are learning and not just think of it as a boring subject. This may lead to more students pursuing careers in science related fields. In order to analyze the effects of active learning, the topics of students' attitudes toward science, assessments, achievement, metacognition, and active learning need to further understood.

Literature Review

Active Learning

Active Learning is an instructional method that engages students in the learning process. The core elements of active learning include student activity, discussion, and engagement (Prince, 2004). Several studies have shown benefits to student attitude, knowledge, critical thinking skills and more when using the active learning method. Active learning leads to better student attitudes and improvements in students' thinking and writing. It is better than traditional lectures for retention of material, motivating students for further study and developing thinking skills (2004). It is also thought that students will remember more content if brief activities are introduced to the lecture contrasting to the traditional belief to push through as much material as possible in a given amount of time (2004). By working through activities and problems students will be more likely to remember the key concepts and understand than if the teacher lectures at them for the whole class. "We are not advocating complete abandonment of lecturing but lecture only half of the class period" (Paulson & Faust, 2012, p.1). The goal is not to never lecture to students again but rather find a balance between lecturing and active learning methods. The combination of the two allows educators to get through the necessary material but still ensure that their students understand what they are learning. Active learning also aids in addressing fundamental misconceptions (Prince, 2004). The active learning format allows

misconceptions to come up naturally in the learning process and students are able to recognize the mistakes they are making and correct them which leads to better retention of the material and a deeper understanding. This moves the classroom from a teacher-centered to a more student-centered model. As Johnson states, “learning is student centered, an active process not a passive experience of absorbing new information...therefore effective teaching should be student-centered and allow students the opportunity to construct knowledge as they encounter new information” (Johnson & McCoy, 2011, pg 41). The student-centered model allows students to construct new knowledge and build upon their old knowledge. This is also shown in research when stating that “the teaching emphasizes the interaction among peers and involves activities and feedback, students are given consistent opportunities to participate in the learning process in the classroom and develop their critical thinking” (Suwondo & Wulandari, 2013, p. 216). The benefits of the active learning style are immense it allows students to better develop their critical thinking skills and gives them more opportunities to participate. It is evident from research that children incorporate information into their existing framework or create new framework, they do not simply absorb information as it is presented to them (Johnson & McCoy, 2011). Using the active learning process allows students a way to discover concepts on their own and to build those frameworks with a more lasting structure than just passively receiving the information through lecture format. Another benefit to active learning is the social environment that is created. When discussing Vygotsky’s theory of proximal development, Bartley & Milner (2011), stated, “human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them” (p. 8). By implementing this group work and active learning style it aids in the human learning process and students are able to learn from each other. This idea is also found in the research which states, “Inquiry based learning gives students the opportunity to be actively involved in the process of learning, how to analyze problems fairly,

objectively, critically, openly, and cooperatively. This will definitely give positive influences on the students' scientific attitudes" (Suwondo & Wulandari, 2013 p. 217).

An active learning environment can foster many positive effects for students. One positive effect is an increase in students' attitude towards science. Students are also shown to find more enjoyment for the subject when the classroom is more active and not solely based on lecture. A third positive benefit that can be seen from the active learning environment is an improvement in metacognition, the awareness of ones thinking. Group Work is also an integral part of the active learning environment and allows students to build educational relationships and problem solving skills.

Attitudes toward science

One positive affect that active learning can have on students is to increase their attitudes towards science. This has been seen in past research from Johnson & McCoy (2011), teachers have reported positive attitudes towards inquiry in the classroom. A student's attitude is defined as "what spurs the student on to greater things in his or her educational development and it is the job of the educator to get through to each student as much as possible" (Bartley & Milner, 2011, p. 7). As an educator it is important to pay attention to student's attitude each and every day, monitor how it changes and how your method of instruction affects them. Bartley & Milner (2011), also stated that "the hope of any teacher is that their instruction will reach all of their students in such a way that the students' attitude towards the teacher's specific subject and education in general, will be altered to the point that the student truly enjoys the learning process" (p. 9). One of the many goals that teachers have is to improve students' attitude in science and even further valuing the lifelong learning. Active learning methods of teaching can really improve student's attitude towards school and learning in general. Inquiry based learning possesses a wide opportunity for students to develop their scientific attitude to the better, cultivate the fundamentals of scientific thinking in students, this will generate

their creativity in solving problems (Suwondo, & Wulandari, 2013). It is important to give students the opportunity to develop a scientific attitude and be cognizant of what they are learning. The results of the two year study of a biostatistics course showed that inquiry-based active learning was able to establish better scientific attitudes in the students (Suwondo & Wulandari, 2013).

Enjoyment

Another positive affect that active learning can have in the classroom is that it can make learning fun. By engaging students we can show them how much fun learning and particularly science can be. As Tyler DeWitt discussed in his TEDTalk, students have trouble understanding the main idea when only using a textbook, the language is often incomprehensible (DeWitt, 2013). By using things other than lecture and reading the textbook teachers can help students to achieve a new level of learning. Even more than that, they can enjoy what they are learning and be able to apply it to the real world. Dewitt suggests using on-line resources or telling stories to explain science terms in simple language. These ideas align with the active learning method used in the classroom and as DeWitt shows, can really motivate students and improve their attitude towards learning and science. Some people may argue that active learning takes away from the amount of content a teacher can get through or it's not real learning. DeWitt discusses the "Cult of seriousness" and how specifically in the scientific community it is frowned upon to use fun or engaging stories, it won't be taken seriously, it is not scientific enough. These ideas are also found in the TEDTalk from Lotto and O'Toole, "true science education gives people a voice... everyone has the potential to discover something new, a small question can lead to a big discovery and change the way someone thinks" (Lotto & O'Toole, 2012). Lotto went to a classroom and worked with young students around 3rd grade and they used active learning to complete science research just like scientists do in the real world. This way of learning changed the way many of the students thought about science, it was no longer just a boring

subject, anyone can discover something new. This led to this class having the youngest published scientist and was even the Editor's choice in science magazine 2012. It is amazing the doors that are opened in a student's mind from the active learning style classroom that would not occur in the traditional lecture format.

Metacognition

One reason the method of active learning is thought to be so successful in improvements for student achievement and knowledge is that it increases metacognition. Metacognition is awareness of one's thought processes or the learning process. If students are cognizant of what they are learning they are engaged in a higher order thinking and will make better connections to old material and new material. This makes it more likely that they will retain the information. This is stated in the article by Johnson and McCoy, "Students in traditional courses reported weaker cognitive, affective and social gains than students in inquiry based learning courses, and they also found instruction to be less helpful" (Johnson & McCoy, 2011, pg. 43). The students benefitted in a positive manner from the active learning instruction including positive social, affective, and cognitive gains. The students who were in a traditional lecture classroom showed negative changes in motivation and beliefs between the beginning and the end of the course (Johnson & McCoy, 2011). The benefits of metacognition as a side effect of active learning are also seen in Prince's research. He states, "Good activities are designed around important learning outcomes and promote thoughtful engagement ... encourage students to think about what they are learning." (Prince, 2004, p. 4). The active learning activities that can get students to recognize what they are learning and how they are learning most affectively really hit the bullseye of effective education. Students will reach that high order thinking and be more likely to retain the information and apply it for future use. Johnson also noted when using a discovery based method, one student in her class who normally takes a bit longer to catch on caught on, very quickly

that day exclaimed, “I get it!” The student was aware that she had completed the learning circle and had grasped an important concept that she may have had trouble with previously. The active learning method also allowed the students to demonstrate ownership of their learning which is essential to foster life-long learning skills in students (Johnson & McCoy, 2011). By students being more aware of their learning abilities they begin to take ownership for their knowledge. This has many positive effects on the student and their learning abilities. This will allow them to really develop their skills for learning and improve their chances for success in high school and higher education. Ultimately the goal of any teaching method is to increase student achievement. Active learning increases students’ achievement in classes in several ways. Improvement of student’s achievement was associated with the change in instructional design (active learning) implanted in lectures, (Suwondo & Wulandari, 2013).

Group Work

Active learning including small group learning has many benefits. For example, if students do not understand a question, problem, or concept they can help each other. Peers are able to break down difficult concepts into easier terms that their classmates may be able to better understand. The students showed positive feelings for such interactions with their peers, high quality peer-relationships are a critical element in the development and socialization of adolescents (Bartley & Milner, 2011). By talking to their partners or groups about a question or problem they can build information off of one another and are more likely to solve problems. The groups also allow students to build connections with classmates which can be useful for questions about assignments, homework, studying for tests etc. They also help each other and that collaborative effort can allow for essential growth in the learning process. The group approach allows students to generate ideas, use language, learn from each other, and recognize that their thoughts and experiences are valuable and essential to new learning (Bartley & Milner, 2011). Small group work is also very beneficial in getting all students in a class to

participate, it breaks the class into smaller units and allows some of the more shy students to speak up. For example, Milner states, “more students can participate in the discussions and can express themselves more candidly, making students more comfortable with one another and their learning environment” (Bartley & Milner, 2011). Small group work also improves team work and builds critical skills that students need to be successful in the work force. In the study done by Bartley and Milner there was a strong correlation between small group work and improvement in student attitude in English Classrooms (Bartley & Milner, 2011). The group work was a change of pace for the students so they were engaged as well as excited about their work. Teachers commented after the lesson with small group work, “The activity was well received by the students and I’ll use it again, the overall attitude of the students was very positive and beneficial to the class” (Bartley & Milner, 2011). This correlation will likely carry over into science as well and shows strong positive benefits and was received well by the students. Bartley even noted that when the group work ended the students would shut down either by putting their heads down or zoning out, or no longer paying attention to the lesson (Bartley & Milner, 2011). When observing students, 47/52 seemed to enjoy some aspect of the group learning and all of the teachers had positive comments about it. He also noticed that the group work seemed to have a positive effect on student engagement and quality of work.

From the research, it is expected that there will be an increase in student’s attitude and achievement in biology as a result of the active learning environment including the use of Learning Assistants, to assist with activities, group work, and discussions.

Methodology

The study sample included 118 students from a Biology 2050 course at Bowling Green State University, a mid-sized liberal arts college located in Northwest Ohio. The course was taken during the spring of 2014 and included students with a variety of majors such as biology, athletic training,

nursing, exercise science, etc. The class meet two times a week in the late afternoon/early evening. The format of the classroom was half lecture and half “active” including discussions, case studies, group work, and activities. To aid to the active learning environment seven undergraduate Learning Assistants were used. The Learning Assistants attended every lecture and were there as a resource for the students to ask questions when assignments and concepts were unclear. When activities, case studies, and group discussions were going on the Learning Assistants were walking around to facilitate and answer questions to aid student learning.

The first test distributed was the Biology Attitude Survey which was administered at the beginning of the semester to determine students’ attitude about biological sciences. A link was e-mailed to the students by a third party source so students could respond honestly without being concerned about their responses affecting their grades. An incentive of bonus points for completing it was also offered to encourage more students to respond. The same survey was again sent out eight weeks later, half way through the semester, to determine if there was any significant changes in students attitude from the active learning style classroom. This survey was adapted from Russel & Holander, 1975 (see Appendix A). It consists of a unidimensional, 14 item survey consisting of Likert-style questions. To determine the reliability of this survey, a pilot test of questionnaire shows the Cronbach Alpha analysis was high, for the pre-test ($r = 0.97$) for the post test ($r = 0.97$).

The survey taken by the students was given after eight weeks of the semester had 16 total questions about the impact of undergraduate learning assistants and active learning on their learning experience in the classroom. The questions were recorded on a computer bubble sheet and asked to what degree each student agreed with the statement with 1 representing strongly agree and 5 strongly disagree. Six questions were stated in reverse to increase the validity of the test. There was an open ended question, “The best part of having Learning Assistants in the classroom was:” (see Appendix C).

This survey was developed by Dr. Underwood and Dr. Partin (biology faculty at BGSU) and reviewed by a group of science education faculty.

In order to determine how active learning has had an effect on students' achievement in biology a pre-test assessment, mid-test assessment, and mid-term grades were used. This assessment was used to help determine what level the students' general science knowledge was at in the beginning of the semester and was again analyzed at half way through the semester to see if there were any significant changes in the students' knowledge as a result of the active learning classroom format. Another factor that was considered in determining how the active learning method effected students' achievement was mid-term Grades. Mid-term grades were prepared by the instructor and included all items completed after eight weeks of the semester, three exams and all assignments aligning with those units.

Observations were also made during class sessions to analyze how receptive students were to the different style of teaching. This assessment was developed from Praxis exam sample questions and AAAS Project 2061 test bank.

The initial and mid-term data were analyzed to look at the affects the active learning style classroom had on student's attitudes, and achievement in biology. Statistical analysis were performed to determine the relationship between student's attitude and achievement in biology. Group differences were explored using analysis of variance (ANOVA). The data collected was compared to determine if there is any growth or improvements from the active learning style classroom. The course evaluation and observations made throughout the active learning environment were used to provide a lens to illustrate the effects of active learning in the science classroom.

Results

Attitude

The Biology Attitude Survey (BAS) at the beginning of the semester (pre) included responses from 97 students with a scale of 1 strongly disagree to 5 strongly agree. The mean for the responses ranged between 3.24 (S.D. = 0.944) for Question 5, “Biology makes me feel secure, and at the same time is stimulating,” up to 3.85 for Question 1 (S.D. = 1.004) “Biology is very interesting to me.” The survey results a mid-term of the semester (post) included responses from 84 students with the lowest mean of 3.11 (S.D. = 1.076) for Question 3, “I am not under a terrible strain in biology class” to the highest mean at 3.64 (S.D. = 1.049) again for Question 1. The mean for the BAS pre-test was 48.91 (S.D. = 11.64) and taken by 93 students. The mean for the BAS post-test was 47.10 (S.D. = 12.30) and taken by 81 students. See Table 1 for a detailed list of questions from the BAS with the means and standard deviations. Six questions were stated reversed so all positive attitudes would show a positive correlation. Overall from pre to post tests, the student means went down on individual items.

A correlation table was created comparing the questions 1-14 with each other. Overall, there were moderate to high positive correlation for the administration of pre-test BAS. The lowest correlation (0.377) was between question 1, “Biology is very interesting to me” and question 12, “I get excited to think about doing a biology experiment.” The highest correlation (0.816) was between question 10 and 13 with all correlations significant at the 0.01 level for the pre-test (See Table 2). For the post-test the lowest correlation (0.412) was between question 5, “Biology makes me feel secure, and at the same time is stimulating” and question 12. The highest value (0.856) was between question 10, “I really like biology” and question 14 “I feel a definite positive reaction to biology, it's enjoyable.” (See Table 3). This test helps to show the validity in the form of measurement we used showing that the assessment was measuring what it was supposed to.

Paired sample t-test for the Biology Attitude Survey was performed. Questions 3, 4, 6, 7, 8, 11, and 15 showed a statistically significant difference and remaining questions had no significant difference (See Table 4). Overall t-test result from the BAS pre to post-test administration was $t(1,80) = 1.94, p = 0.5$.

Another form of assessment to analyze student's attitude was the classroom format evaluation which consisted of 16 total questions, 10 questions about the use of undergraduate learning assistants and 6 questions about the classroom format of active learning. It was administered half-way through the semester and 108 students completed it. The values ranged from 1, strongly agree to 5, strongly disagree. The percent of students that agreed for question 2 was the lowest at 29.6% ($X = 3.16, S.D. = 1.14$), "Without the LAs, my opinion of this call would change for the worse." Up to 75.4% of students agreed for question 3 ($X = 1.97, S.D. = 0.94$), "It is helpful to have someone available to ask questions during class who is closer to me in age." Question 7 and 13 also had over 70% agree, "More questions were able to be answered because LAs could help not just the professor," and "Activities in the class gave me a better understanding of the material" respectively. See Table 5 for mean and standard deviations and the percent of students that agreed on all questions.

Achievement

To assess student's achievement in biology, students took a 30 item assessment test at the beginning of the semester and again mid-way through the semester. 92 students took the pre-test and 91 students took the post-test. The overall mean for the pre-test was of 58.15 ($S.D. = 14.80$) and for the post-test the mean was 60.70 ($S.D. = 17.20$). For the pre-test category students were placed in three categories: High ranged from 86-64, with 24 students, medium ranged from 63-50 with 31 students, and low ranged from 49-0 with 24 students. For the mid-test students were grouped in three

categories: high 90-70 which had 28 students, medium 69-53 which had 24 students, and low 52 -0 which had 28 students.

Another method of assessment used was student's midterm grades calculated by the professor after eight weeks of the semester. The students mean at mid-term was 80.88 with a standard deviation of 11.48. For the midterm grades data analysis, students were grouped in three categories: High (100-88), medium (87-76), and low (75-0). There were 29 students for the high category, 28 for medium, and 24 students for low.

ANOVA

In order to analyze the group differences on attitudes in biology and the level of achievement at the midway point in the semester to investigate potential impact of the learning environment an ANOVA was conducted. The attitudes in biology was calculated using the Biology Attitude Survey and achievement values were calculated using the professors midterm grades and the students score on the mid-term assessment in biology. A 3x 3 (MidTest x MidGrade) ANOVA was conducted on the means of the Biology Attitude Survey at the mid-term of the semester (see Table 6). With a family-wise alpha level of 0.05, the main effect on attitudes in biology by the achievement on mid-term grades was significant, $F(2, 80) = 3.15, p > .05$. However, there was not a significant main effect found in the means of attitudes in biology by mid-term test nor was an interaction effect found. Subsequently, post-hoc analysis to probe significant mean differences on attitude were conducted maintaining a family-wise alpha of 0.05 utilizing Tukey HSD technique. There were significant differences between high ($\underline{M}=51.55, \underline{SD}=11.72$) and low ($\underline{M}=40.26, \underline{SD}=11.42$) and medium ($\underline{M}=48.36, \underline{SD}=11.61$) and low ($\underline{M}=40.26, \underline{SD}=11.42$) achieving students on biology attitude. (See Table 7).

Discussion

From the biology attitude survey there are some important details that can be drawn. Students tend to have a slightly positive attitude towards science as the mean for all questions for the pre and post-test indicates that the average is at least “neutral” to “somewhat agree”. When looking at the mean values for the pre and post responses it can be seen that for almost every question that the mean decreased in the post-test showing that the students actually had a slightly more negative value attitude towards science after 8 weeks of the course. The difference is very small and was only statistically significant for a few Questions (Q 3, 4, 6, 7, 11, 15). This could be explained because at the beginning of the semester students may have a better attitude towards their classes in general than in the middle of the semester when things start to get more difficult, there are more exams and assignments due etc. Another possible reason for this small decrease in students attitudes towards biology could be that they didn't really know much about biology coming into the course and half way through the course when they took the second survey they decided it was harder than they expected. When looking at similar research, it was found that non-majors attitudes had a larger variance in their attitude towards biology as compared to the biology majors so majors attitudes was less of a significant predictor for their understanding of the Nature of Science (Partin et. Al, 2013). This relates because many students in the Biology 2050 course are biology majors, or are at least going into a science related field such as exercise science, nursing, dietetics, athletic training, education etc. Most of them should already have at least a slightly positive attitude towards biology and science in general since their major involves science. It is hard to increase students attitude towards the subject in a such a short amount of time, (8 weeks) especially when those students already have a relatively “positive” attitude towards biology.

From the learning assistant evaluation several positive conclusions can be drawn. It is shown that having learning assistants in the classroom is helpful, with over 50% of those surveyed in the class

agreeing that it is helpful having someone closer to me in age to ask questions, more questions were answered due to their presence, activities in the class gave the students a better understanding of the material, and group discussions were helpful in making students apply the material. I think that more positive comments would have been found if there would have been more group discussions and activities implemented in the classroom but more than half of class time was spent lecturing. When evaluating students responses to the fill in the blank question, mostly positive comments were found. There were 114 responses with approximately 100 of them positive, 10 neutral, and 4 negative responses. Of the 100 positive responses 64 referred to having the learning assistants available to answer questions, not having to interrupt lecture with a small question, or feeling stupid for asking a question in front of the whole class. The other 36 positive comments mentioned benefits such as getting papers graded quickly, liked doing activities in class, made better sense of the material and instructions given in class and helped the class to run smoother. Many also benefitted from the review sessions that learning assistants held and individual help they received. The learning assistants also served as a resource for many students and it was helpful having someone similar in age to relate to and answer questions. A few students even commented that they would like to do more activities in class. Several of the neutral comments said things such as, “The learning assistants had little or no effect on the class.” Some of the negative comments included things such as I would have learned more from traditional lecture, and having the learning assistants was a distraction to the classroom. Student showed positive comments when evaluating the classroom format on activities in class gave me a better understanding of the material and group discussion were helpful in making me apply the material. However, overall students disagreed with the statements “I would have preferred a traditional lecture because I would have learned more” and “I found the reading quizzes helpful and I would recommend this class and style of teaching to other students.” These results could be explained that

some aspects of the classroom were affective such as activities and group discussions but students did not feel that the reading quizzes were helpful. I think another important thing to note is that it is difficult to get students be receptive to a new format of teaching. They may be used to a traditional lecture format for over 10 years from junior high and high school and whatever their current level of college is. It is to break through that shell and be receptive to something new, especially when it can be more challenging than simply showing up to class and listening.

When looking at the results from student achievement for the mid assessment, the mean score of the assessment did increase but so did the standard deviation. The assessment tested student's general science knowledge and how to interpret data. It is hard to make a large difference in student's general science knowledge in only an 8 week course. The student's mid-term grades appeared to be about what is expected for a course at this level half –way through the semester ($X= 80.88$, S.D. 11.48).

The results of the ANOVA revealed significant impact of students achievement of the mid-grade on students attitude towards biology as determined by the Biology Attitude Survey for categories High to Low and Medium to Low.

One limitation of this study is that the second set of data was collected after only eight weeks of the course which is not a large amount of time to change students' attitudes toward science and opinions about the nature of science when their ideas have been formed since junior high and high school. Another limitation to the study is that it is hard to get students to try their best on an assessment, survey, or evaluation if they know that it is not truly affecting their grade in the course. While we offered students extra credit for completing the assessments and evaluations it is difficult to know if they truly tried their best or simply guessed on many of the questions.

Conclusion

One implication from this study is that teachers should try to implement active learning into their classroom whenever possible as it seems to improve a student's attitude and content knowledge. Professors should put more emphasis on group activities and discussion as they engage students and help them to better understand and recall the material. It also increases the student's ownership of their own learning and improves their metacognitive skills. Professors should aim to shift the classroom from being teacher centered to a more student centered model. This could be done by educating professors on the benefits of active learning on student's achievement, attitude, metacognition, and more. Workshops could be hosted to encourage active learning in the classroom. Many professors and teachers want to spend more time on inquiry but have trouble figuring out how to do so. As Johnson stated, "Math and Science teachers of all grade levels have reported less time devoted to inquiry learning than ideal" (Johnson & McCoy, 2011, p. 45). Having workshops could greatly benefit teachers and professors and help them find ways to implement active learning into the classroom while still covering all of the content expected. Universities could consider in-service days for teacher during the various breaks most colleges and universities have such as fall break, winter break, spring break and summer sessions. Johnson also said that "Pre-service teachers reported the intention of incorporating inquiry laboratory activities after participating in their own inquiry based investigations" (Johnson & McCoy, 2011, p. 45). If we can get the message out to teachers and professors about the importance of active learning and help them understand the benefits and how to implement it effectively into the classroom we can make a huge difference in classrooms and lecture halls across the country.

Another way to implement what was found in this study is to have professors put active learning as a course outcome on their syllabus reminding students and themselves of the importance.

Finally, it could be implemented as a foundation for the school or university in which it wants all professors and to strive to create an engaging learning environment both inside and outside the classroom. Prince states in his article the student involvement/engagement is one of the most important predictors of success in college (Prince, 2004). Professors should be informed of this to help their students succeed. Students should also be aware of this so they can be more conscious of their engagement in the classroom. It is important for professors to remember that goal is not to fill the students mind with knowledge and hope they remember some of it but rather treat as something that needs a spark to sustain itself. If you can get students to be interested in a subject or even develop a deeper understanding of the material it will stay with them forever instead of forgetting facts they read from a PowerPoint months or even years ago.

As found from this study a high positive attitude towards biology predicts high achievement in students. It is important for professors to improve student's attitudes towards biology. One way to do this is to make the course material engaging and relevant to the student's life whenever possible. This will help student's achievement in biology. It is also important for professors to give the students general assessments at the beginning of the semester for them to be able to gauge where their students are currently at with their level of knowledge so they can build off of that and not start out with material that is too hard or too easy but to be as effective as they can be.

Further study can be done in this area by taking the same surveys (BAS, Classroom Format Evaluation, and mid-term assessment of achievement in biology). again at the end of the semester to determine if larger changes have occurred as a result of the active learning style classroom from the beginning of the semester to the end. From these results further questions can be asked to find the most effective way to engage students in the classroom. What do students prefer to do in class; discussions,

activities, simulations, examples, lecture etc. and which one improves achievement and attitude the most?

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Table 1

Biology Attitude Survey: Means Table		Pre			Post		
	Question	N	Mean	Standard Deviation	N	Mean	Standard Deviation
1	Biology is very interesting to me.	97	3.85	1.004	84	3.64	1.049
2	I like biology, it does not scare me to take it.	97	3.62	1.245	84	3.61	1.141
3	I am not under a terrible strain in a biology class.	97	3.45	1.041	84	3.11	1.076
4	Biology is fascinating and fun.	97	3.78	0.904	84	3.55	0.911
5	Biology makes me feel secure, and at the same time is stimulating.	97	3.24	0.944	84	3.14	0.959
6	Biology does not make me feel uncomfortable, restless, irritable, and impatient.	97	3.61	0.995	84	3.3	1.084
7	In general, I have a good feeling toward biology.	97	3.76	0.851	84	3.52	0.938
8	When I hear the word "biology" I have positive feelings.	97	3.64	1.072	84	3.44	1.09
9	I do not approach biology with a feeling of hesitation.	97	3.33	1.143	84	3.25	1.063
10	I really like biology.	97	3.56	0.989	84	3.4	1.031
11	I have always enjoyed studying biology in school.	97	3.45	1.041	84	3.29	1.115
12	I get excited to think about doing a biology experiment.	97	3.32	1.151	84	3.5	0.885
13	I feel at ease in biology and like it very much.	97	3.29	1.000	84	3.26	1.019
14	I feel a definite positive reaction to biology, it's enjoyable.	97	3.45	0.979	84	3.36	1.049

(Questions 2, 3, 6, 8, 9, and 12 were stated reversed so all positive attitudes would show a positive correlation).

Table 2**CorrelationMatrix: Biology Attitude Survey Pre-test**

Pre	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12	Q 13	Q 14
Q 1														
Q 2	0.652													
Q 3	0.437	0.529												
Q 4	0.640	0.481	0.604											
Q 5	0.556	0.432	0.589	0.671										
Q 6	0.523	0.626	0.686	0.553	0.588									
Q 7	0.615	0.592	0.652	0.704	0.615	0.639								
Q 8	0.616	0.543	0.680	0.746	0.662	0.696	0.716							
Q 9	0.535	0.602	0.661	0.675	0.689	0.774	0.756	0.761						
Q 10	0.654	0.589	0.612	0.754	0.761	0.647	0.728	0.771	0.766					
Q 11	0.626	0.488	0.529	0.714	0.674	0.505	0.699	0.745	0.678	0.814				
Q 12	0.377	0.413	0.478	0.408	0.419	0.565	0.482	0.601	0.592	0.446	0.417			
Q 13	0.595	0.566	0.664	0.692	0.788	0.712	0.755	0.779	0.800	0.816	0.754	0.553		
Q 14	0.613	0.519	0.593	0.748	0.739	0.644	0.743	0.743	0.768	0.758	0.675	0.517	0.748	

Moderate to high positive correlation for the Biology Attitudinal Survey with values ranging from 0.377 to 0.816, all correlations are significant at the 0.01 level.

Table 3**Correlation Matrix: Biology Attitude Survey Post-test**

Post	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12	Q 13	Q 14
Q 1														
Q 2	0.677													
Q 3	0.579	0.712												
Q 4	0.662	0.592	0.567											
Q 5	0.627	0.614	0.651	0.737										
Q 6	0.699	0.797	0.768	0.638	0.712									
Q 7	0.695	0.803	0.756	0.704	0.680	0.781								
Q 8	0.719	0.809	0.760	0.737	0.688	0.805	0.844							
Q 9	0.686	0.718	0.788	0.579	0.627	0.740	0.726	0.829						
Q 10	0.759	0.680	0.601	0.813	0.721	0.678	0.750	0.793	0.676					
Q 11	0.727	0.705	0.627	0.711	0.649	0.676	0.731	0.807	0.702	0.821				
Q 12	0.454	0.650	0.513	0.449	0.412	0.571	0.610	0.556	0.480	0.462	0.476			
Q 13	0.742	0.701	0.644	0.700	0.726	0.692	0.712	0.784	0.717	0.838	0.813	0.494		
Q 14	0.731	0.703	0.606	0.777	0.752	0.679	0.776	0.777	0.697	0.856	0.819	0.493	0.836	

Moderate to high positive correlation for the Biology Attitudinal Survey with values ranging from 0.412 to 0.856, all correlations are significant at the 0.01 level.

Table 4**Paired Samples Test: Biology Attitude Survey**

	t	df	sig (2-tailed)
Pair 1 Q1p-Q1t	1.754	80	0.083
Pair 2 Q2p-Q2t	-0.652	80	0.516
Pair 3 Q3p-Q3t	2.519	80	0.014
Pair 4 Q4p-Q4t	3.102	80	0.003
Pair 5 Q5p-Q5t	1.174	80	0.244
Pair 6 Q6p-Q6t	2.385	80	0.019
Pair 7 Q7p-Q7t	3.155	80	0.002
Pair 8 Q8p-Q8t	2.073	80	0.041
Pair 9 Q9p-Q9t	0.434	80	0.665
Pair 10 Q10p-Q10t	1.937	80	0.056
Pair 11 Q11p-Q11t	2.193	80	0.031
Pair 12 Q12p-Q12t	-1.975	80	0.052
Pair 13 Q13p-Q13t	0.134	80	0.894
Pair 14 Q14p-Q14t	1.24	80	0.218
Pair 15 AttPre-AttPost	2.294	80	0.024

REPORT T-TEST STATISTIC $t(1,80) = 1.94, p 0.5$

Table 5**Learning Assistant Evaluation**

Question	Mean	% agree	Std. Dev.
Having LAs in the classroom was helpful.	2.20	68.7	1.06
Without the LAs, my opinion of this class would change for the worse.	3.16	29.57	1.14
It is helpful to have someone available to ask questions during class, who is closer to me in age.	1.97	75.42	0.94
The presence of LAs in the classroom is distracting.	3.68	62.28	1.13
The LAs antics and activities kept me awake when lectures became boring.	3.01	38.27	1.20
I didn't notice any difference in the class as a result of the LAs presence.	3.07	48.25	1.34
More questions were able to be answered because LAs could help and not just the professor.	2.01	74.78	1.13
I found review sessions with the LAs helpful.	2.73	29.57	1.09
I would have found it helpful (and would have attend) additional review sessions with the LAs.	2.42	53.04	1.05
I was able to interact with the LAs as much as I would like.	2.46	46.84	1.05
Classroom Format			
I've learned more with this format of teaching than in a traditional lecture.	3.03	38.74	1.38
I would have preferred a traditional lecture because I would have learned more.	2.73	46.84	1.36
Activities in the class gave me a better understanding of the material.	2.27	72.07	1.09
Group discussions were helpful in making me apply the material.	2.64	54.96	1.23
I found the reading quizzes helpful.	2.98	42.34	1.22
I would recommend this class and style of teaching to other students.	2.95	41.66	1.31
Average	2.71	51.46	

Table 6**ANOVA Table**

Tests of Between - Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta. Squared
MidGradCat	848.17	2	424.085	3.15	0.049	0.081
MidTestCat	315.201	2	157.601	1.17	0.316	0.032
MidGradCat*MidTestCat	91.61	4	22.903	0.17	0.953	0.009
Error	9568.887	71	134.773			
Total	190185	80				

Table 7

Mean Table for ANOVA

	Mid Grad Cat		MidTestCat	Mean
			Std. Dev	N
High	High	54.29		
	Medium	46.14	13.95	17
	Low	49.80	6.59	7
	Total	51.55	5.54	5
Medium	High	54.00	11.72	29
	Medium	45.50	9.64	9
	Low	46.00	13.45	12
	Total	48.36	8.94	7
Low	High	40.50	11.61	28
	Medium	38.60	20.51	2
	Low	40.75	18.93	5
	Total	40.26	8.17	16
Total	High	53.21	11.43	23
	Medium	44.25	13.09	28
	Low	43.68	13.00	24
	Total	47.19	8.53	28

Appendix A

Biology Attitude Survey

1= strongly disagree 2= somewhat disagree 3= not sure 4= somewhat agree 5= strongly agree

- 1) 1 2 3 4 5 Biology is very interesting to me.
- 2) 1 2 3 4 5 I don't like biology, and it scares me to have to take it.
- 3) 1 2 3 4 5 I am always under a terrible strain in a biology class.
- 4) 1 2 3 4 5 Biology is fascinating and fun.
- 5) 1 2 3 4 5 Biology makes me feel secure, and at the same time is stimulating.
- 6) 1 2 3 4 5 Biology makes me feel uncomfortable, restless, irritable, and impatient
- 7) 1 2 3 4 5 In general, I have a good feeling toward biology.
- 8) 1 2 3 4 5 When I hear the word "biology," I have a feeling of dislike.
- 9) 1 2 3 4 5 I approach biology with a feeling of hesitation.
- 10) 1 2 3 4 5 I really like biology.
- 11) 1 2 3 4 5 I have always enjoyed studying biology in school.
- 12) 1 2 3 4 5 It makes me nervous to even think about doing a biology experiment.
- 13) 1 2 3 4 5 I feel at ease in biology and like it very much.
- 14) 1 2 3 4 5 I feel a definite positive reaction to biology; it's enjoyable.

Appendix B

Biology 2050 Course/LA Evaluation

Fill in the Scan-tron sheet for each of the following questions in the following format:

A= strongly agree B= somewhat agree C= not sure D= somewhat disagree E= strongly Disagree

Impact of Learning Assistants (LA's)

This section asks you to reflect on the impact having undergraduate Learning Assistants (LAs) in the classroom has had on your learning experience in this class.

1. Having LAs in the classroom was helpful.
2. Without the LA's, my opinion of this class would change for the worse.
3. It is helpful to have someone available to ask questions during class, who is closer to me in age.
4. The presence of LAs in the classroom is distracting.
5. The LA's antics and activities kept me awake when lectures became boring.
6. I didn't notice any difference in the class as a result of the LA's presence.
7. More questions were able to be answered because LA's could help and not just the professor.
8. I found review sessions with the LA helpful.
9. I would have found it helpful (and would have attend) additional review sessions (possibly every other week) with the LAs.
10. I was able to interact with the LAs as much as I would like.

Classroom Format

This semester in an attempt to avoid traditional lecture format, more student-centered active learning strategies were employed. In addition to lecture, the classroom experience included in class group activities, reading quizzes and occasional discussions. Please reflect on how this teaching strategy impacted your learning experience

11. I've learned more with this format of teaching than in a traditional lecture.
12. I would have preferred a traditional lecture because I would have learned more.
13. Activities in the class gave me a better understanding of the material.
14. Group discussions were helpful in making me apply the material.
15. I found the reading quizzes helpful.
16. I would recommend this class and style of teaching to other students.

On the back of this sheet, please complete this sentence:

The best part of having LAs in the classroom was: _____