Improving Student Attitude Toward Science Through Active, Collaborative Learning

by

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Field Project

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Abstract

As the importance of technology in our daily lives increases rapidly, the importance of a healthy appreciation for science learning increases as well. This field project addressed the effects of instructional strategies on student attitude toward science learning. The research question was "Will moving from a direct instruction, lecture-based approach to science instruction (behaviorist approach) to a more active and collaborative approach (cognitivist approach) improve student attitudes toward science learning?" The project took place over two weeks and included four lessons in which sixteen seventh and eighth graders, who are used to a direct instruction, lecture-based approach, were asked to work collaboratively on active, hands-on activities. Pre and post-project attitudinal survey results showed that the project lessons did not affect student attitude toward science learning. However, survey results did show that a majority of students did enjoy working collaboratively using hands-on activities. In order to see a positive attitudinal effect, it was concluded that this new instructional approach would need to be used more regularly and teachers would need professional development in order to support students in their transition to this style of learning.

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Table of Contents

List of Tables

Chapter I: Introduction

Identify the Issue

Throughout the researcher's 20 year career in education, there has been a repeated theme at every school that he has taught at; indifference and even dislike for science. Students achieved poor test results in science. Graduates reported struggling in high school level science classes. The researcher, who was the principal and learning leader at each of these schools, noted that the predominant method of instruction from Kindergarten through the eighth grade followed a behaviorist approach in the form of direct, lecture based instruction with little hands on student activity and collaboration (Stravredes, 2011). Students were not allowed to "do" or share the science they were learning. The question could then be asked, "Does the direct instruction approach lead to a negative attitude toward science which then results in poor science learning?" Therefore, the purpose of this project is to explore the connection between science instruction and student attitude toward science by testing whether or not active collaborative learning activities in science can improve student attitudes toward science learning.

Importance of the Project

There is no doubt that we live in a technological age in which every aspect of our lives is affected. With the rapid expansion of the world's economies and populations, occupations that require a high level of scientific understanding such as engineers, computer scientists, inventors, physicians, and research will continue to be required (National Research Council (NRC), 1996). Education professionals understand this as they routinely speak of the importance of Science, Technology, Engineering, and Math (STEM). In addition, as our technological world advances, there are more and more negative effects on our environment. This is causing a greater demand for more scientifically skilled groups of individuals to understand these negative impacts on our environment. Our world needs citizens who can appreciate and support solutions to the problems such as climate change and pollution (NRC, 1996). In addition, a more positive attitude toward science may encourage more youth to consider the sciences as a career path (Osborne, Simon & Collins, 2003).

Project Goal

The goal of this field project is to test whether or not moving from a direct instruction, lecture-based approach to science instruction to a more active and collaborative approach will improve student attitudes toward science learning. The findings of this project will then aid my faculty in planning science instruction and curriculum as well as guide possible professional development opportunities in the subject of science.

Chapter II: Literature Review

Introduction

Humans are blessed by God with the capacity and desire to learn. Even though the capacity for learning may be fully intact, learning can be hindered in humans who lack a positive attitude toward a given objective to be learned (Adesoji, 2008; Erdemir, 2009). Many students have developed a negative attitude toward learning science somewhere during their elementary or middle school experience. Could the learning environment or teaching strategies that these students experience be a cause? The following research centers on how a teaching approach which encourages students to be more active and work collaboratively might positively impact student attitude toward science learning.

Behaviorism vs. Cognitivism

Behaviorist learning theory forms the foundation of traditional instructional practices in which the teacher is the active participant in the instructional process, typically in the form of oral lecturing, and the student is a passive participant called upon to recall facts and perform procedures (Stravredes, 2011). Cognitivism is a learning theory that believes learners should take a more active role in their learning (Stravredes, 2011). It also believes that the teacher should still direct learning by determining learning objectives and by providing context and an environment that allows students to build on prior knowledge (Stravedes, 2011). Suggested cognitivist teaching strategies that promote student learning include those that involve student activity, reduce anxiety, and promote positive attitudes in addition to problem solving activities (Stravedes, 2011).

Attitude Affects Learning

Motivation and attitude have a strong impact on student learning (Adesoji, 2008; Erdemir, 2009). Researchers have even found that attitude toward science can be predictive of future science learning (Singh, 2002). This is supported by Salta and Tzougraki (2004), who found a moderate positive correlation in a group of 11th graders between their attitude toward science and their achievement in science. Attitude helps create engagement which leads to achievement (Singh, 2002). Since student attitude toward science has been shown to be influential in science achievement, the question remains, how can science educators influence these attitudes?

Active Student Involvement and Collaboration

One way to improve student attitude toward science is through teaching methods (Erdemir, 2009; Singh, 2002). Student attitudes and engagement are raised when students are given the opportunity to take control of their learning through greater autonomy (Osborne et al., 2003). Therefore, science educators will want to become accustomed to and proficient in those instructional practices that have been found to promote positive attitudes toward science.

The *National Science Education Standards (NSES)* lists standards for how teachers should teach science. The *NSES* encourages science teachers to encourage collaboration among students during instruction as it not only helps student science achievement but also fosters proper attitudes toward science (1996). In addition to the *NSES*, other researchers have also found that collaborative learning has a positive influence on student attitude toward science (Acar & Tarhan, 2008; Chung & Son, 2000;

Köse, Şahin, Ergü, & Gezer 2010). Baker found that collaborative grouping of middle school students into mixed sex groups led to an increased interest in science among girls along with intentions to take future science courses (2013). However, the *NSES* went on to state that other strategies will also be needed to successfully educate science learners (1996).

Active, hands-on learning is one of those strategies. Students who are active in the instructional process, manipulating, measuring, observing, and recording data have been found to have more positive attitudes towards science than their peers who are asked to complete a worksheet following a traditional teacher led lecture (Holstermann, Grube, & Bögeholz, 2010; Johnson, Wardlow, & Franklin, 1997; Siegel & Rainey, 2003; Ornstein, 2006). While comparing two fifth grade research groups, one focused on hands-on activities and the other focused on traditional textbook learning, Foley and McPhee (2008) found that students in active, hands-on classes developed a more favorable attitude toward science along with a better understanding of the nature of science than their textbook counterparts. Hands-on projects in the primary and elementary grades have also been found to develop a lasting interest and favorable attitude toward science in female students (Baker, 2013). In general, research supports the fact that students want more opportunities to engage in practical activities that allow for extended investigation, experimentation, and discussion with peers (Osborne et al., 2003).

The use of problem solving strategies and activities has also been shown to improve student attitudes toward science (Malik et al., 2010). However, how this problem solving is carried out in practice is important to producing the previously stated effect on attitude. Science teachers who have been using a traditional instructional approach focused on lecture and simple seatwork will not be able to use a student-driven problem solving approach immediately. Instead, they will need to provide more guidance for their students during initial problem solving activities as these students will be highly dependent on their teachers for direction during learning activities. Adesoji (2008) found this to be true, as students exposed to traditional instructional approaches showed a positive change in attitude toward science after exposure to teacher guided problem solving activities. This same effect was not shown after independent, student-driven problem solving activities.

Summary

Attitude affects learning. One way that research shows that teachers can positively impact student attitude toward science learning is through learning strategies that encourage students to be active in their learning through activities that include manipulating objects, observing and measuring effects, and tracking data. Problem solving activities which include the active learning qualities previously mentioned can also produce positive attitudes toward science learning. A final learning strategy that can nurture positive learning attitudes is the use of collaborative learning groups.

Chapter III: Implementation

Introduction

Student attitude is a key component to student learning (Adesoji, 2008; Erdemir, 2009) and can even be a predictor of future science learning (Singh, 2002). Therefore, it is critical for educators to find ways to develop positive attitudes toward learning. One way to accomplish this may be to move from a behaviorist, teacher focused instructional style to a more cognitivist, student focused instructional style which encourages students to be more active learners, working collaboratively with their peers. The question this project considered was "Will moving from a direct, lecture-based approach to science instruction (behaviorist approach) to a more active and collaborative approach (cognitivist approach) will improve student attitudes toward science learning?"

Procedures

The field project compared the quantitative and qualitative results of two attitudinal surveys (Appendix A & B) that were administered before and after exposure to four science lessons in which students were asked to be active participants within collaborative learning groups.

Lesson #1

The first lesson dealt with the topic of measuring the width of an individual's blind spot (optic disk) on both the right and left eyeball (Appendix C). Students were paired up with a partner chosen by the teacher. Each group was given a meter stick and a handout. The teacher read through the handout with the students as well as reviewed the concept of similar figures before allowing students to begin working on the activity. The following day, once student pairs had finished calculating a measurement for each partner's right and left blind spot, a whole group activity took place to share and discuss their results. During the activity, students were asked to individually create a table using a spreadsheet in which the results from each student would be entered in order to calculate the mean of the class's blind spot for each eye. The individual results and group mean provided an opportunity to compare and contrast results, speculate on differences, discuss outliers, and consider why God created humans in this way.

Lesson #2

The second lesson was an investigation which challenged the students to answer the open-ended question, "How long would you survive in an air locked classroom?" (Appendix D). After a teacher-led introduction to the current status of civilian space travel, a discussion centered around the hazards of space travel took place which led to the importance of oxygen for space travel being discussed. The students were then shown a video on the importance of oxygen for survival. Following that video, the students were presented with the question along with important assumptions and caveats which focused them in their research, strategizing, measuring, and calculating. Students were allowed to form their own groups of two or three. Before the students were allowed to begin, a performance assessment rubric (Appendix D) was distributed to each student and explained. At this time, the students were informed that they would need to present their answer and solution method for the rest of the class using a slide presentation. Each group was given a tape measure and allowed to use their Chromebooks in order to research. Groups needed to come up with a basic solution strategy approved by the teacher before they were permitted to measure the classroom which would serve as the "airlocked classroom". Students were given two science lesson periods of one hour each and their free time to complete their work. A third science lesson was used to make their presentations.

Lesson #3

The third lesson explored the subject of ocean currents (Appendix E). Students were placed in multi-grade and gender groups of two or three by the teacher. Each group was then given a lesson handout and assigned an investigation topic from the handout focused on ocean currents. Their task was to first investigate the topic using their textbook, a YouTube video provided, and web search and then try to demonstrate the topic for the class using a wave pool. All supplies that students would need for their demonstrations were listed on the handout and provided by the teacher. Groups were given a single one hour lesson period to research the topic and develop their demonstration. The next one hour lesson period was used by groups to present demonstrations and answer questions from classmates. Students not presenting were directed to record their observations from the demonstrations in their science notebooks for later reference.

Lesson #4

The fourth lesson was an extension of the first lesson above. Students were asked to measure the blind spot for both eyes of an adult over the age of twenty using the same technique from lesson #1. They were then asked to individually create another table using a spreadsheet just like in lesson #1 in which the results for each adult would be entered in order to calculate the mean of the adult blind spot for each eye. The same partner groups from lesson #1 were used to encourage completion of the task, review technique procedures, and check partner calculations. Students who did not have a meter stick or tape measure to use at home were provided one. The individual results and group means from both the students and the adults provided another opportunity to compare and contrast results between youth and adults, speculate on similarities and differences, discuss outliers, and consider what other investigative activities could be engaged in to further the learning already started.

Artifacts

Qualitative and quantitative data was collected through a "pre" survey (Appendix A) given prior to the first project activity and then a second "post" survey (Appendix B) given at the conclusion of the fourth lesson. The initial pre survey measured the students' attitude toward science and science instruction up to this point in their schooling, and the second (post) survey measured the students' attitude following the project's implementation. The survey consisted of questions using the 5-point Likert-system as well as open ended questions. The following is a summary of the responses for both surveys.

Pre Survey Responses

#1. *What is your favorite subject in school?* (Free response)

62.5% of the students chose Social Studies and 18.8% chose Science. The students' Social Studies teacher encourages students to be more active in their learning and minimizes the use of textbooks.

#2. *I like science class.* (5-point Likert response)

The mean and mode of student responses was 3 or "Neutral."

#3. *I like doing experiments and activities in science class.* (5-point Likert response)

The mean of student responses was 4.4 and the mode was 5 which falls between "Agree" and "Strongly Agree."

#4. How are science classes conducted in your classroom? (Choice of four responses)

50% of the students chose "The teacher conducts a discussion on a science topic" and the other 50% chose, "The students read the textbook and then the teacher explains it."

#5. *How would you prefer your science class to be conducted?* (Choice of four responses)

The majority of the students at 75% preferred, "The students do experiments/activity." The remaining 25% of students were evenly split between, "The teacher conducts a discussion on a science topic" and "The students read the textbook and then the teacher explains it."

#6. *I benefit from working in a group.* (5-point Likert response and an open ended response)

The mean of student responses for this statement was 3.75 and the mode was 4 which is very close to being considered "Agree".

Table 1

Student explanations for Pre Survey statement #6: I benefit from working in a group.

Number of responses	***Type of response*** (+ denotes positive response; - denotes negative response)
9	+ Teamwork/help each other
4	+ More fun working together
5	- Concern over a loss focus on learning/distracting/loud
1	- Lack of independent work

#7. *Student groups should be used in science class.* (5-point Likert response and an open ended response)

The mean of student responses for this statement was 3.6 and the mode was 4 which falls between "Neutral" and "Agree". No responses lower than 3 or "Neutral" where given. There was one 5 or "Strongly Agree."

Table 2

Student explanations for Pre Survey statement #7: Student groups should be used in science class.

Number of responses	***Type of response***
8	Teamwork is beneficial, but distractions are a concern
6	Teamwork/help each other
2	Balance with independent work
2	More fun working together

Two benefits (Teamwork and More Fun) and two concerns (Distractions and Lack of Independent Work) for group work were mentioned. Of the eight students who responded that “Teamwork is beneficial, but distractions are a concern,” seven had responded to the statement by circling “Neutral” and one had responded with “Agree.”

#8. *What do you not like about science classes?* (Open-ended response)

Over half of the class of 16 students mentioned that science class was “Boring, repetitive and based on the book, notes, and lecture.”

Table 3

Student responses to Pre Survey question #8: What do you not like about science classes?

Number of responses	***Type of response***
9	Boring, repetitive and based on the book, notes, and lecture
3	Not enough review/worktime
3	Students talking over teacher/consequences/disrespect
1	Put on the spot w/questions
1	No group work
1	No experiments

#9. *What would you like to change (or to add) in your science class?* (Open-ended response)

For this question, students were able to include more than one response to the question. Over half the students responded that science class should include more experiments.

Table 4

Student responses to Pre Survey question #9: What would you like to change (or to add) in your science class?

Percent of Students	***Type of response***
56.25%	More Experiments
25.00%	More Experiments and group work
12.50%	Group work
6.25%	More discussions

<u>Post Survey Responses</u>

#1. *I like science class.* (5-point Likert response)

The mean and mode of student responses was 3.0 or “Neutral.”

#2. *I like doing experiments and activities in science class.* (5-point Likert response)

The mean of student responses was 4.3 and the mode was 5 which falls between “Agree” and “Strongly Agree.”

#3. *I like how we have been studying science the past four lessons.* (5-point Likert response and an open ended response)

The mean of student responses for this statement was 3.7 and the modes were 3 and 4 which falls between “Neutral” and “Agree.” All students responded with a 3 or higher. One student responded with a 2 or “Disagree.”

Table 5

Student responses to Post Survey statement #3: I like how we have been studying science the past four lessons

Number of responses	***Type of response*** (+ denotes positive response; - denotes negative response
10	+ Like experiments
3	+ Activities were challenging
1	+ Like group work
3	- Missed book work
1	- Don't like group work
1	- Out of order

A majority of ten out of sixteen students stated they liked doing "experiments" in science during the four project lessons.

#4. *I benefited from working in a group the past four lessons*. (5-point Likert response and an open ended response)

The mean of student responses for this statement was 3.9 and the mode was 4 which is nearly "Agree." All students responded with a 3 or higher except for one student who responded with a 2 or "Disagree."

Table 6

Student responses to Post Survey statement #4: I benefited from working in a group the past four lessons.

Number of responses	***Type of responses*** (+ denotes positive response; - denotes negative response
10	+ Teamwork/help each other
3	+ More fun/like working together
2	- Group conflict/shirkers

A majority, ten out of sixteen students, stated "Teamwork" was a benefit of working in groups during the four project lessons. Two students stated they were concerned by some group conflict and some students not participating.

#5. *Student groups should continue to be used in science class.* (5-point Likert response and an open ended response)

The mean of student responses for this statement was 4 and the mode was 5 which falls between "Agree" and "Strongly Agree."

Table 7

Student responses to Post Survey statement #5: Student groups should continue to be used in science class.

Number of responses	***Type of responses*** (+ denotes positive response; - denotes negative response
10	+ Teamwork/help each other
5	+ More fun/like working together
3	- Group dynamics/shirkers

A majority of ten out of sixteen students stated "Teamwork" as a reason why group work should continue to be used in science class. Three students state concern over group conflict and some students not participating.

#6. *What would you like to change about how the last four lessons were taught in science?* (Open-ended response)

Seven types of suggestions were fairly evenly distributed across the students tested.

Table 8

Student responses to Post Survey question #6: What would you like to change about how the last four lessons were taught in science?

Number of Responses	***Suggestions***
3	Nothing
3	More Experiments
3	Need some independent book work
2	More consistent topic sequencing
2	Fewer presentations
2	Less math activities/more hands on
2	Building background is still important

#7. *In the future, how would you prefer your science class to be conducted?* (Choice of five responses)

A majority of students preferred that future science classes have “the students do experiments/activities in groups.” The remainder of students would prefer either more independence in learning and/or more teacher directed learning

Table 9

Student responses to Post Survey question #7: In the future, how would you prefer your science class to be conducted?

Percent of Students	***Response options***
6.25%	The teacher conducts a discussion on a science topic.
12.50%	The students do experiments/activities independently.
62.50%	The students do experiments/activities in groups.
18.75%	The students read the textbook and then the teacher explains it.
0.00%	The students learn a new topic by doing research projects.

#8. *What was your favorite lesson of the four lessons?* (Choice of four lessons)

This question was added by the researcher at the time of the survey. Over half of the students enjoyed the Ocean Currents lesson which involved much handling and manipulation of physical materials.

Table 10

Student responses to Post Survey question #8: What was your favorite lesson of the four lessons?

Percent of students	***Lesson***
56.25%	Ocean Currents
25.00%	Blind Spot (Lesson #1)
6.25%	Running Out of Oxygen
12.50%	No Response

Results

The "pre" and "post" surveys were used to evaluate whether or not the active, collaborative science lessons taught during the project improved student attitudes toward science learning. Based on the data collected from both surveys, it cannot be shown that these lessons produced a change in student attitude toward science learning. The students began and ended the project with a neutral attitude toward Science as seen in the mean student response of 3 or "Neutral" on both surveys to the statement, "I like science class." The Wilcoxon signed-rank test was used to check for significance in differences between the pre and post mean scores for this statement. However, because only 5 of the 16 participants had changed scores, the test could not be validated. Additionally, the students began and ended the project with a positive attitude toward science as seen in the mean staying nearly the same at 4.4 or “Agree” for the pre survey and 4.3 for post survey for the statement, “I like doing experiments and activities in science class.”

However, the data focused on the instructional practices does provide strong insight on student preferences toward science instruction. 75% of students responded to the post survey question, “In the future, how would you prefer your science class to be conducted?” with “The students do experiments.” Student responses agreed with the post survey statements dealing with instructional practices, “I like how we have been studying science” (Mean = 3.7; Mode = 3 & 4), “I benefited from working in groups” (Mean = 3.9; Mode =4), and “Student groups should be used in science class” (Mean = 4; Mode =5). This suggests that students do prefer instructional practices that include activities in which students are actively involved in collaborative groups.

Chapter IV: Reflective Essay

Introduction

Attitude toward a subject is critical to the learning process. Teaching techniques could potentially be a way in which educators can help nurture more positive student attitudes toward the study of science. The question this project considered was whether or not moving from a direct, lecture-based approach to science instruction (behaviorist approach) to a more active and collaborative approach (cognitivist approach) will improve student attitudes toward science learning.

Conclusions

Based on the data collected, the more active, collaborative approach to science instruction during the project duration did not produce a change in student attitude toward science learning. The students began with a neutral attitude toward science and ended with a neutral attitude. However, students did appreciate the opportunity to work in collaborative groups and participate in hands-on activities. The apparent disconnect between the neutral overall attitude toward science and the positive attitude toward certain instructional strategies may be the result of a number of factors.

First, the use of collaborative groups was relatively new for these students. While they enjoyed the socializing aspect, many were not sure of the expectations of collaborative work. Therefore, some students bore more of the workload than others. Multiple students reported that they enjoyed working together as long as everyone was participating.

Second, not all activities fit into the students’ definition of active learning. Most students enjoyed working with physical materials and tools; however, many did not enjoy doing research for use in problem solving open ended questions.

Third, even though students view collaboration and active learning favorably, they still need to find purpose in their learning and find confidence in the continuity of subject matter. The lesson topics for the project were disjointed, and the lesson objectives did not flow from one to the other as seen in the lesson topics - Optical Blind Spot, Measuring Oxygen within a Room, and Ocean Currents. Some students reported that they would prefer lesson topics and objectives to be connected in some way versus a random sequence of lessons. A series of lessons on the same topic would improve this study if it is repeated.

Fourth, as a teacher who was not as familiar with these instruction strategies, I struggled in my delivery of these lessons. I felt very much like a beginning teacher in various ways. Upon reflection, I found that as a teacher turns over more control of the learning environment to student groups, the teacher’s expectations for students and the methods of formative assessment need to change along with the monitoring of those expectations and student learning. The questioning of students needs to change from pulling facts out of students to leading students to discover connections and new thought processes. By not effectively making necessary changes in lesson delivery, I feel that I may have created a less than positive learning environment for some of these lessons.

Recommendations

While moving from a direct, lecture-based, behaviorist approach to science instruction to a more active and collaborative cognitivist approach may improve student attitudes toward science learning, this project shows that just incorporating a few active and collaborative lessons is not sufficient in influencing student attitude toward science learning. Much more needs to take place in order for these techniques to be effective.

First, the use of active and collaborative lessons needs to be used more regularly and begin sooner than seventh grade. It takes time and repetition to break the behaviorist dependency of students on the teacher for their learning. Only through time and encouragement will students develop a familiarity with this type of learning, develop confidence in taking risks in their learning, and experience the joy of learning science. By taking risks and seeing a positive reward, appreciation begins to grow.

Second, students need to be highly supported by the teacher in this transition as students who are used to a behavioristic instructional approach focused on lecture and simple seatwork will not be able to move across the pedagogical spectrum to a collaborative, student driven, open-ended problem solving approach immediately. Just throwing students into groups with the task of learning by doing will not work. Instead, teachers will need to provide more guidance for their students during initial active and collaborative activities as these students will be highly dependent on their teachers for direction. This recommendation aligns with the findings of Adesoji (2008).

Third, independent activities based on book work and research should not be removed altogether. These activities still have a place for many students, especially as part of a differentiated plan for science instruction.

Finally, teachers who are unfamiliar with this cognitivist approach to teaching science will need professional development in order to increase the effectiveness of their instruction. Through professional courses, readings, and learning communities, teachers can develop awareness of necessary environmental needs, expectations, and assessments to carry out and support learning while receiving necessary support from those who are more practiced in these strategies. Additionally, a budget to support this professional development along with physical classroom materials will be necessary.

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Appendix A: Science Attitude Survey #1

Grade: ________ **Gender:** Male / Female (circle the appropriate)

Please read through the following statements and then respond to each statement. Remember to be honest! Your responses will not be used to determine your grade but will help the teacher improve your learning.

1. What is your favorite subject in school? ___________________
   Why?____
   ____

2. I like science class. (Circle response)

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. I like doing experiments and activities in science class. (Circle response)

Strongly Disagree Disagree Neutral Agree Strongly Agree

4. How are science classes conducted in your classroom? Circle best option:
   a. The teacher conducts a discussion on a science topic.
   b. The students do experiments/activity.
   c. The students read the textbook and then the teacher explains it.
   d. The students learn a new topic by doing research projects.

5. How would you prefer your science class to be conducted? Circle best option:
   a. The teacher conducts a discussion on a science topic.
   b. The students do experiments/activity.
   c. The students read the textbook and then the teacher explains it.
   d. The students learn a new topic by doing research projects.
      Explain why? ____
      ____
      ____

6. I benefit from working in a group. (Circle response)

Strongly Disagree Disagree Neutral Agree Strongly Agree

How or why not?____
____

7. Student groups should be used in science class. (Circle response)

Strongly Disagree Disagree Neutral Agree Strongly Agree

8. What do you not like about science classes?

9. What would you like to change (or to add) in your science class?

Appendix B: Science Attitude Survey #2

Grade: ________ **Gender:** Male / Female (circle the appropriate)
Please read through the following statements and then respond to each statement. Remember to be honest! Your responses will not be used to determine your grade but will help the teacher improve your learning.

1. I like science class. (Circle response)

Strongly Disagree Disagree Neutral Agree Strongly Agree

2. I like doing experiments and activities in science class. (Circle response)

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. I like how we have been studying science the past two lessons. (Circle response)

Strongly Disagree Disagree Neutral Agree Strongly Agree

Why? ____

____

4. I benefited from working in a group the past four lessons. (Circle response)

Strongly Disagree Disagree Neutral Agree Strongly Agree

How or why not?____

____

5. Student groups should continue to be used in science class. (Circle response)

Strongly Disagree Disagree Neutral Agree Strongly Agree

Why? ____

____

6. What would you like to change about how the last four lessons were taught in science?

____

____

____

7. In the future, how would you prefer your science class to be conducted? Circle best option:
    1. The teacher conducts a discussion on a science topic.
    2. The students do experiments/activities independently.
    3. The students do experiments/activities in groups.
    4. The students read the textbook and then the teacher explains it.
    5. The students learn a new topic by doing research projects.
    Explain why?

    ____

    ____

Appendix C: Lesson #1

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Measuring Your Blind Spot

Publication No. 10244

Introduction

Seeing is believing. See for yourself that you have a blind spot. Then measure it!

Concepts

- Blind spot (optic disk)
- Retina
- Lens
- Similar triangles

Background

The lens in the front of the eye focuses images on the retina in the back of the eye. In the retina, the image impulses are converted to nerve impulses which are then sent via the optic nerve to the brain for interpretation. In the retina there is an area known as the optic disk. (See Figure 1.) In the optic disk area, the nerve fibers converge and leave the eyeball. In addition, a central artery and vein also pass through the eye in the optic disk area. Because the passageway for these structures is through this part of the retina, there are no receptor cells in the optic disk area, therefore, since there is no image reception occurring in the optic disk, this area is often referred to as the "blind spot."

Materials

Blind Spot Visual Chart
Meter stick

Safety Precautions

This activity is considered safe, but since the eye is the center of experimentation, cautions should be issued and care taken. Protective eyewear will not interfere with experimental results and should be worn during this activity.

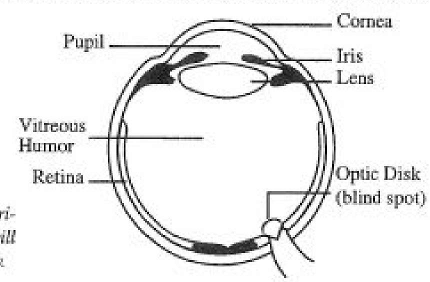


Figure 1. Structure of the eyeball

Procedure

1. Obtain a Blind Spot Visual Chart. Use a ruler to measure the distance between the dot and asterisk. This is distance **g** in Figure 2.
2. Follow the directions on the chart and experience the blind spot phenomena for both your left and right eye.

Perform steps 3–5 with a laboratory partner *being careful when measuring near the eyes*. Safety glasses should be worn.

3. Have your lab partner hold a meter stick along the side of your head as you determine where the marker disappears and reappears as you view the Blind Spot Visual Chart. Stop moving the chart when the marker disappears and have your lab partner measure from the front of your eye to the chart. This measurement is distance **a** in Figure 2. Then measure the distance from your eye to the chart when the marker reappears. This is distance **b** in Figure 2.

4. Record the measured distances.
5. Repeat the experiment to secure measurements for your lab partner.
6. Use the measurements and the diagrams in the Discussion section to calculate the width of your blind spot, labeled **e** in Figure 2.

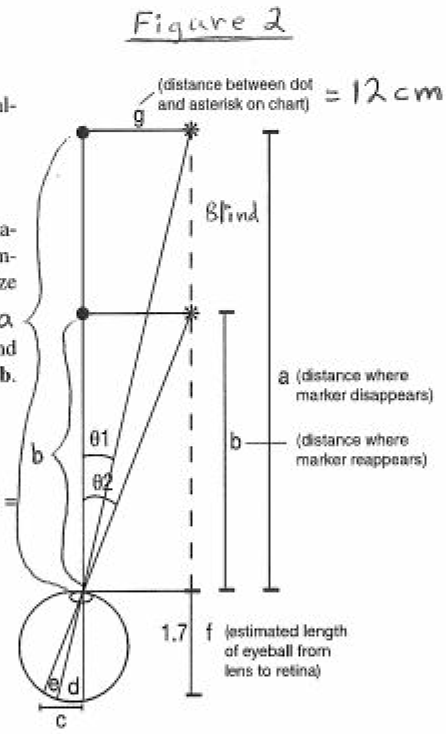


Figure 2. Geometry of blind spot calculation

Discussion/Results

The size of the blind spot will vary from individual to individual. The calculation for the width of the blind spot is only an estimate based upon some basic geometry and several assumptions. Two methods are shown below for calculating the size of the blind spot. Refer to Figure 2 for the following formulas and calculations.

The distance of the blind spot is shown as **e** in Figure 2. Both distances **d** and **c** can be calculated using similar triangles and the measured distances **a** and **b**. The blind spot (**e**) can be calculated as:

$$\mathbf{e} = \mathbf{c} - \mathbf{d}$$

Method 1: Equivalent triangles

Example calculations are shown for results that have measured distances **a** = 48 cm and **b** = 38 cm.

Using distances **a** and **b**, **c** and **d** can be calculated:

$$\frac{g}{b} \quad \frac{12\text{ cm}}{38\text{ cm}} = \frac{c}{1.7\text{ cm}} \quad \frac{c}{f} \qquad \frac{12\text{ cm}}{48\text{ cm}}\left(\frac{g}{a}\right) = \frac{d}{1.7\text{ cm}} \quad \frac{d}{f}$$

$$\mathbf{c} = .54\text{ cm} \qquad \mathbf{d} = .43\text{ cm}$$

$$\mathbf{e} = \mathbf{c} - \mathbf{d}$$

$$\mathbf{e} = .54\text{ cm} - .43\text{ cm} = .11\text{ cm}$$

Method 2: Trigonometry

The relationship can also be expressed as:

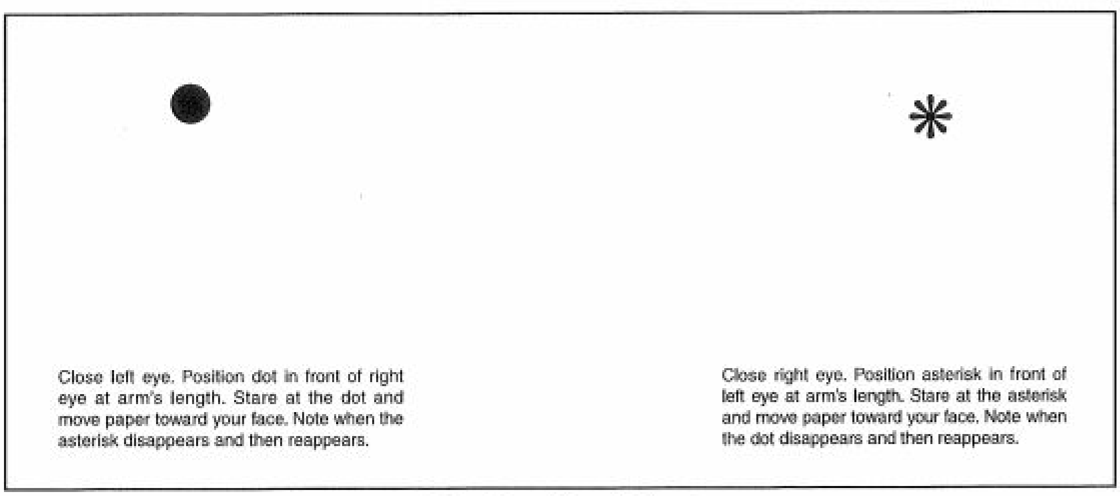
$$\mathbf{e} = \mathbf{f}\,(\theta_2 - \theta_1) \text{ where:}$$

$$\mathbf{f} = \text{distance between retina and lens}$$

$$\theta_1 = \tan^{-1}\left(\frac{g}{a}\right) \qquad \theta_2 = \tan^{-1}\left(\frac{g}{b}\right)$$

Using 1.7 cm as an estimate of eyeball length:

$$\mathbf{e} \approx 1.7\left[\tan^{-1}\left(\frac{12\text{ cm}}{38\text{ cm}}\right) - \tan^{-1}\left(\frac{12\text{ cm}}{48\text{ cm}}\right)\right] = 1.7\,(.0658) = 0.11\text{ cm}$$



Blind Spot Visual Chart

Appendix D: Lesson #2

Title: Investigation - How long will we survive in our airlocked classroom?

Subject: Math - Volume; Science - Oxygen Use By Humans

Grades: 7th grade

Objectives:

- Students will practice measuring and problem solving.
- Students will review their knowledge of volume and using unit rates.
- Students will explain their solution method presentations orally to others.
- Students will discover the minimum volume of oxygen needed by humans

Standards:

Math MN 7.1.2.1 Add, subtract, multiply and divide positive and negative rational numbers that are integers, fractions and terminating decimals; use efficient and generalizable procedures, including standard algorithms

Math MN 7.3.2.3 Use proportions and ratios to solve problems involving scale drawings and conversions of measurement units.

Lang. Arts MN 7.9.1.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.

e. Cooperate, mediate, and problem solve to make decisions as appropriate for productive group discussion.

Materials Needed:

- Tape measures
- Scratch paper to keep track of measurements
- Chromebook

Strategy:

Share with the students a story about the future of space travel to the moon and beyond. The SpaceX is working on that right now. Ask students if this type of travel is necessary. Will it become widespread? What potential dangers exist for humans in this type of travel? If a student does not mention it, the teacher will bring up the danger of running out of oxygen. Video will be shown on the importance of oxygen for survival. Discussion will lead to the lesson investigation: **How long will we survive in our airlocked classroom?**

Students will be partnered up and given the task of finding the answer to this question. Each pair will need a tape measure, paper for taking notes, and a Chromebook for looking up information such as the amount of oxygen a person uses in a day. Students will be informed that they will be creating a slide presentation that reports their answer and explains their method for finding the answer. It will be stressed that they need to keep track of the numbers that they are using and how or where they found them. This will be critical in being able to explain their solution method well. A rubric (located at the end of this lesson plan document) will be provided to each group and explained. I found that humans need 19 cubic feet. Before the students are allowed to begin, the teacher will state that students can assume that the air has the normal amount of oxygen in it at the time the room becomes airlocked.

Two rooms will be needed. Students will be given 45 mins to strategize and carry out their solution method. They will need to carry out their strategizing in classroom #1. Once their strategy is developed and approved by the teacher, they will then be able to move into classroom #2 and carry out their strategy. This is done in order to avoid idea poaching. The teacher will circulate throughout each room as necessary monitoring progress and posing questions as necessary.

Students will be given the next day to complete their presentations. On the second day following the initial investigation, student pairs will present the performance assessment listed below.

Biblical Integration: Discuss the idea that the ratio of pi was part of creation.

Performance Assessment: (done with partner)

Students will be asked to create a presentation slide that displays their solution to the problem and outlines the steps taken to find the answer. Students will need to give an oral explanation along with the slide presentation in front of class.

Conclusion:

Through this authentic investigation, students will be more motivated to take ownership of the learning while they practice measuring and problem solving, review knowledge of volume and unit rates, and engage in public speaking during their solution method presentation. le given its diameter as well as explain how their understanding and use of pi.

Science Extension: Students research the following questions on Chromebooks:
Would we survive long enough to use up all the oxygen?
Why does too much carbon dioxide become toxic?

Resources:
https://health.howstuffworks.com/human-body/systems/respiratory/question98.htm

Student Name____________________

Grade: 7/8
Objectives:

- Students will practice measuring and problem solving.
- Students will review their knowledge of volume and using unit rates.
- Students will explain their solution method presentations orally to others.

Investigation Performance Assessment Rubric

Criteria	3	2	1
Investigation Solution	Answer was +/- 15 minutes of the correct answer	Answer was +/- 25 minutes of the correct answer	Answer was outside of +/- 25 minutes of the correct answer
Written explanation of solution method.	The explanation of the solution method was logical and clearly understandable.	The explanation of the solution method was logical but difficult to understand.	The explanation of the solution method was neither logical nor easy to understand.
Partner Work	Student was an active participant and helped partner in his/her learning through discussion and questioning	Student was an active participant in activity but without discussion and questioning.	Student interacted with partner at a minimal level.

Appendix E: Lesson #3

Title: Causes and Effects of Ocean Currents

Subject: Earth Science

Grades: 7th-8th grade

Objectives:

- Students will develop a hypothesis on a cause of ocean currents and model it using various materials of their choosing.
- Students will record observations on a lab report form that explains their understanding of the concepts regarding ocean currents using words and drawings.
- Students will draw conclusions from their observations and models on how ocean currents influence local weather.

Standards: MN 8.3.2.1.2 Recognize that **oceans** have a major effect on global climate because water in the **oceans** holds a large amount of heat.

MN 8.3.2.1.3 Explain how heating of the Earth's surface and atmosphere by the sun drives convection within the atmosphere and hydrosphere producing winds, **ocean currents** and the water cycle, as well as influencing global climate.

Materials Needed:

- Textbook
- Chromebook
- Ice Cubes (2 cups)
- Water
- Droppers
- Table Salt (1 container) to model higher-density water
- Food Coloring (1-red and 1-blue)
- Four clear plastic rectangular basins (Approx. 18" X 50") or four small aquariums
- Small Fan to create surface currents (1)
- Several small objects to represent zooplankton, nutrients, and phytoplankton
- A flat rock to model continental deflection (1)
- Heat source such as hotplate

Strategy: Lesson will begin with a clear container of water placed in front of the room. Teacher will state, “Students, you will all play a part in teaching your classmates and teacher about the causes of ocean currents and how they affect life on earth. We are also going to get our hands wet!”

Before beginning the lesson, the teacher will discuss with students what they already know about ocean currents as well as review transfer of thermal energy by convection, conduction, and radiation followed by a review of causes of wind and density. All these topics were covered earlier in the year. Lab safety in regard to using a fan near water, glass objects, and heat sources will also be discussed.

Following this review, the teacher will explain that students will be placed into groups of two or three in order to do a quick eight minute fact finding activity on an assigned concept connected with ocean currents. Each group will have its own concept. They may use their textbook and/or the internet. Teacher will tell students the page number of the concept. A Youtube video is also provided for them. Following their research, students will be given time to develop a hypothesis about their concept and how to model it using the materials provided and the water tanks in the room. These models will be displayed to the entire class.

Following the research and the development of a hypothesis and model, all students will make observations about each model including their own for later reflection. They are also encouraged to draw pictures of what is taking place in each model. A "Modeling Ocean Currents Lab" sheet is provided at the end of this lesson plan.

Formative Assessment:

Each student will individually reflect on all their observations and explain in writing and pictures how ocean currents take place and how they impact local weather and life on earth. The teacher will use this assessment to inform further review or reteaching.

Conclusion: Ocean currents are an amazing component of God's creation that affects all of us and yet can be easily overlooked. Through student research and creation of models, students will better understand from each other how ocean currents develop and how currents due in fact impact life on earth.

References: *Science Explorer - Earth's Water,* Book H (Prentice Hall, 2002)
Youtube.com
Cpalms.org - lesson idea

Modeling Ocean Currents Lab

Your group will be assigned a concept to investigate, and then create a model for it. You will then present your model to the rest of your class. Your classmates will be recording their observations from your presentation in writing and drawing.

Group 1: (pg. 135) Surface currents https://www.youtube.com/watch?v=WEe1bVjORN4

Group 2: (pg. 135)The three things that affect surface currents https://www.youtube.com/watch?v=i2mec3vgeaI

Group 3: (pg. 136)Deep currents https://www.youtube.com/watch?v=FuOX23yXhZ8

Group 4: (pg. 135) Convection currents https://www.youtube.com/watch?v=0IUP665PQPU

Group 5: (p 137) Upwelling & importance to the marine system https://www.youtube.com/watch?v=Al8WrXkLuL4

Group 6: (p. 136) The global conveyor belt & what it transports https://www.youtube.com/watch?v=L9zjmC8InKA

Group 7: (pg. 136) How ocean currents affect local weather https://www.youtube.com/watch?v=6vgvTeuoDWY

Group Concept/Problem: ____

Materials

- Ice Cubes (2 cups)
- Water (enough to fill the basin to 2")
- Table Salt (1 container) to model higher-density water
- Food Coloring (1-red and 1-blue)
- Rectangular Basin or small aquarium
- Small Fan to create surface currents (1)
- Several small objects to represent zooplankton, nutrients, and phytoplankton
- A flat rock to model continental deflection (1)

Procedure

1. Take 8 minutes to read about your assigned concept.
2. Examine the materials available and formulate a hypothesis on how you can create a model of your assigned concept.
3. Write your hypothesis below.

Hypothesis: ____

1. When your group's turn is up, test your hypothesis in the ocean basin provided with the materials your group selected.
2. Record your observations on the back in writing and draw a diagram of what you see.
3. Record your observations in writing and draw a diagram for the other group's presentations in your Science notebooks.

Group Observations (Please use back):