THE EFFECTS OF INQUIRY-BASED TEACHING IN THE MIDDLE SCHOOL SCIENCE CLASSROOM

by

Brandon Duke Furr

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ABSTRACT

Cut Bank Middle School 8th-grade students were introduced to inquiry-based learning through inquiry-based teaching. Students had been reliant on receiving information though lecture style learning with some hands-on activities. This project examined the usage of inquiry-based teaching instead of lecture style. This project was done over two units where treatment groups received inquiry-based teaching while the non-treatment group received lecture style teaching. The periods rotated on the style of instruction they received. The treatment groups had full inquiry-based lessons and the non-treatment group received lecture style instruction and then the activities to follow. Students took a pre- and post-test from each unit. The tests were used to show normalized gains during the unit and to compare to the other classes. Observations of student attitudes and behavior towards inquiry-based learning were recorded in a journal. At the end of units and the end of the study students were given surveys to give feedback about their style of learning choice and effort put in during the units. The treatment groups got scores that were lower than the non-treatment group. The conclusion of this study was that balancing inquiry-based teaching and lecture teaching would be best for students and help improve their understanding of science.

CHAPTER ONE

BACKGROUND AND INTRODUCTION

Context of the Study

I teach life and physical science at Cut Bank Middle School in Cut Bank, Montana. Cut Bank is a small farming and railroad town with a population of 3,025 and is located on the border of the Blackfeet Indian Reservation (Cut Bank, Montana population, 2021). Cut Bank Public Schools currently has 806 students enrolled, of which 167 of these students are middle school students, grades 6-8th. Cut Bank Public Schools serves primarily low-income students; most students are on free or reduced lunch, and it is a Title I school. Over 50% of the district student population is Native American (Hofstad, Principal, November 2022 personal communication).

Cut Bank has seen an increase in population over the last two years. Many families moved to Cut Bank during and after the pandemic. As a result, the student population is higher now than it has been in over ten years. Cut Bank is experiencing a teacher shortage, and with the increase in students, it has pushed many classes over 20 students. This has led to less one-on-one time. Over the last few years, many elementary teachers have had to spend less time on social studies and science to focus on language arts and math. Students do not have a lot of experience with science, and when they do it tends to be negative due to a high volume of reading with little to no hands-on activities (Hofstad, March 2022 personal communication).

The purpose of my study was to see how inquiry-based practices impact a student's learning in a grade 8 physical science class. Inquiry-based teaching would allow students a

different experience with science, possibly change attitudes towards science, and make learning science fun.

Focus Question

My focus question was, How does a student's learning and attitude change using inquiry-based teaching in a grade 8 science classroom?

CHAPTER TWO

CONCEPTUAL FRAMEWORK

History of Inquiry-Based Learning

Inquiry-based learning first appeared in Ancient Greece with the philosopher, Socrates. Socrates questioned everything about the natural world and believed that he knew nothing until he explored his questions. The questions he asked seemed to be simple, but after exploring his questions, he was able to find out if his ideas were true, false, or even if some of their thinking in his time was flawed. Ever since Socrates introduced the idea of inquiry-based learning, future generations have continued to adapt his ideas to help them learn through questioning (Friesen & Scott, 2013).

The Middle Ages and the Renaissance further elaborated on the process of inquiry. People sought ways to simplify work and prove scientific ideas of the time. Often their discoveries such as the microscope, the telescope, and the printing press did not work out on the first attempts. This meant that they had to keep questioning and exploring how to make them work, until they were able to find a way to make them work. These discoveries also led a charge of inquiry and inspired many people to question what they knew and encouraged exploration and discovery in many fields (Friesen & Scott, 2013).

Next came, John Dewey who introduced the idea of using inquiry as the primary teaching method in science classrooms. Early on, this was modeled off the scientific method in the classroom. Dewey advocated for using perplexing situations to find ways to explain the situations, develop a hypothesis, test solutions, and share conclusions following analysis. Dewey

explored and experimented with different school subjects. He encouraged educators and students to use problems from their own experiences and use inquiry to help find and explain solutions to their problems. Dewey believed and proposed that students should be actively learning instead of the teacher using traditional lecture style learning and the teacher should facilitate and guide the learning. Dewey and Socrates thought that inquiry should be used to gain knowledge and use inquiry to solve problems in life and learn how to live more fully engaged lives (Friesen & Scott, 2013).

Inquiry-Based Learning Teacher Roles and Perspectives

Inquiry is a style of learning that involves exploring the material and natural world, which leads to students asking questions, making discoveries, and testing the discoveries to build understanding (What is inquiry?, 2020). The inquiry method of teaching and learning science mimics a way that a scientist would do science in the real-world. Inquiry-based learning allows students to build new knowledge and to do so more independently. It also allows students to build knowledge through authentic science experiences. Another form of inquiry is guided inquiry. Guided inquiry is viewed as a team approach between the teacher and student. In guided inquiry, students search for an answer to science phenomena with the guidance of an educator (Eltanahy & Forawi, 2019).

Teachers reported that when students become active in their learning, it is friendly to all types of learners, and keeps them engaged throughout the process (Eltanahy & Forawi, 2019). Teaching through inquiry-based learning illuminates' misconceptions and allows students to change their own thinking (Llewellyn, 2014). The teachers who were surveyed reported that it does take time and training to master techniques. Many preferred to use a guided approach,

supplying students with a few questions to pick from about the presented phenomena. The teachers agreed that it was tough to follow a specific plan for each class and it ended up varying on how each class went. Periods were started with a big demonstration of phenomena and then guided from there. Teachers believed 8th grade students were able to apply inquiry well and it helped develop analytical skills (Eltanahy & Forawi, 2019).

Inquiry is a style of learning that involves exploring the material and natural world, which leads to students asking questions, making discoveries, and testing the discoveries to help understanding (What is inquiry?, 2020). The teacher can also play an active role in student success for inquiry-based learning by creating an atmosphere that is designed for student inquiry. Without the need for as many books and papers, the classroom can be kept clutter-free and ready for students to actively explore. Teachers are encouraged to use as much natural light as possible. As a source of energy, natural light can inspire the development of positive emotions and thoughts. Student desks can be placed in groups of three or four to take away the normal lecture feel of a classroom. The layout should be changed periodically to show flexibility. Having a classroom arrangement like this can help create a feel of openness and promote clarity while reducing ambiguity. Displays of nature through posters or a small waterfall can symbolize peace and serenity for all in the classroom. During passing periods, teachers can play relaxing music for students. This creates a calm environment, soothing anxieties and opening students' minds to a new style of inquiry-based learning before class starts (Llewellyn, 2014). All strategies are implemented to help students feel more comfortable in the science classroom. This can help students feel more open to trying something new like inquiry-based learning. These strategies

help students feel like they are not fully in a learning area and help stay relaxed when they are challenged to do different things and discoveries through inquiry-based learning.

In one study, teachers expressed difficulties with students working together and that large class sizes were not effective for learning. Teachers can help alleviate these difficulties by posting the essential question on the markerboard, reminding students throughout the entire lesson of the daily goals. The essential question can then be utilized to guide a closing discussion after the activity is completed (Eltanahy & Forawi, 2019).

Teachers can use stations, which help spread students out to help maintain a productive classroom. An example of stations would be during an evolution unit where students use fossils to show evidence of evolution and at another station students are trying to find the right way to make the geological time scale. Stations are most successful when each station can offer a new and unique task that helps keep students engaged and motivated. Teachers can have students work in pairs. When students work in pairs, they spend more time on task and there tends to be less time off task than in group work. Pairs simplify teacher's job by limiting the time they spend dealing with student behavior and redirecting students to stay on task. Partner work also promotes mutual contribution, rather than in a small group where one or two students do most of the work. Providing students with time limits is another way to keep them on task. Projecting a timer with work time remaining for students allows them to be more aware and motivates students to finish in the allotted time (Llewellyn, 2014).

Inquiry-Based Learning Student Roles and Perspectives

In the 5E learning cycle, students engage in a topic, explore the topic, explain, elaborate, and evaluate the topic. Students are engaged through presentation of phenomena by video or a

class demonstration (Bybee, 2006). Phenomena is defined as observable events that occur in the universe and that we can use scientific knowledge to explain and predict (Montana NGSS, 2022). Once that is over students have the chance to question and try to figure out how the phenomena works. Students can change their perspective and become inquiry-based learners by simply questioning what they believe with the help of the 5E learning cycle (Llewellyn, 2014). While completing a 5E learning cycle, students reported that they were engaged, answered a certain question, collected the data, and used discussion to further their understanding of the topic. Students used small groups to work together, however they worked to answer different questions. Students were concerned and explained that, at times, they felt they did not have the proper amount of time to get results or form an explanation. Most students reported that inquiry-based learning changed their perspective on science and that they found it more engaging than the traditional way of science education (Eltanahy & Forawi, 2019).

Another benefit of inquiry-based learning is students being able to observe the science themselves. When students are simply told what happens, they have difficulty imagining what is said to be true. Students also get satisfaction of experiencing and discovering the science on their own. This opportunity for real world application enhances student curiosity by building investigation skills and teaching students how to apply new knowledge. Students also gain familiarity and perspective on what a scientist experiences in their career and learn that science involves discussion and cooperation among individuals (Harlen, 2013).

Self-Regulation in Inquiry-Based Learning

Using inquiry-based learning in science education builds student independence by teaching them to self-regulate. Self-regulation is students regulating themselves without an

intervention from an outside person. This independence teaches them to take control of and reflect on their learning. The inquisitive nature of science courses sets them apart from other classes. With the use of inquiry-based learning, students are more engaged and invested in their learning. Students can develop the understanding of science, reasoning skills, and learn the power of positive attitudes. Students cannot learn everything about the real world in school, so inquiry-based learning teaches students how to apply these skills to real world problems (Harlen, 2013). In comparison, traditional science instruction is centered on finding a correct answer and mastering the content knowledge of that grade. This teacher-centered method of teaching has a focus and importance that is not placed on inquiry, discovering, and loving science, but on being able to pass a test. Without inquiry-based learning, students lose the opportunity to explore science (Spencer & Walker, 2011).

Inquiry-based learning has helped increase student motivation and promotes student development of self-efficacy. Motivation and self-efficacy are beneficial because, as they are developed, students gain self-confidence and the belief that they can solve any science problem that comes their way. Self-efficacy also helps students develop motivation in and out of the classroom, benefiting their learning and gaining confidence socially. With inquiry-based learning students can develop a freedom of learning. With guidance, students can be responsible for their learning and in turn have autonomy in how they learn through the inquiries that they perform. Instead of students being told what to know and how to do something, students have the independence to explore in their own way, making their learning more meaningful to them (Moote, 2020).

In a recent study of inquiry-based learning that took place in three classes of math and science, all saw a small increase in self-regulation, self-regulated learning, and self-determination. These skills varied from student-to-student, but overall small gains were made. Inquiry-based learning was found to have a positive impact on self-regulated processes of students. It also impacted some students who experienced major changes in overall self-regulation, self-regulated learning, and self-determination. Students were able to rely less on the teacher to tell them what they should know and do and become more responsible for their own learning. Learners became more motivated and determined to find answers to different inquiries. Inquiry-based learning allowed students to take control of learning and themselves. Many students were able to realize they are responsible for themselves and what they learn. The study showed there was a significant increase in science motivation overall, and a small increase in student interest in science-based career opportunities (Moote, 2020).

One way to engage students is through exploring a phenomenon. An example of a phenomenon is a water strider. Water striders do not break surface tension and can appear to be walking on water. Before the explanation of phenomena is presented, students are more likely to participate in the discussions of an explanation. When inquiry-based learning is utilized, the cognitive thinking level of students increases, compared to when it is not in use, leading to an increase in self-regulation of students. In another study, inquiry-based learning led to a 17% increase in students using high cognitive thinking over lower cognitive thinking through exploration (Marshall & Horton, 2011). This allows students to become more responsible for their learning and improves their self-regulation skills.

CHAPTER THREE

METHODOLOGY

Demographics

Cut Bank is a small farming and railroad town located in northcentral Montana. The current population of Cut Bank is 3,025 (Cut Bank, Montana population 2021). Many families who live here do not make the average income in Montana and consequently, many students in Cut Bank School District qualify for free and reduced lunch, which makes Cut Bank a Title I school. Over 50% of Cut Bank Public Schools students identify as Native American. There is also a lot of movement in the student population, where children enter and leave the school district frequently throughout the school year, as their living arrangements change (Hofstad, Principal, March 2022, personal communication).

This study was conducted in the 8th grade science classroom across three periods with 50 students overall. Eleven of the students have Individual Education Plans (IEPs) and there are 3 students who have 504 Behavioral Plans. Period 1 has 15 students; period 3 has 22 students with 10 IEP's and 1 504; and period 5 has 13 students one whom has an IEP and 2 504s. Student academic and behavioral abilities vary in each class. The Covid-19 shutdowns drastically affected these students (Hofstad, Principal, November 2022, personal communication). The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for work with human subjects was maintained (Appendix A). The purpose of this study was to determine the effects of inquiry-based teaching in an 8th-grade classroom.

Treatment

Starting after winter break, I started to implement inquiry-based learning strategies to lead up to our full inquiry-based units. This was done so that students would not be thrown off by a major change in my teaching style. The first treatment consisted of showing phenomena-based videos to all three class periods with no context for students to get used to inquiry. Wondering what happened, and how it happened without an explanation, and was then discovered over time by the students. During the periods, I asked questions such as, what happened in the video, how did you know, can you prove how you know it. The next treatment I used to help students was allowing them to have access to do their own learning in the lab. After presenting the phenomena for the unit/day students went to the lab and had materials to work with, to allow them to further explore with guided help from myself.

This study was conducted over two units starting after winter break. The first unit was about physical and chemical properties, as well as physical and chemical changes. Periods 1 and 3, the Treatment Group received inquiry-based learning that was set up with the phenomena video of objects changing both physically and chemically (*N*=37). The rest of the unit, students were able to do hands-on activities to explore the different physical and chemical properties/changes of objects. The unit ended with a quick half-hour of a lecture to tie it all together for the students before moving on. The 5th period class, the Non-Treatment Group received normal lecture followed by lab style instruction that I have used over the last two years (*N*=13). There would be a lecture day and then a lab day that had detailed instructions to follow for exploring chemical and physical properties/changes.

The following States of Matter Unit that the study covered was states of matter and how they change. This time, 5th period, the Treatment Group (*N*=13) received this unit from an inquiry-based learning standpoint. They also started with videos of matter changing and different states, and those students were then able to do all discovering through hands-on activities in the lab. Periods 1 and 3, the Non-Treatment Group (*N*=37) received lecture, then detailed lab instructions to learn about the states of matter and how they changed.

My third form of treatment was using daily check-ins from all students. I used these to find out if students were confused or had any issues from the lesson that day, be it either inquiry-based or traditional style learning. I introduced the students to several formats for collecting formative data. The first was a one sentence summary, where students wrote a sentence about what they learned from the day's lesson. Also used was the muddiest point, where students were able to make a statement on something they did not understand or ask a question. Formative data was also collected using the one-minute paper, where students had to write down everything they learned from the day in a minute and fit as much in as possible.

Data Collection Instruments

The first method of data collection I used was a pre- and post-test for both units that was provided with our text from McGraw Hill, Chapter 6 Foundations of Chemistry Pre- and Post-Test and Chapter 7 States of Matter Pre- and Post-Test (Appendix B; Appendix C). The Foundations of Chemistry and States of Matter Pre- and Post-Test were administered between the treatment and non-treatment periods of the study. The results were compared using normalized gains (Hake, 1998).

The second method of data collection I used was on student attitudes in a Student Attitude Journal, through observations that I kept in Google Document (Appendix D). I recorded different attitudes/behaviors and comments that I witnessed or heard from students during both treatment and non-treatment. The findings were used to see the difference in student attitudes during both styles of learning.

Following lessons during treatment and non-treatment, students were assigned either the Foundations of Chemistry and States of Matter Muddiest Point (Appendix E), Foundations of Chemistry and States of Matter One Sentence Summary (Appendix F), or Foundations of Chemistry and States of Matter One Minute Paper (Appendix G). Using this information, I was able to figure out how to make the next day's inquiry-based lesson or traditional style learning lesson. The data was analyzed to find out how students felt after inquiry-based lessons or traditional style learning. If most students had the same question or issue, we did a new lesson on it and if many students were good, we moved on. Student quotes were used to support the data that was collected from the pre- and post-tests.

After each unit of both traditional style and inquiry-based learning students were given a survey for Foundations of Chemistry and States of Matter Student Self-Evaluation (Appendix H). Students had a rating scale of strongly agree, agree, disagree, and strongly disagree for all questions. Students were asked if they found the unit interesting, if they tried to learn, if they are proud of their work, if they learned something new, if they had fun during the unit, and if they felt ready for the next unit. I used these answers as a percent to show evidence of learning style preference and to find out if the students had put their effort into trying during the unit.

After completing each unit students were given the 7th-Grade Style Learning Survey about how they felt about traditional lecture style learning, which was the way I taught them in 7th-grade (Appendix I). Students were asked how they would rate the traditional style, if they felt traditional style has enhanced their learning, and if they would rather be taught by lecture or inquiry-based learning. I used the numbers as a percentage from each question that students had to answer to get their feelings on traditional learning. Student quotes were included from their responses to help back up the data to document evidence of learning style preference.

After completing each unit students were given the New Style Learning Survey about how they felt about inquiry-based learning (Appendix J). Students were asked how they would rate inquiry-based teaching, if they felt inquiry-based teaching has enhanced their learning, and if they would rather be taught by lecture or inquiry-based. I used the numbers as a percentage from the options students had to select an answer to see how students responded about traditional lecture style and I used quotes from their responses to help back up the data to show evidence of learning style preference.

Table 1. Data Triangulation Matrix.

Research Question	How does a student's learning and attitude improve using inquiry-based teaching in a grade 8 science classroom?						
Data Collection Method	Foundations of Chemistry and States of Matter Pre- and post-test	Inquiry-Based Student Journal	Foundations of Chemistry and States of Matter Muddiest Point	Foundations of Chemistry and States of Matter One-sentence summary	Foundations of Chemistry and States of Matter One-minute paper	Foundations of Chemistry and States of Matter Student Self-Evaluation	7^{th}-Grade Style Learning Survey and New Style Learning Survey

CHAPTER FOUR

DATA AND ANALYSIS

Results of Foundation of Chemistry Tests

On the Foundations of Chemistry Pre-Tests, the Treatment Group averaged 9.4 points (49%) with a range of scores from 3 to 15 points out of 19 points (*n*=30). The post-test for the Treatment Group had an average of 10.6 points (55%) with a range of 2 to 17 points. The normalized gain for the Treatment Group was 0.11, which according to Hake (1998) this would be considered no gain. The treatment group did see a small improvement overall although they did not show any normalized gains.

The Non-Treatment Group averaged 9.2 points (48%) with a range of 4 to 13 points (*n*=13). On the following post-test they averaged 10.2 points (53%) with a range of 6 to 17 points. This would also be considered no normalized gains according to Hake (1998) with a gain of 0.10. This period like the other two did see a small gain in overall test average. Comparisons for pre- and post-test averages for the treatment and non-treatments groups are below (Figure 1).

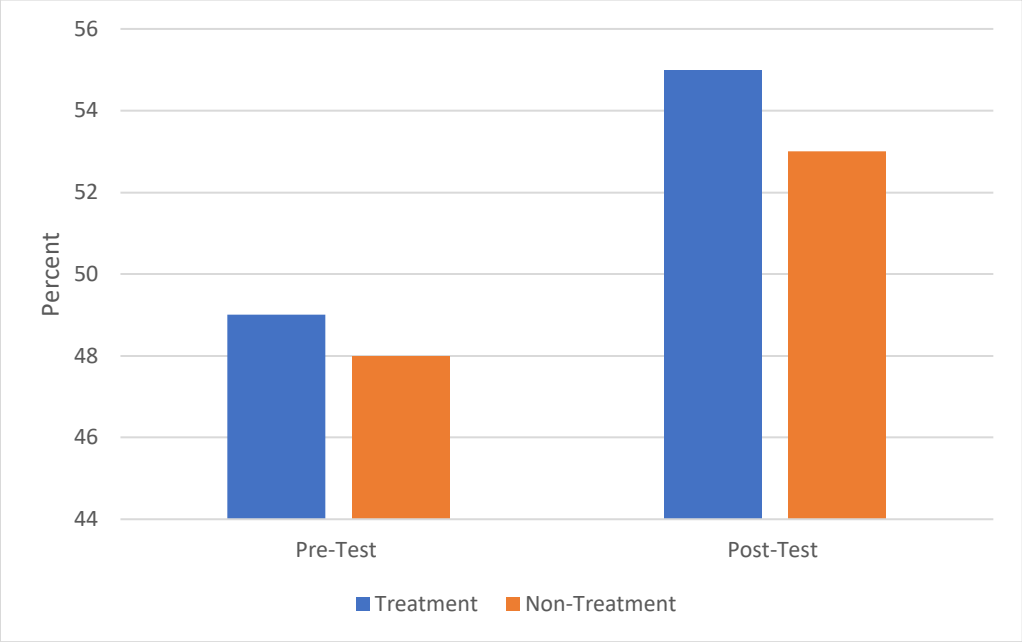

Figure 1. Foundations of Chemistry Pre- and Post-Test. A bar graph showing the difference between Foundations of Chemistry Pre- and Post-Test averages for the Treatment and Non-Treatment Group, (*n*=30) (*n*=13).

Style of Learning Results Foundations of Chemistry

After the unit was finished, students were asked to take the Student Self-Survey Foundations of Chemistry. Students in the treatment group who received inquiry-based teaching reported that most of them found the unit interesting (Figure 2). There were 23.3% who strongly agreed, 66.7% who agreed, 6.7% who disagreed, 3.3% who strongly disagreed with question.

Students of the Treatment Group were also asked if they had made an effort to learn during this unit. Most students responded that they put effort into learning, 30% reported that they strongly agreed, 56.7% agreed, and 13.3% disagreed that they had made an effort to learn. One student reported that he enjoyed this style of learning because he got to work with his hands and that made him put in more effort. This data shows that the majority of students put in the effort to learn and do the work during the different activities they were faced with completing for

the unit and there were some students who did not put forth the best effort during this unit. One student who did not make an effort commented that she did not like inquiry-based and that made her not want to do anything.

Students of the Treatment group were asked if they had learned something new during the Foundation of Chemistry Unit. Thirty-six-point seven percent of students reported that they strongly agreed they had learned something new, 46.7% agreed, and 16.7% disagreed. Most students reported that they had learned something new about the early stages of chemistry while other students reported that they came away from this unit with no new knowledge.

Students were also asked if they had fun learning during this inquiry-based unit (Figure 2). Fifty-three-point three percent of students strongly agreed, 36.7% agreed, 6.7% disagreed, and 3.3% strongly disagreed to having fun during this unit. Most students had fun during this new style of learning and ways in the classroom, while others reported that they did not enjoy the new style of learning with this unit. Students who had fun agreed that it was because they were able to work with their hands and not have to take notes. The disagreeing students did not like having full guidance and step by step instructions to follow.

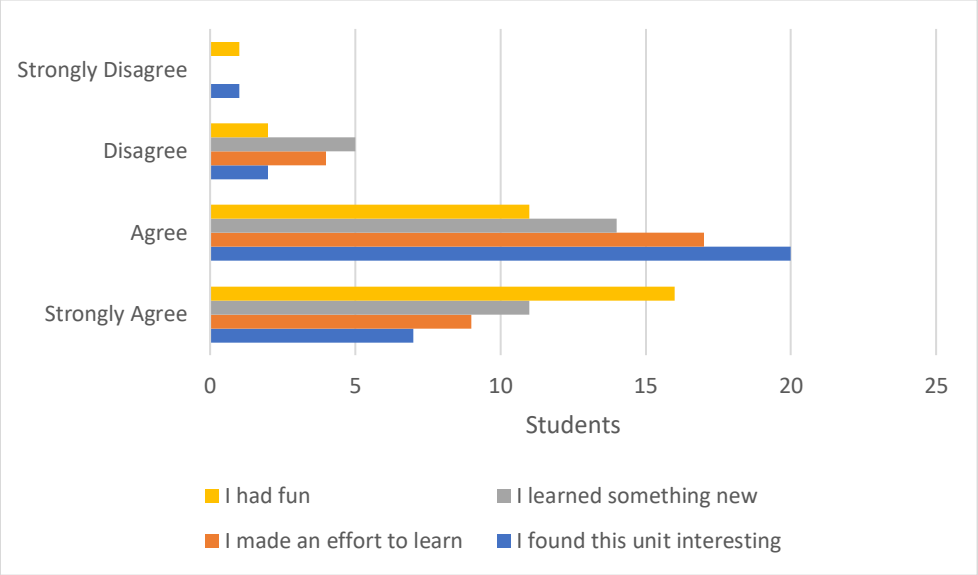

Figure 2. Foundations of Chemistry Treatment Group Survey Results. Bar graph showing the responses of students who found the unit interesting, made an effort to learn, learned something new, and had fun learning during this unit, (*n*=30).

The Non-Treatment Group received normal style of teaching with lecture and then activities to tie the lecture together. This group took this survey at the conclusion of the Foundations of Chemistry Unit, like the treatment group. This period had the same survey questions as the treatment group except that it all pertained to lecture style learning. Students were not required to take this survey and had 10 participants. When students were asked if they had found Foundations of Chemistry interesting 50% said strongly agree and 50% said agreed. When students were asked if they made an effort to learn during this unit, 20% strongly agreed and 80% agreed. Surveyed students reported that they did learn something new during this unit with 60% strongly agreeing and 40% agreeing. These were the exact same number for students having fun during this unit (Figure 3).

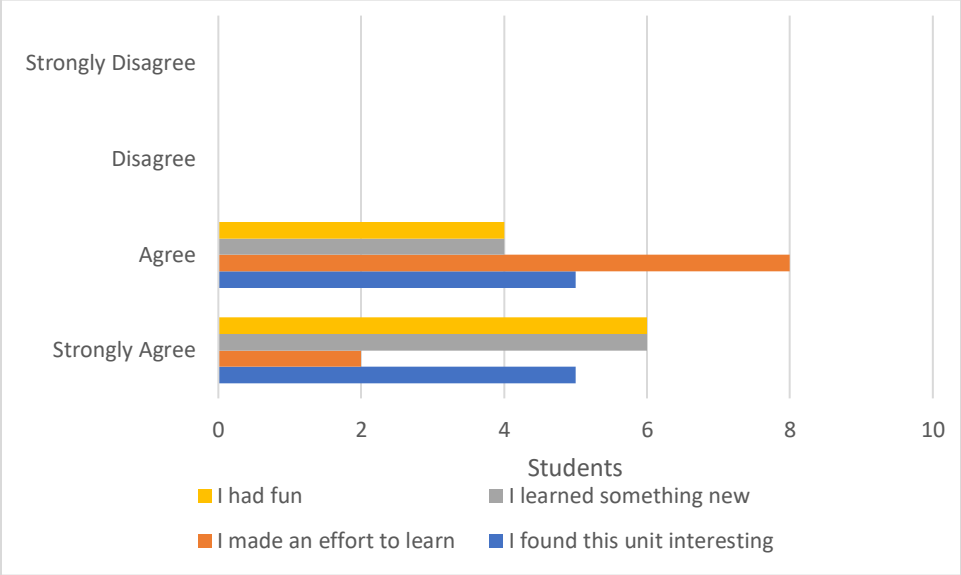

Figure 3. Foundations of Chemistry Non-Treatment Group Survey Results. Bar graph showing the Non-Treatment Group to finding this unit interesting, making an effort to learn, learning something new, and having fun, (*n*=10).

Results of States of Matter Tests

The Treatment Group had all 13 students take the pre-test and the results were an average of 8.7 points (51%) with scores ranging from 2 to 16 points out of 17 points (*n*=13). All 13 students also took the post-test for States of Matter and averaged 11 points (64%) with a range of 2 to 16 points. The normalized gain for this class period was 0.27 and according to Hake (1998) that shows a small gain for this treatment group. Although, this period did show a good improvement for overall test percentage(Figure 5). One student told me that she really enjoyed the projects and learning like this. She also said she was not a fan not being told exactly what to do and what is expected of her. She said it made her feel uneasy and some anxiety and could have led to her lower score on the test and maybe even her classmates as well.

The non-treatment group had 30 students take the pre- and post-test (*n*=30). On the pre-test the non-treatment group averaged 7.9 points out of 17 points (46%). The range of the test

scores were 1 through 16 points. On the post-test the group averaged 11.2 points (65%). The normalized gains for the non-treatment group were 0.38. According to Hake (1998) this would be considered a small gain (Figure 4).

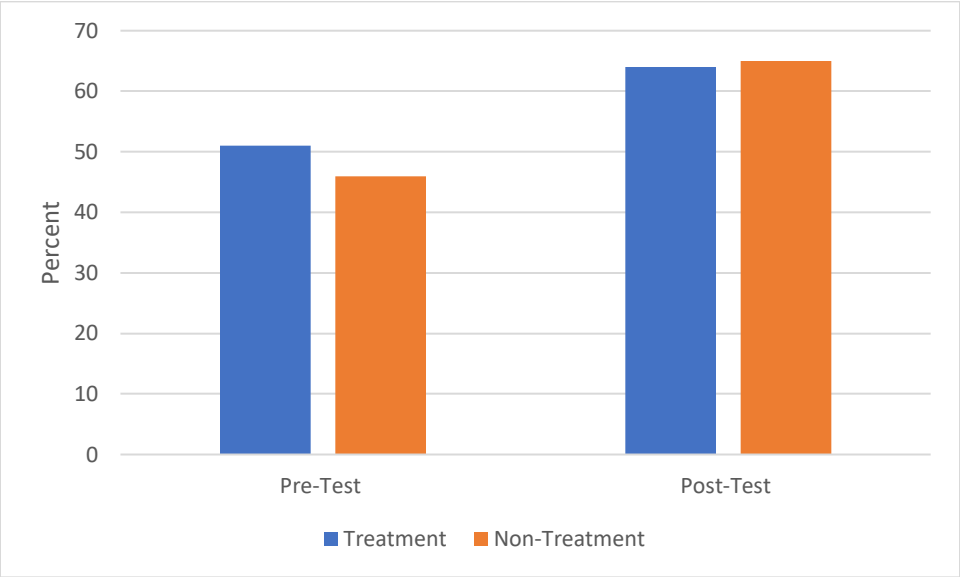

Figure 4. States of Matter Pre- and Post-Test. Bar graph comparing the differences between pre- and post-test scores with the Treatment and Non-Treatment Groups (*n*=30) (*n*=13).

Style of Learning States of Matter

Following the conclusion of the States of Matter Unit and the States of Matter Post-Test each period was given a Student-Self Survey about how the information was presented to them with a different style of learning from the last unit. Taking the survey was not required of the students. There were 10 of 13 students from the treatment group who took the survey when it was given. The first question asked if students found the unit interesting. Forty percent of students said that they strongly agreed the State of Matter unit was interesting and 60% agreed that it was interesting (Figure 5).

Students were then asked if they made an effort to learn during this unit. Thirty percent of students reported that they strongly agreed about the effort they put in for the unit, 60% said they agreed they made an effort and 10% reported they disagreed with their effort to learn.

Students were then asked if they had learned something new during this unit and style of learning. 60% of students reported that they strongly agreed they learned something new, 40% agreed they learned something new.

Students were then asked if they had fun learning during this unit. Forty percent of students reported that they strongly agreed they had fun, and 60% agreed that they had fun during the unit.

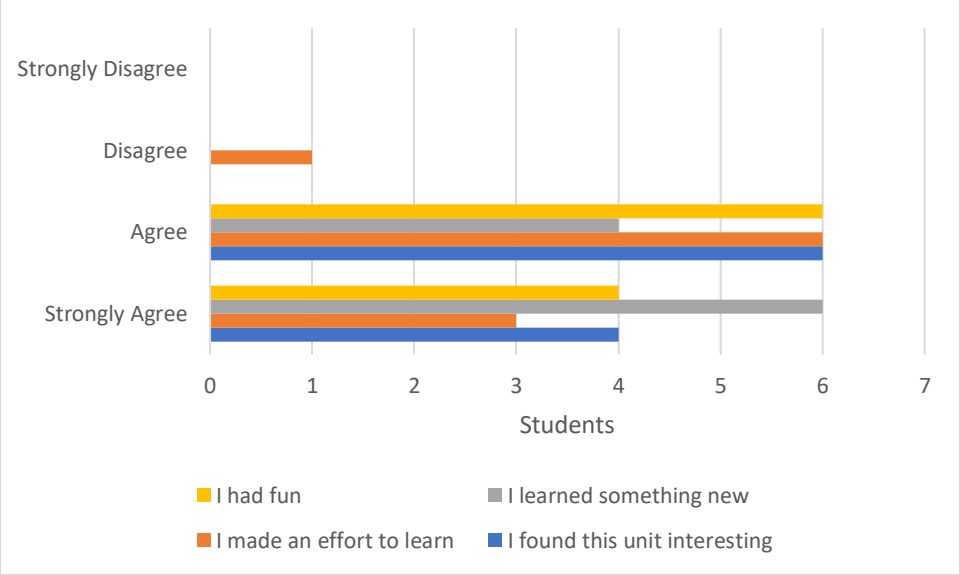

Figure 5. States of Matter Treatment Group Survey Results. Bar graph showing Treatment Group responses to finding this unit interesting, making an effort to learn, learning something new, and having fun, (*n*=10).

Students of the Non-Treatment Group took the same Student Self-Survey, but the focus was on their feelings of learning through lecture style learning. These students were not required to take the survey. The Non-Treatment Group had 28 students respond to the survey. The first

question that was asked if students found the States of Matter Unit interesting from the lecture style point of view. Twenty-five percent of students responded that they strongly agreed it was interesting, 64.3% agreed that it was interesting, 7.1% disagreed that it was interesting, and 3.6% strongly disagreed about the unit being interesting.

The students of the non-treatment group were then asked if they made an effort to learn during this unit. Twenty-eight-point six percent of students strongly agreed that they made an effort to learn the material from this unit and 71.4% of students agreed they made an effort to learn.

Students were then asked if they felt they had learned something new during this unit. Thirty-nine-point 8 percent of students said that they strongly agreed they learned something new, 50% agreed about learning something new, and 10.7% said they disagreed about learning something new during the unit.

To close out the survey, students were then asked if they had fun learning during this unit and style of learning. Twenty-eight-point six percent of students responded that they strongly agreed they had fun during this unit, 57.1% agreed they had fun, 10.7% disagreed about having fun, and 3.6% strongly disagreed about having fun during this unit (Figure 6).

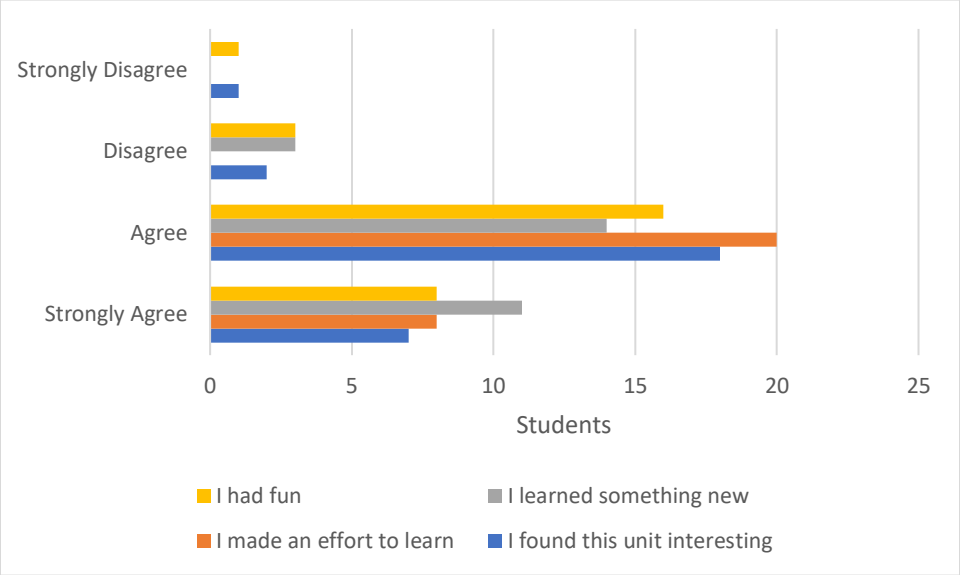

Figure 6. States of Matter Non-Treatment Group Survey Results. Bar graph showing how Non-Treatment Group responded to finding this unit interesting, making an effort to learn, learning something new, and having fun during the Sates of Matter Unit, (*n*=28).

Results of Student Preference Style of Learning

At the conclusion of the study, the last piece of information that was asked of the students was to complete two more surveys. One that was about receiving information from the teacher through lecture style learning and through inquiry-based learning. Students were not required to take these surveys, and both were offered on the same day.

Students were asked if they felt lecture style learning had enhanced their learning on The Normal Way of Learning Survey (*n*=37). Sixteen-point two percent of students responded that they felt it significantly enhanced learning, 43.2% said lecture style moderately enhanced learning, and 40.5% said it helped enhance their learning by a little (Figure 7). No students taking the survey said it did not help their learning.

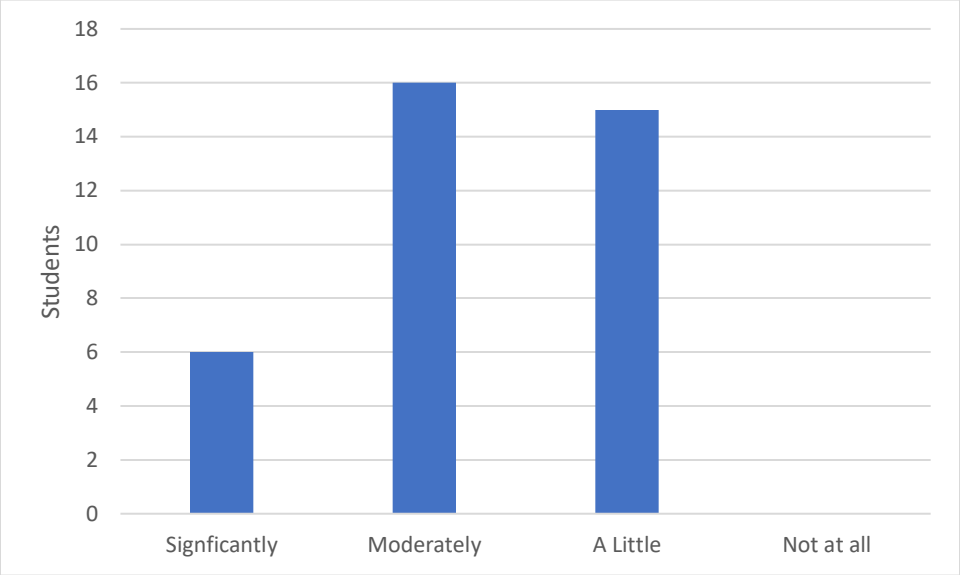

Figure 7. Traditional Style Enhanced Your Learning. Bar graph showing how Non-Treatment Group students believe lecture style learning has enhanced themselves, (*N*=37).

Students were asked if they would rather be taught by lecture or inquiry-based learning as the last question on this survey. Fifty-eight-point eight percent of students said they would prefer lecture style learning and 43.2% said they prefer inquiry-based learning.

The same two questions were asked on The New Style of Learning Survey with lecture switched to inquiry based. This survey had 33 students take it when it was offered (*N*=33) Students were asked if they felt inquiry-based learning had enhanced their learning. Thirty-six-point four percent of students said it significantly helped their learning, 27.3% reported that inquiry-based moderately enhanced learning, 30.3% said inquiry-based enhanced their learning by a little, and 6.1% said it did not help enhance their learning (Figure 8).

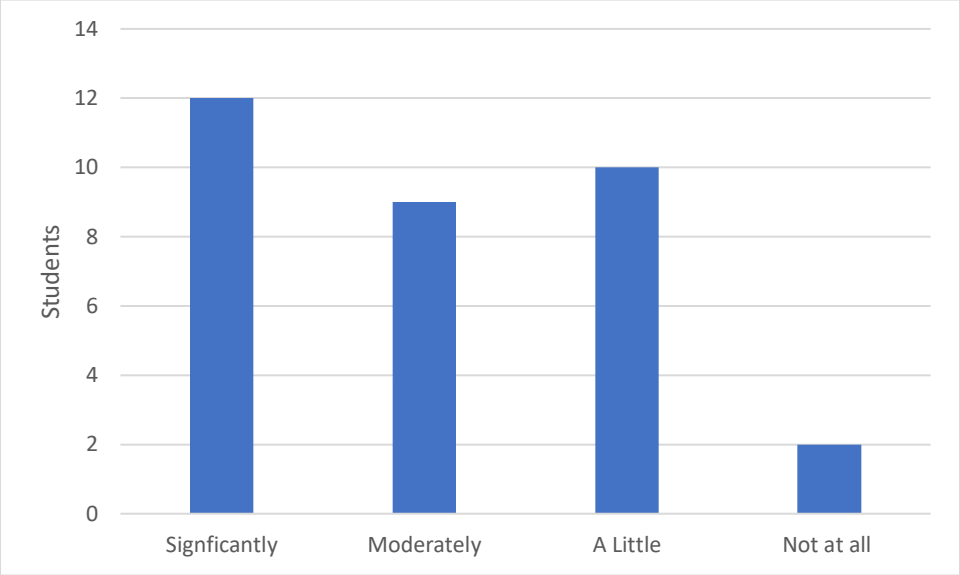

Figure 8. Inquiry-Based Enhanced Your Learning. Bar graph showing how Treatment Group students believe inquiry-based learning has enhanced themselves, (*n*=33).

The last question students were asked to answer from this survey was if they would rather be taught by lecture style or inquiry-based learning. Students were asked this question to see if there would be similarity between the answers. Fifty-one-point five percent of students picked lecture style, while 48.5% picked inquiry-based. Many students reported that they did not fully enjoy inquiry-based teaching because they were unsure of what exactly they were supposed to do and were more concerned about getting everything right and making sure they got an A on the unit. Students reported that it was fun, but not having as much guidance from myself was another reason they did not enjoy it. One student commented that she had a hard time finding time to make up the inquiry-based lessons and felt lost the day after being gone compared to lecture days when everything could be found on Google Classroom. Overall, most students reported feeling uneasy and anxious about this style of learning, but that it was fun at the same time.

CHAPTER FIVE

CLAIMS, EVIDENCE, REASONING

Claims From the Study

This action research project was designed to answer if inquiry-based teaching or regular lecture style teaching was better in an 8th-grade classroom. As a result of the study, three claims can be made as follows:

(1) students enjoyed both styles of learning and made improvements during each style,

(2) student engagement increased during inquiry-based teaching and student behaviors and attitudes towards science improved during inquiry-based teaching, and

(3) student self-regulation increased during inquiry-based teaching.

The evidence from the study showed that both treatment and non-treatment teaching approaches resulted in minimal normalized gains. More importantly each class showed improvement from the pre-test to the post-test and when students were able to see results of the post-tests for each unit, I overheard statements such as, “I knew that!” and “I overthought that question.” This told me that students knew what they were doing but had an off day and struggled on the test. I believe that students showing any sort of gain from the pre-test to the post-test shows that students made a gain and, in both inquiry-based teaching and lecture style teaching students made a gain.

During the New Style of Learning and 7th-Grade Style of learning Surveys, students were asked, if they would prefer inquiry-based teaching methods or lecture like they were taught in the previous school year. From the data above, the 7th Grade Style of Learning Survey asked about

inquiry-based teaching had 37 students respond, 56.8% of students said lecture and 43.2% said inquiry. On the other survey about lecture teaching, 33 students responded 51.5% students preferred lecture and 48.5% students preferred inquiry. This data showed that students were close to being split on which style they liked best. Many students reported that inquiry was more fun than what we had been doing, they also reported they had felt inquiry taught them while being more interactive. Students also reported that it was much better than taking notes, they got to experience how science works rather than the teacher telling them, and it gave them more of a chance to work with each other. On the flip side, the most common response for student who chose lecture said they liked it best because it is what they were used to in science class. Students also stated that it was easier to make up missed lectures than it was for missed inquiry lessons. Students also commonly reported that they enjoyed getting the background on a lesson before doing the activity. The same group of students also reported that it either took them a while to get comfortable with inquiry-based teaching or they never fully got comfortable with it. One student said, “Inquiry was fun, but I liked lecture more because I knew exactly what I was supposed to learn and be doing, I didn’t like the not fully knowing as much.” These show that students had mixed feelings about the styles and that a mixed method might have been best for these students.

The second claim that student engagement, attitudes, and behaviors had improved were observed by me. I noticed that while students seemed unsure of what they were doing at times during inquiry-based teaching, the challenge of the activities kept students engaged during the units and the periods, which led to better behaviors and less redirections than what was observed from the non-treatment groups. There were many students who stepped up to the challenge of

inquiry-based teaching and kept a positive attitude while putting in their observed best efforts. During this time many students were overheard saying how much they were enjoying science and other teachers mentioned that students seemed to be more excited about science. “I was excited about inquiry because my interest in science went up,” said one student. There were four students who shut down during the treatment part of the study. It was impossible to get them to do any work and when asked how I could help the common response was “I don’t like this and I’m not doing it.” This was also an answer for why students selected lecture in the surveys and explained why. Three of the four students displayed negative attitudes towards science saying, “I hate science.” These same three showed a tendency to try and be a distraction to the class by refusing to work, do things wrong, and to try to destroy equipment. The other student would sit and do nothing but was not a distraction to other classmates.

The last claim was that students were able to self-regulate better during the study. I noticed with the treatment groups in the first unit that students were encouraging classmates to work and help in their groups. Many students were able to start sensing when they were off task/topic and start to correct it before I came to help redirect. The non-treatment group during the first unit showed common classroom struggles such as students talking during lecture, students finding and creating distractions all while not having encouragement from classmates to listen and behave. When the groups switched for the second unit, I observed the new non-treatment groups acting the same way as the other non-treatment group. The same kids that could self-regulate were not showing the same willingness to do so. The same leaders who were stepping up and telling students to behave and stay on track were now speaking out less and it was not received the same as it was before. The new treatment group did not show as much self-

regulation as the other treatment groups. They did see two students step up who tried their best to keep students on task and be leaders. Having something engaging did help these students, although redirections were still needed. Overall, students did better when engaged than students who were not engaged.

Value of the Study and Consideration for Future Research

The value of this study seemed to wavier depending on the mood of students during data collection days. There were many pre- and post-tests that students completed within 10 minutes of receiving them. There were mixed results in the surveys, and after lesson data collections with students choosing not to do them or write a serious answer when they did. The real value showed with student test scores and that there were improvements from the treatment and non-treatment groups and more questions asked from students during inquiry-based teaching that related back to real world issues for students.

Impact of Action Research on the Author

This action research project placed my inquiry-based teaching methods and strategies at a close look. The biggest change I will be making as a teacher is finding a way to create a balance between inquiry-based teaching and lecture teaching. It is clear from student reporting that a balance between the two would work for my school. I would also like to change more of my assessments, so we have a written assessment and a hands-on assessment to make sure all learners are supported.

During this study, I had to put more effort into my content knowledge to be able to redirect students as needed and catch possible misconceptions they could possibly make before it

was too late. I found myself needing to do more lesson adjusting on the fly due to no period being the same and seeing some periods finish early while others struggled with the same lesson. I felt growth as an educator in both of these areas and discovered how important it is for students to find the answer and not to shut students down when they are driven to find the answer. This allowed me to have a better relationship with students and let them be students and themselves while I was also learning with them. It was important that I also learn to give up some of the control that I felt I had needed in my classroom.

Doing this research project has allowed me to see the value and have more respect for research in education. This was something I had never thought of and assumed that most of these studies were done either not by educators or done in a place that they would get the results that they wanted. I learned that this is not an easy task, and it is not done in places you would get the answer you were expecting. I plan on continuing to use smaller research projects in my classroom to help myself and students grow in science education.

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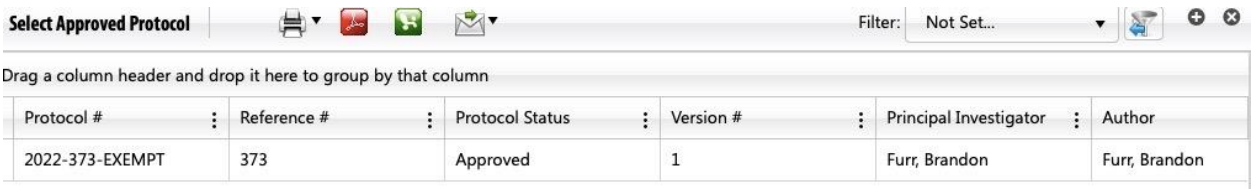
APPENDICES

APPENDIX A

IRB APPROVAL



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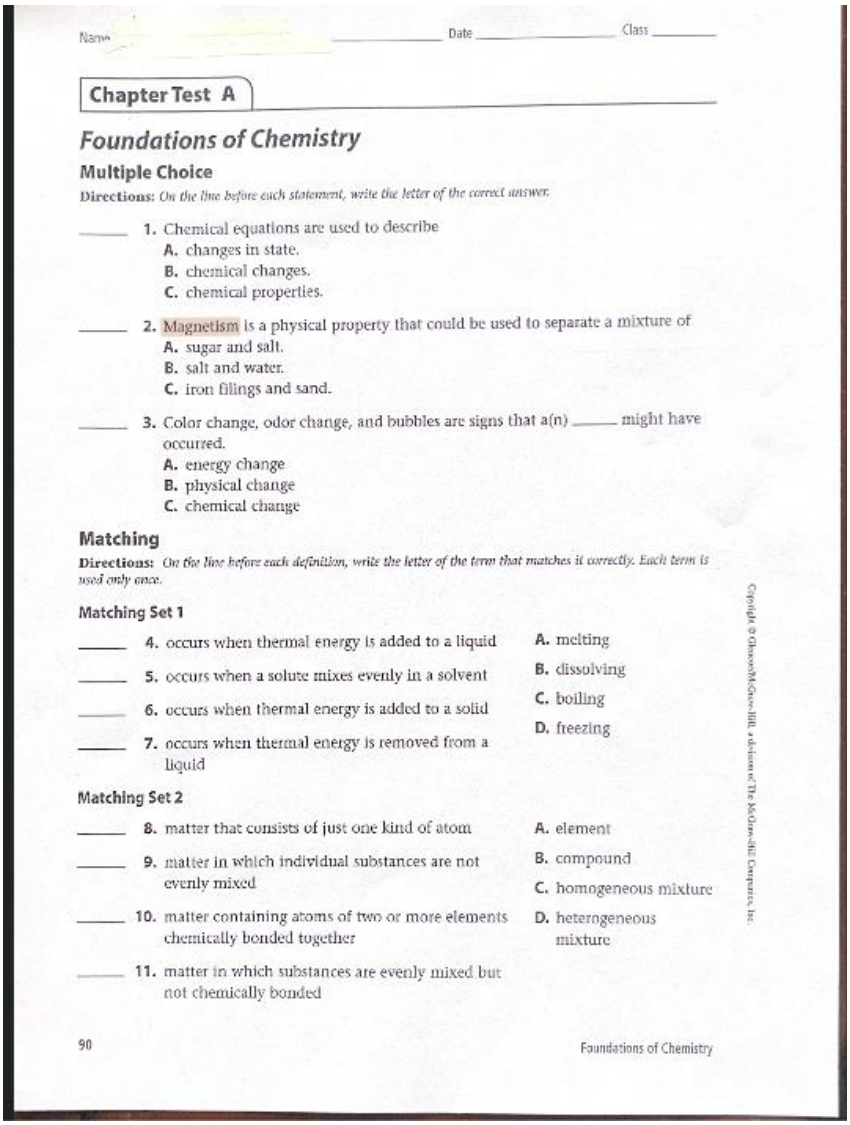
Protocol #	Reference #	Protocol Status	Version #	Principal Investigator	Author
2022-373-EXEMPT	373	Approved	1	Furr, Brandon	Furr, Brandon

APPENDIX B

FOUNDATIONS OF CHEMISTRY TEST



Name _____ Date _____ Class _____

Chapter Test A

Foundations of Chemistry

Multiple Choice

Directions: *On the line before each statement, write the letter of the correct answer.*

_____ 1. Chemical equations are used to describe
- **A.** changes in state.
- **B.** chemical changes.
- **C.** chemical properties.

_____ 2. Magnetism is a physical property that could be used to separate a mixture of
- **A.** sugar and salt.
- **B.** salt and water.
- **C.** iron filings and sand.

_____ 3. Color change, odor change, and bubbles are signs that a(n) _____ might have occurred.
- **A.** energy change
- **B.** physical change
- **C.** chemical change

Matching

Directions: *On the line before each definition, write the letter of the term that matches it correctly. Each term is used only once.*

Matching Set 1

_____ 4. occurs when thermal energy is added to a liquid

_____ 5. occurs when a solute mixes evenly in a solvent

_____ 6. occurs when thermal energy is added to a solid

_____ 7. occurs when thermal energy is removed from a liquid

- **A.** melting
- **B.** dissolving
- **C.** boiling
- **D.** freezing

Matching Set 2

_____ 8. matter that consists of just one kind of atom

_____ 9. matter in which individual substances are not evenly mixed

_____ 10. matter containing atoms of two or more elements chemically bonded together

_____ 11. matter in which substances are evenly mixed but not chemically bonded

- **A.** element
- **B.** compound
- **C.** homogeneous mixture
- **D.** heterogeneous mixture

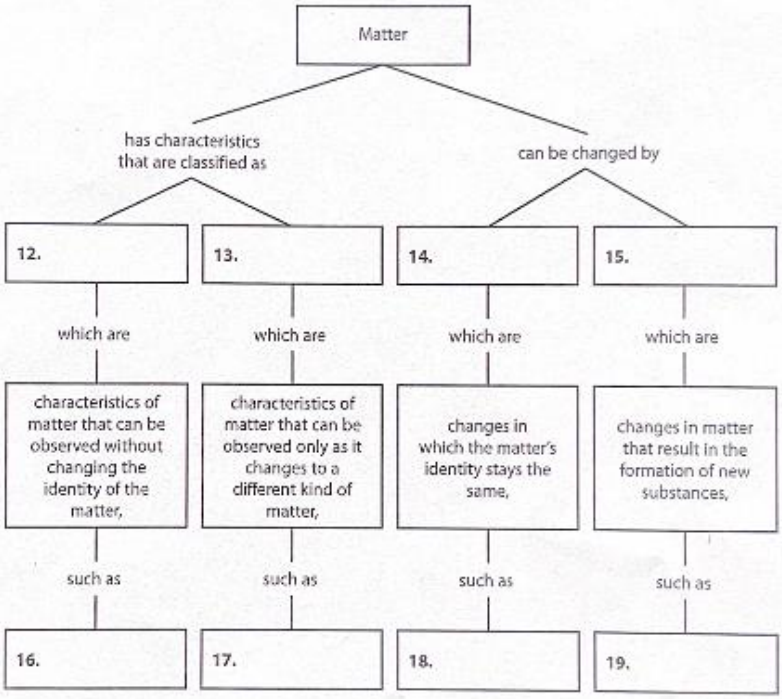
Name _____ Date _____ Class _____

Chapter Test A continued

Interpreting a Diagram

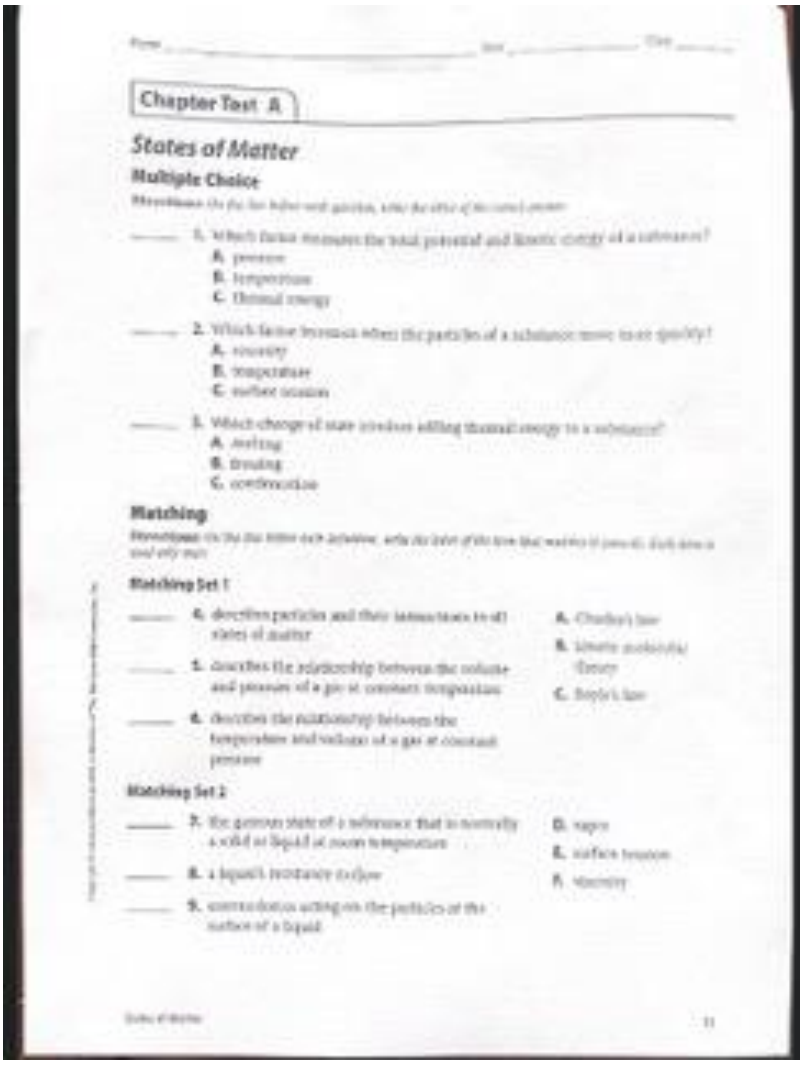
Directions: *Complete this concept map by choosing terms from the word bank and writing them in the correct spaces. Each term is used only once.*

ability to burn	chemical changes	chemical properties
deposition	melting point	physical changes
physical properties	rusting	



APPENDIX C

STATES OF MATTER TEST



Chapter Test A

States of Matter

Multiple Choice

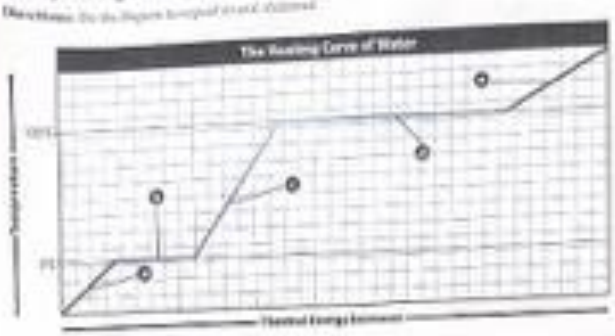
Matching

Matching Set 1

Matching Set 2

Chapter Test A continued

Interpreting a Diagram



10. **Identify** the core character represented by a and c.

11. **Identify** the core character represented by c.

12. **Write** the letter that represents the particles with the greatest attractive forces between them.

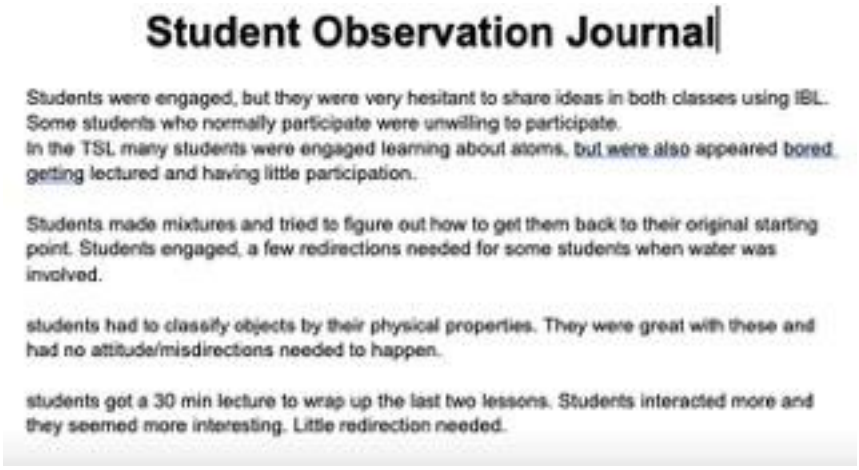
13. **Write** the letter that represents the particles with the greatest attractive forces between them.

14. **Name** the change of state represented by b.

15. **Explain** what is occurring at d and identify what type of change of state this is.

APPENDIX D

STUDENT OBSERVATION JOURNAL



Student Observation Journal

Students were engaged, but they were very hesitant to share ideas in both classes using IBL. Some students who normally participate were unwilling to participate.
In the TSL many students were engaged learning about atoms, but were also appeared bored getting lectured and having little participation.

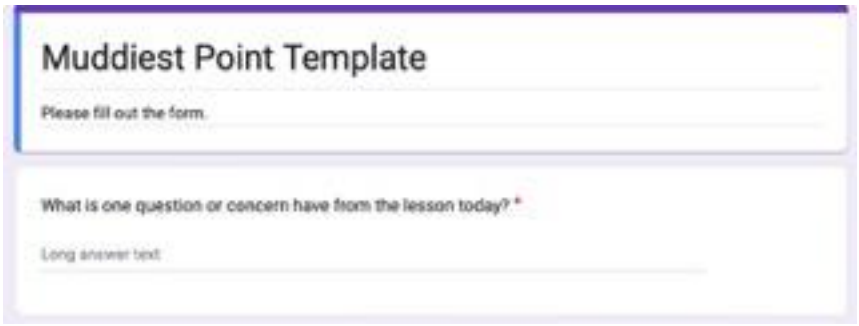
Students made mixtures and tried to figure out how to get them back to their original starting point. Students engaged, a few redirections needed for some students when water was involved.

students had to classify objects by their physical properties. They were great with these and had no attitude/misdirections needed to happen.

students got a 30 min lecture to wrap up the last two lessons. Students interacted more and they seemed more interesting. Little redirection needed.

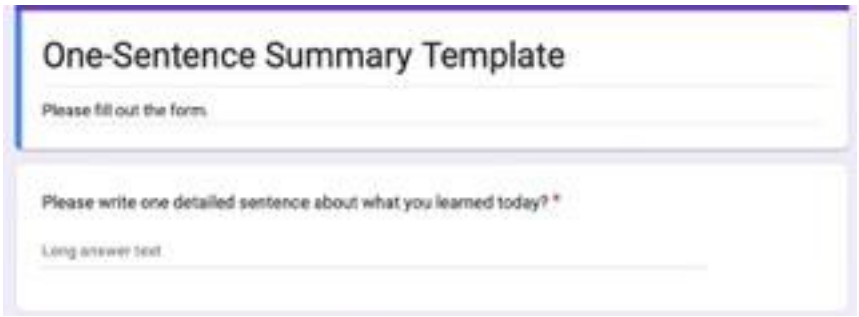
APPENDIX E

FOUNDATIONS OF CHEMISTRY AND STAES OF MATTER MUDDIEST POINT



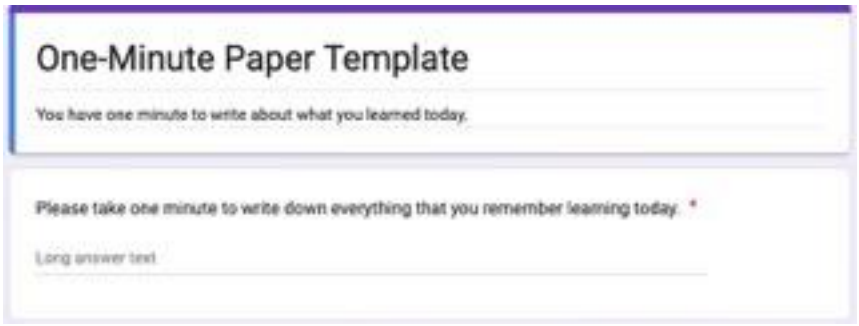
APPENDIX F

FOUNDATION OF CHEM AND STAES OF MATTER ONE-SENTENCE SUMMARY



APPENDIX G

FOUNDATIONS OF CHEMISTRY AND STATES OF MATTER ONE-MINUTE PAPER


One-Minute Paper Template

You have one minute to write about what you learned today.

Please take one minute to write down everything that you remember learning today. *

Long answer text

APPENDIX H

STUDENT SELF-EVALUATION

Student Self-Evaluation

Please fill out this form.

* Required

1. I found this unit interesting. Please select one. *

Mark only one oval.

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

2. I made an effort to learn during this unit. Please select one. *

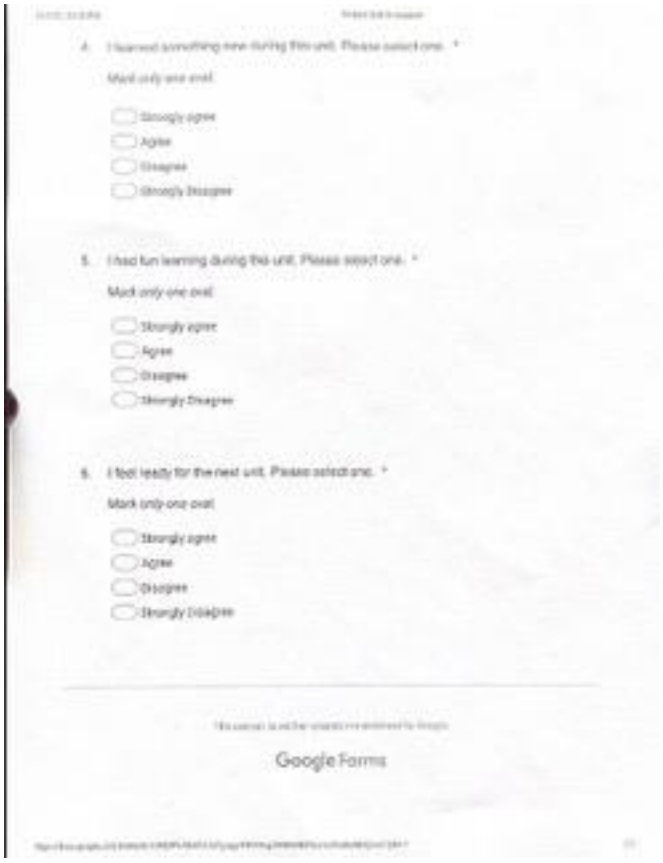
Mark only one oval.

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

3. I am proud of the work I did during the unit. Please select one. *

Mark only one oval.

- Strongly agree
- Agree
- Disagree
- Strongly Disagree



4. I learned something new during this unit. Please select one. *

Mark only one oval.

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

5. I had fun learning during this unit. Please select one. *

Mark only one oval.

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

6. I feel ready for the next unit. Please select one. *

Mark only one oval.

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

Google Forms

APPENDIX I

7TH-GRADE STYLE LEARNING SURVEY

End of Capstone IB Survey

Please fill out all questions and give feedback when asked.

* Required

1. Based on your experience, how would you rate the lecture style of learning in this class? Please select one. *

Mark only one oval.

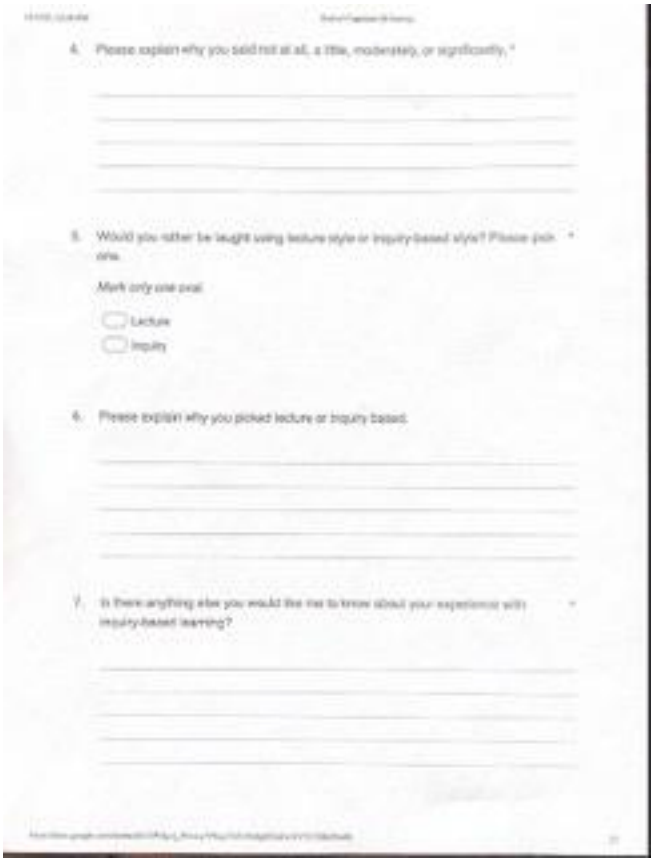
- Excellent
- Very good
- Good
- Poor

2. Please explain why you said excellent, very good, good, or poor. *

3. Do you feel lecture style learning has enhanced your learning? Please select one. *

Mark only one oval.

- Not at all
- A little
- Moderately
- Significantly



4. Please explain why you said not at all, a little, moderately, or significantly. *

5. Would you rather be taught using lecture style or inquiry-based style? Please pick one. *

Mark only one oval.

- Lecture
- Inquiry

6. Please explain why you picked lecture or inquiry based.

7. Is there anything else you would like me to know about your experience with inquiry-based learning? *

APPENDIX J

NEW STYLE LEARNING SURVEY

End of Capstone TL Survey

Please fill out all questions and give feedback when asked.

* Required

1. Based on your experience, how would you rate the lecture style of learning in this class? Please select one. *

Check all that apply.

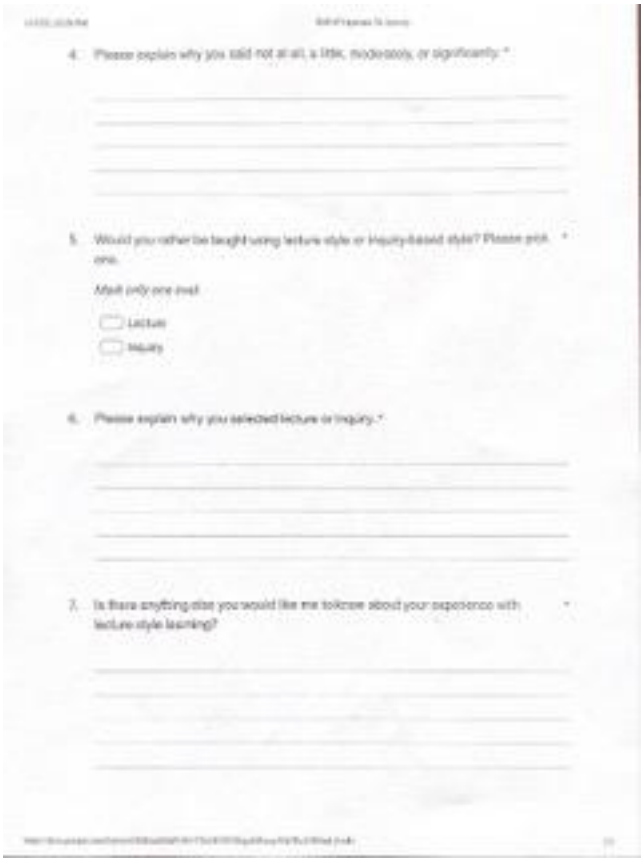
- Excellent
- Very good
- Good
- Poor

2. Please explain why you said excellent, very good, good, or poor. *

3. Do you feel lecture style learning has enhanced your learning? Please select one. *

Mark only one oval.

- Not at all
- A little
- Moderately
- Significantly



4. Please explain why you said not at all, a little, moderately, or significantly: *

5. Would you rather be taught using lecture style or inquiry-based style? Please pick one. *

Mark only one oval.

- Lecture
- Inquiry

6. Please explain why you selected lecture or inquiry: *

7. Is there anything else you would like me to know about your experience with lecture style learning? *