

A STUDY OF THE IMPACT OF SOCRATIC SEMINARS  
ON A SIXTH-GRADE SCIENCE CLASSROOM

by

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

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY  
Bozeman, Montana

July 2019

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## ACKNOWLEDGEMENT

I would like to thank Dr. Eric Brunsell and Dr. John Graves for all the support they provided as I began my Capstone project and learned the writing and formatting expectations. I would also like to thank Dr. Marcie Reuer for her consistently positive and encouraging feedback throughout the final Capstone writing and development process. It was needed and very much appreciated. Thank you to Diana Paterson for her timely responses to numerous questions throughout the MSSE program and to Lindsay Hall for her formatting expertise. Many thanks to Joe Bradshaw for his science and education expertise. I would like to extend many thanks to my colleagues, Dean Byers, Joyce Perkins, Aaron Fischer, and Kim Wichers, my Principal Joel Vanderyacht, and all of my students this year. They provided me with valuable feedback throughout my research process and helped me constantly improve the Socratic Seminars and my data collection tools. Additionally, I would like to thank my mother, Jo-Ellen Smith for her time and feedback on my paper and the women of my book club whose ideas helped me think about my project in a vitally different light. Finally, and most importantly, I give infinite thanks to my husband, Chris Piasecki. Thank you for being my sounding board, my editor, my brainstorming partner, and my second, third, and fourth pair of eyes on every tool used, piece of data analyzed, conclusions reached, and paper sections written.

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## ABSTRACT

Not only do we expect our future scientists to have a deep understanding of science content, but we expect them to be able to communicate these ideas. Previous research shows that student-led classroom discussions not only encourage the development of critical thinking skills and a depth of knowledge, but they teach scientific discourse practices and aid in academic language development. This study investigated the impact of preparing for and participating in Socratic Seminars on the depth of student content knowledge. Additionally, it aimed to determine the impact of Socratic Seminars on student confidence with science content and the achievement gap between English Language Learner (ELL) and non-ELL students in a 6<sup>th</sup> grade science classroom. To make this determination, every other science unit included a Socratic Seminar as an extension activity. To examine the effect of Socratic Seminars on content knowledge and the achievement gap, the study compared the results of end of unit content assessments, Socratic Seminar scores, and student interviews. To measure student confidence, the study compared student responses on end of unit reflection surveys, weekly reflections, and interviews. Quantitative results indicated no impact of Socratic Seminars on student's depth of knowledge of science content or in closing the achievement gap and mixed impact on student confidence. However, qualitative results indicated an increase in content knowledge and confidence for all students. Although this study provided mixed results as to the impact of Socratic Seminars on content knowledge, confidence, and the achievement gap, student statements and questions during seminars, in addition to interview results show that Socratic Seminars promoted deep exploration of ideas and had a positive impact on the Next Generation Science Standards, Science and Engineering Practices of *Engaging in Argument from Evidence* and *Obtaining, Evaluating, and Communicating Information*. They are therefore a valuable extension activity format in a science classroom.

## INTRODUCTION AND BACKGROUND

The 2018-19 school year was my third consecutive year teaching sixth grade math/science at Nooksack Valley Middle School in Everson, Washington. Nooksack Valley Middle School is a public school that had 326 students enrolled in grades six through eight for the 2018-19 school year (personal communication, J. Vanderyacht, October 2, 2018). Data from the 2017-18 school year shows that the student population was 49.6% male and 50.4% female. Students identified as White (58.3%), Hispanic (31.6%), Two or More Races (5.5%), American Indian/Alaskan Native (3.8%), Asian (.6%), and Black/African American (.3%). In May of 2018, 50.3% of students qualified for free or reduced-price meals and 12.1% were designated as English Learners because they speak a primary language other than English (Office of Superintendent of Public Instruction, 2018).

Throughout the 2018-19 school year, I taught 52 of the 125 sixth-grade students at Nooksack Valley Middle School, 10 of whom were monitored through our English Language Learner (ELL) program. I taught two classes every day, each in a two-hour block that included both math and science. Our sixth-grade science curriculum included a section of life science focused on the human body, a science fair, and a section on space science that is focused on the Earth, Moon, and Sun system.

Data from the historic Washington State Measurement of Student Progress in Science and the more recent Washington Comprehensive Assessment of Science (WCAS), show that ELLs at Nooksack Valley Middle School consistently score lower than the student population as a whole. For example, 37% of sixth-grade ELL students

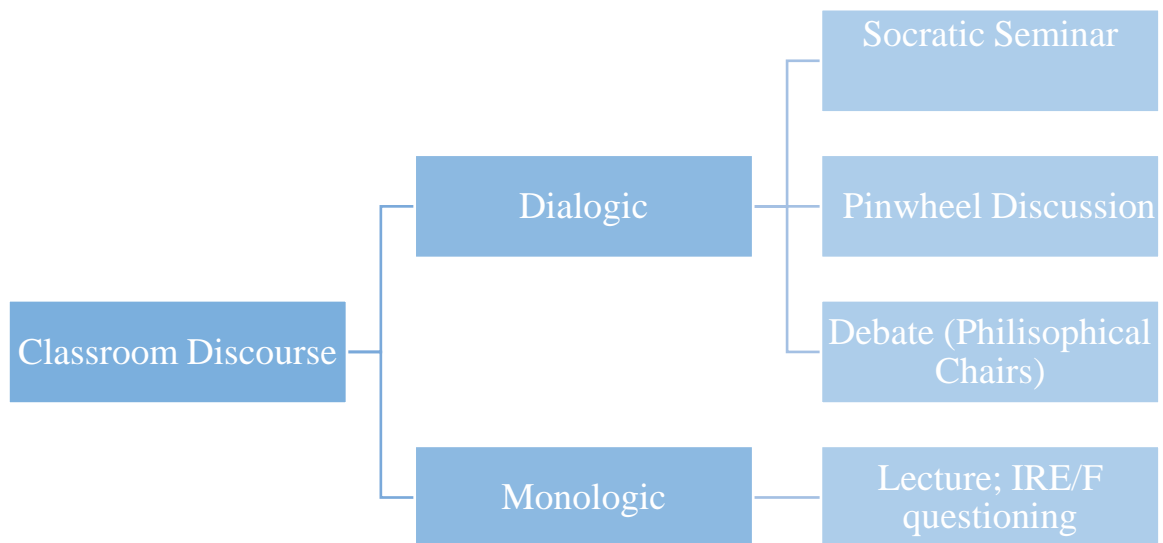
met standard on their 2018 WCAS whereas 75% of non-ELL students met standard on the same test (Educator Access Plus, 2018). In past years, I saw this dichotomy present on summative assessments in my classroom. This was especially true for assessments that required significant written or verbal description. Additionally, I found that many students are not confident in their content knowledge and rely on my feedback to recognize their understanding of content.

Previous professional development informed me that one of the best ways to support language development is through providing opportunities for student dialogue. I also knew that although I provide an extension to each unit throughout the year, I do not always see these extensions provide opportunity for deeper exploration and understanding of ideas. Through this reflection I was led to the idea of introducing formal discussion, in the form of Socratic Seminars, to my classroom in every other unit throughout the year. I planned to use a combination of surveys, content quizzes, interviews, discussion rubrics, and student reflections to track the impact these discussions had on students' content knowledge and confidence.

Overtime, I developed the following primary research question: What are the effects of Socratic Seminars on student's depth of understanding of science content? In addition, the following sub-questions were addressed: 1) How does preparation for and participation in Socratic Seminars impact student confidence with science content? 2) How does preparation for and participation in Socratic Seminars effect the achievement gap between ELL students and non-ELL students?

## CONCEPTUAL FRAMEWORK

A review of the literature regarding the impact of Socratic Seminars begins with description of the two primary categorizations of classroom discourse [monologic and dialogic] and their impact on learning. This leads to discussion of the impact of student-talk on the development of academic vocabulary. Specific studies are cited which prove the positive impact of discussion on content comprehension and test scores. The literature review ends with an overview of three formal discussion formats that encourage dialogic dialogue and promote meaning-making (Figure 1) and a discussion of appropriate accommodations for ELL students within these formats.



*Figure 1.* Overview of discourse types and their associated classroom activities.

Traditional classroom discourse relies heavily upon a monologic structure in which the teacher does the majority of the talking or lecture and students do the majority of the listening. In this structure there is very little opportunity for students to ask questions or surface misconceptions (Wells & Arauz, 2006). Monologic discourse is often supplemented with IRE/F (teacher initiation, student response, teacher

evaluation/follow-up) questioning formats. These formats assess student recall of facts from the textbook and the teacher without allowing for students to engage in inquiry and investigation of ideas. Therefore, they do not support the development of critical thinking and deep understanding (Applebee, Langer, Nystrand & Gamoran, 2003; Boyd & Markarian, 2011). Boyd and Markarian (2011) explain:

The danger in utilizing only top-down approaches [in classroom discussion] is that if the student is left only with shallow pseudo-concepts that are not further developed, these pseudo-concepts may be quickly pruned from memory like neurons lacking synaptic connections. However, if the scaffold is anchored in student foreknowledge and co-constructed with student contribution, a teacher, and classroom talk, it can offer guided participation toward exploring, ventriloquating, rehearsing, and more successfully appropriating the language and constructs of schooling. (p.521)

Dialogic discourse is focused on developing authentic conversation and exchange of ideas (Molinari & Mameli, 2010). In a dialogic classroom, students use their experience to develop ideas through discourse (Boyd & Markarian, 2011). This discussion structure therefore provides opportunities for meaning-making through student exploration, questioning, and struggle. A study by Applebee et al. (2003) found that well-facilitated dialogic discussion helped students comprehend difficult text because it encouraged students to make predictions, link new ideas from the text to prior knowledge, create and answer questions related to the reading, develop clear ideas and understanding, and use evidence to support reasoning. Additionally, students who have the opportunity to discuss scientific concepts and phenomena will mimic and adopt scientific discourse practices (Alozie, Moje & Krajcik, 2009).

Not only does well-run dialogic discussion support the comprehension of content and the development of scientific practices, but it provides opportunity for students to use

academic vocabulary and learn from other's use of said vocabulary. The use of language is a structure for meaning-making just as the need to make meaning necessitates the learning of language (Halliday, 1993). All students, but especially ELLs, have the most opportunity to learn and utilize academic English through their interactions at school (Carhill-Poza, 2015). If teachers do not provide students with the opportunity to speak with their peers, encourage discourse, or provide scaffolds for students who need it, these students will not build academic English.

Studies show, again and again without rebuttal, that student-centered discussion in the classroom supports the understanding of complex ideas. Informal peer discussion and debate proved an effective strategy to help students understand difficult concepts and develop conceptual understanding with a group of 350 undergraduate students (Smith et al., 2009). Analysis of conversation in a dialogic classroom also showed that this discussion structure creates a classroom culture in which students take chances, analyze one another's ideas, and challenge themselves and their peers (Boyd & Markarian, 2011).

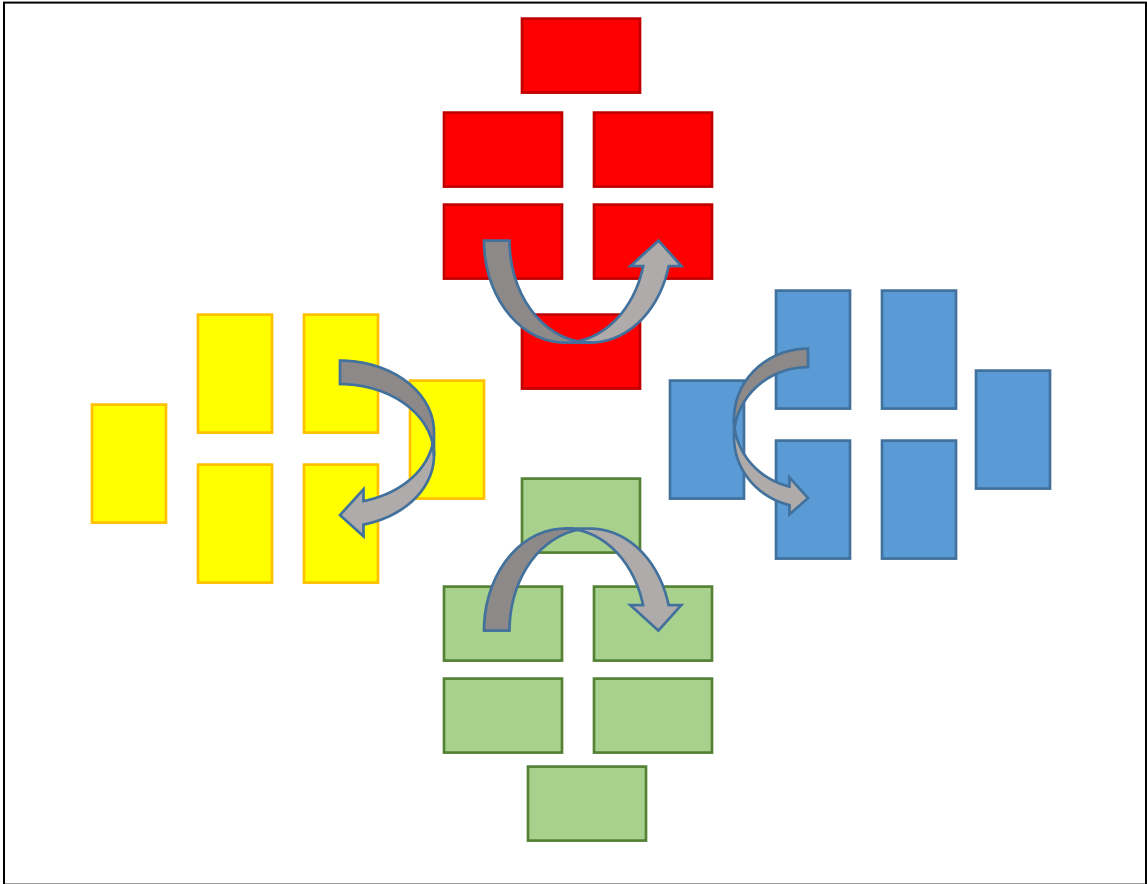
Encouraging dialogic dialogue in the classroom may use many discussion formats. One of the most widely used formal discussion practices and dialogic discussion formats is a Socratic Seminar. Socratic Seminars, otherwise known as Socratic Circles or Padeia Seminars, are discussions that follow the question-based teaching practices of the Ancient Greek Philosopher, Socrates. The National Padeia Center describes a Socratic Seminar as, "a collaborative, intellectual dialogue facilitated with open-ended questions about a text" (National Padeia Center, 2015, para. 5). Socratic Seminars foster collaborative intellectual dialogue by focusing discussion on the issues and principles of a

particular text and the differing opinions and interpretations resulting from these issues. Students construct meaning through interpretation, analysis, and participation in structured discussion. After reading the selected text, the teacher will begin the discussion with a focused question upon which the discussion will be based. For example, the class might be assigned to read Rachel Carson's *Silent Spring*. The discussion may begin with the question, "What is the main idea of *Silent Spring*?" The students are then responsible for reasoning and determining arguments and analysis for the question based upon textual evidence (Chowning, 2009). According to Roncke, the use of Socratic Seminars increases student reading comprehension and diversifies student thinking and discussion (2016). As a result of building these skills, dialogic talk in classrooms increases student achievement on state testing. A study of nine schools showed higher achievement on state testing after implementing a Padeia model (Robinson, 2008).

Another popular discussion tactic in and out of school is a debate. Philosophical Chairs is a form of values continuum that enacts debate in a classroom and allows all students to participate. This discussion format is also often based upon the reading and analysis of a text. After reading the text, the teacher will ask a question and students will stand at one side of the room or another to represent whether they agree or disagree. One or more students will then take turns defending their argument using evidence. After listening to one-another, students may choose to move and support the other argument (Gonzalez, 2015). In closing a unit on weather and climate, a teacher might assign a number of articles arguing for or against the theory of anthropomorphic global warming. In Philosophical Chairs, students would be asked to move to one side of the room if they

want to argue that humans are causing global warming and the other side to argue that Earth is involved in a natural cycle of warming.

A final discussion tactic that encourages dialogic discourse is a Pinwheel Discussion. In this discussion format, students are divided into four groups. Three of these groups are assigned to represent a specific point of view and the fourth is in charge of encouraging discussion. Groups work together to create arguments and collect evidence. Representatives from each group then sit facing one-another with the other group members behind them (Figure 2). The representatives begin the discussion using the questions and ideas they developed with their group. Group representatives rotate in to participate in the conversation (Gonzalez, 2015). To close an astronomy unit, for example, a teacher might ask the class, “When did the universe begin?” The class would then be divided into four groups. Three groups would each represent a well-known astronomer. Each of the three groups would use evidence from previous lessons to develop an informed answer to the proposed question. The fourth group would prepare a number of questions to elicit additional ideas and dialogue throughout the discussion. A representative from each group would then begin playing their role as assigned in the conversation.



*Figure 2.* Classroom layout for a Pinwheel Discussion.

The achievement gap noted in the introduction of this paper exemplifies the need to differentiate instruction. Differentiation is defined by Tomlinson et al. (2003) as “an approach to teaching in which teachers proactively modify curricula, teaching methods, resources, learning activities, and student products to address the diverse needs of individual students and small groups of students to maximize the learning opportunity for each student in a classroom (Bearne, 1996; Tomlinson, 1999)” (p.121). Accommodations suggested specifically for ELL students participating in Socratic Seminars include modeling the roles students will play in the seminar by showing a video of a Socratic Seminar, including sentence starters for students in their preparation documents, pairing

students for both reading and performance during the seminar, and providing students with a set number of chips that they give up each time they talk in order to encourage and equalize participation (Fenner & Snyder, n.d.; Socratic Seminar, n.d.). Use of these suggested strategies aims to eliminate barriers language learners might encounter in a rigorous activity like a Socratic Seminar and therefore allow all students equal opportunity to participate in and learn from the seminar experience.

Dialogic discourse, as opposed to monologic discourse, is a means by which students can develop and truly comprehend both ideas and language. Analysis of previous studies that employ dialogic discourse practices find that students improve in their ability to comprehend complex ideas and their acquisition of academic English. Additionally, dialogic discourse leads to increased student confidence levels in classroom discussion and higher test scores. Socratic Seminars, Philosophical Chairs, and Pinwheel Discussions, when accommodated appropriately, provide all students with the chance to prepare for and participate in dialogic discussion practices. These discourse strategies give all students the chance to grapple with complex ideas, share their thoughts, analyze others' theories, and make sense of concepts together.

These opportunities teach students the crucial skills of critical thinking, analysis, and communication necessary to succeed as future scientists. Not only do we expect our scientists to be able to make sense of complex ideas and form theories supported by evidence, but we expect them to be able to communicate these ideas to the general public and within their own communities. Theories must be based upon multiple sources of evidence and withstand the test of disagreement. As science educators, we must teach our

students the importance of discourse, disagreement, and resolution in order to ensure sound theories, flexibility, fact-based reasoning, and productive discourse into the future. Dialogic discourse practices are therefore a crucial science teaching tool.

## METHODOLOGY

This action research-based classroom project implemented Socratic Seminars in a 6<sup>th</sup> grade science classroom in order to answer the following research questions: What are the effects of Socratic Seminars on student's depth of understanding of science content?, How does preparation for and participation in Socratic Seminars impact student confidence with science content?, and How does preparation for and participation in Socratic Seminars effect the achievement gap between ELL students and non-ELL students? The research methodology for this project received an exemption by Montana State University's Institutional Review Board. Compliance for working with human subjects was maintained (Appendix A).

Data collection began in October 2018 and ended in May 2019. Throughout the study, all 51 sixth graders were exposed to six alternating treated and un-treated units about human body systems and Earth in space. All units included instruction utilizing the 5-E Instructional Model. This meant that each unit included at least one lesson that addressed the following purposes: *engage* students, allow students to *explore* ideas through asking questions and completing a laboratory exercise or investigation, *explain* content, *extend* ideas, and *evaluate* student understanding. Throughout all units I provided opportunity for hands-on investigation and student-driven questioning in addition to instruction through reading, videos, and written explanation.

The data collection tools used to answer the research questions are displayed in

Table 1.

Table 1  
*Data Triangulation Matrix*

Research Questions	Data Collection Instruments		
Primary Question: What are the effects of Socratic Seminars on student's depth of understanding of science content?	Content Quiz	Interview Questions	Discussion Rubric
Research SQ. 2: How does preparation for and participation in Socratic Seminars in the science classroom impact student confidence with science content?	Unit Reflection Survey	Weekly Reflections	Interview Questions
Research SQ. 3: How does preparation for and participation in Socratic Seminars in the science classroom effect the achievement gap between ELL students and non-ELL students?	Content Quiz	Interview Questions	Discussion Rubric

#### Outline of Treatment and Data Collection

Treated units alternated throughout the year and included a Socratic Seminar as the extension in the 5-E instructional model. For each Socratic Seminar, the focused question was based upon the unit's essential question and students used a variety of evidence (text, video, and lab-based) to support arguments and ideas related to the focus question. During the seminar the class was divided into an inner circle and an outer circle. The inner circle had about 45 minutes for discussion with a 3-minute break. The inner circle students then switched with the outer circle students, and the second group of students had a separate 45 minutes for discussion with a 3-minute break.

Prior to beginning treatment, I worked to establish trust within my classroom communities with teambuilding initiatives and the creation and adherence to classroom

norms and expectations. My classes also learned and consistently practiced discussion expectations and norms. This included the teaching and use of discussion starters, hand signals, and academic vocabulary in partner, small group, and whole class discussion. Prior to the first Socratic Seminar, students watched a video of an 8<sup>th</sup> grade class participating in a Socratic Seminar. The class used this video to set goals and norms for our own Socratic Seminars (Figure 3). Additionally, I taught and modeled the development of evidence-based questioning. Students used scaffolded tools to prepare for, practice, and assess evidence-based questioning.

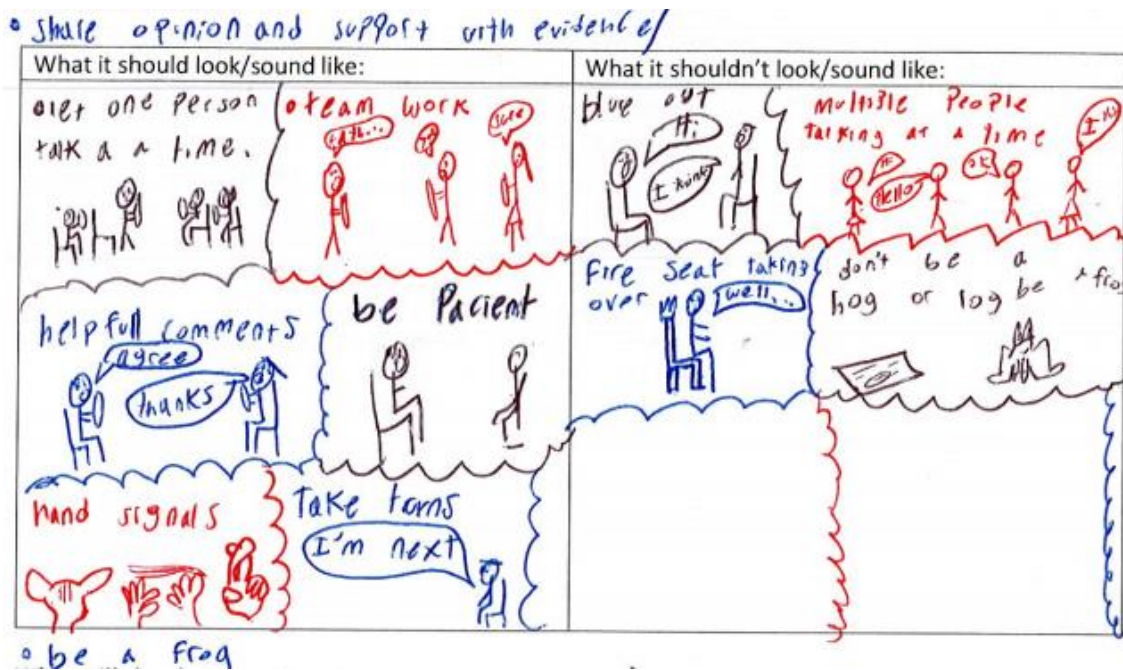


Figure 3. Student list of classroom norms for a Socratic Seminar.

During treated units, students participated in a Socratic Seminar and I assessed their preparation and participation for the discussion using the Discussion Rubric (Appendix B). For each discussion, I chose the discussion topic and major question and provided students with discussion preparation worksheets including discussion starters

and graphic organizers to help students prepare arguments and collect evidence. Students had one to two days to prepare with an assigned partner for their discussion. On the day of discussion, I re-outlined discussion norms and expectations. Halfway through each discussion, students had the opportunity to provide feedback to their partner. After the discussion, students reflected on the discussion through a discussion debrief form.

Throughout each unit students completed Weekly Reflections that asked about their confidence with the week's content. These were inspired by Angelo and Cross' Minute Paper formative assessment (1993). At the end of each week, I asked students to independently respond to the following questions: 1) What do you feel like you know really well from science this week? 2) What is one idea/skill you want to focus on improving next week in science?

At the end of each unit, all 51 sixth-grade students completed a quiz on Microsoft forms that assessed content knowledge specific to that unit. Each quiz included two or three, level three and four depth of knowledge questions (Appendix C). I scored student answers on a scale of one to four using the Short Answer Rubric (Appendix D). These scores are referred to as Content Quiz scores and results.

Additionally, students completed a Unit Reflection Survey of their confidence with each unit of study (Appendix E). Students completed the survey on Google Forms within one day of each end of unit quiz.

At the end of each unit I conducted an in-person interview with five sixth-grade students, randomly selected out of the group of 51 (Appendix F). Interviews occurred on the day following the completion of the unit quiz. I recorded and transcribed each

interview using an IOS voice recording application. The five students included four non-ELL students and one ELL student. This ratio modeled the student population in my classes. Students were selected randomly from designated groups of ELL and non-ELL name lists. It was important that interviews were done randomly in order to hear the voices of a variety of students. I made sure to include an ELL student in each survey group in order to determine whether Socratic Seminars impacted depth of content knowledge for all students, including ELL students.

#### Data Analysis Processes

In order to determine whether Socratic Seminars had an impact on students' content knowledge I used Microsoft Excel to compare Content Quiz scores by unit with a stacked column chart. Additionally, I compared the mean Content Quiz score for treated and untreated units and used Microsoft Excel to perform a paired t-test to determine whether the difference in these averages was significant. I also analyzed interview results for themes and sorted them based upon the level of content knowledge demonstrated by student answers.

To determine the relationship between Content Quiz scores and Discussion Rubric scores, I used Microsoft Excel to calculate the mean Discussion Rubric score for each student and compared this with the mean Content Quiz score for each student using a scatter plot. I used Microsoft Excel to calculate the correlation coefficient between Discussion Rubric and Content Quiz scores. I also made a contingency table displaying the number proficient and non-proficient Discussion Rubric and Content Quiz scores. I

then used the Social Science Statistics, Easy Fischer Exact Calculator to perform a Fischer Exact Test (Stangroom, 2018).

To determine whether Socratic Seminars impacted student confidence, I analyzed data from the two most relevant questions on the Unit Reflection Survey. These were: “How confident are you that your answers on the unit test are correct?” and “How confident do you feel about explaining what you learned to others?” For each question, I used Microsoft Excel to compare student answers using a stacked column chart. I compared the mean percent of students who answered *Kind of Confident* and *Very Confident* for treated versus untreated units. I also categorized Weekly Reflection responses and used Microsoft Excel to compare the percent of total answers in each category for treated versus untreated units. Additionally, I sorted interviews that showed a positive versus a negative level of confidence and those that showed a higher confidence level in writing versus speaking.

To determine whether Socratic Seminars impacted the achievement gap between ELL and non-ELL students, I compared the mean Content Quiz score for treated and untreated units for ELL students and for non-ELL students. I used Microsoft Excel to perform a paired t-test using Content Quiz scores from treated versus untreated units for ELL students and non-ELL students to determine whether there was a statistically significant difference between the two. I also analyzed interview results for themes and sorted them based upon the level of content knowledge demonstrated by ELL and non-ELL students

To determine the relationship between Content Quiz scores and Discussion Rubric scores for ELL and non-ELL students, I used Microsoft Excel to calculate the mean Discussion Rubric score for each student in each group and compared this with the mean Content Quiz score for each student in each group using a scatter plot. I used Microsoft Excel to calculate the correlation coefficient between Discussion Rubric and Content Quiz scores for ELL and non-ELL students. I also made a contingency table displaying the number of proficient and non-proficient Discussion Rubric and Content Quiz scores for ELL and non-ELL students. I then used the Social Science Statistics, Easy Fischer Exact Calculator to perform a Fischer Exact Test for each group (Stangroom, 2018).

#### Reliability and Trustworthiness

To ensure an adequate level of reliability and trustworthiness in this mixed methods study, I used a variety of data collection instruments to answer each question. These included both quantitative and qualitative data collection methods. Analysis included statistical tests in addition to means comparisons, frequency comparisons, graphical displays, and theme analysis from interviews. I took care in choosing appropriate statistical tests for the small sample size of 51 students.

Although I made a concerted effort to limit the variables in my classroom in relation to this action research project, not all controlled variables stayed perfectly constant throughout the school year. The content of each unit and the resulting investigations, reading activities, and extension activities changed throughout the year, as did the questions on the end of unit quizzes. To minimize the impact of this change, I

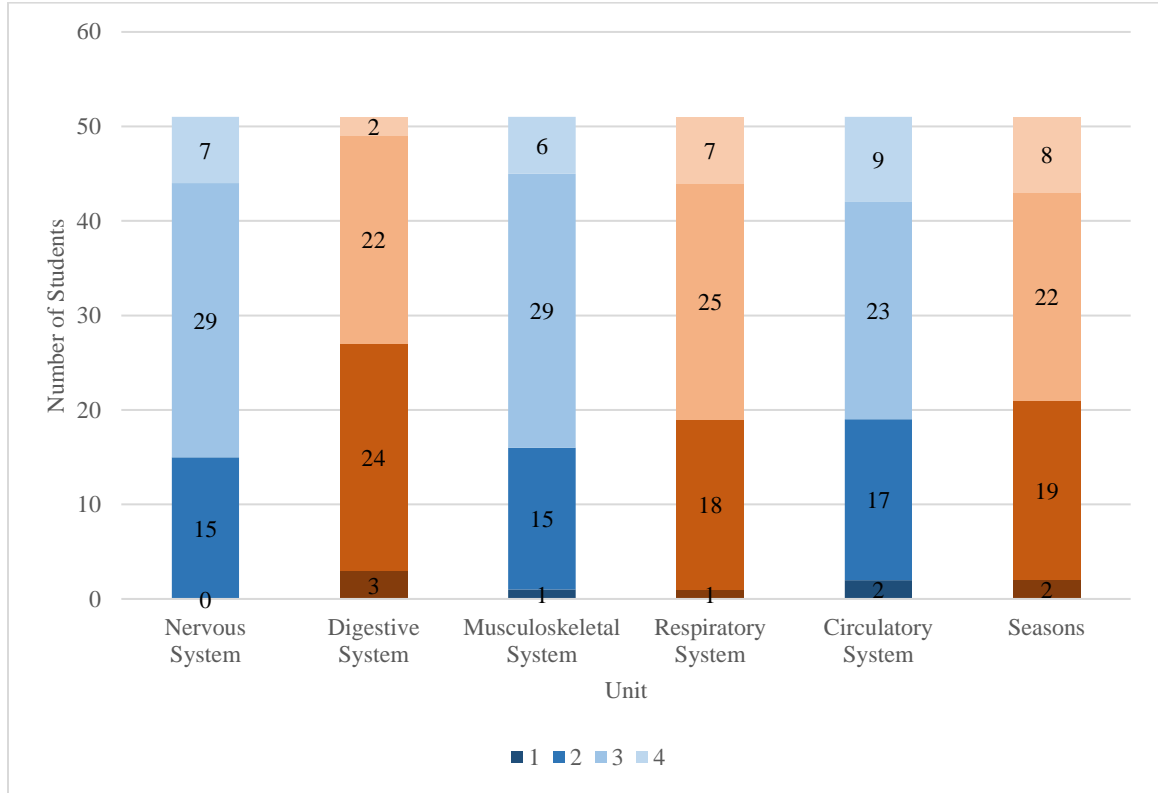
taught each unit using the 5-E instructional structure and included a similar style of level three and four depth of knowledge questions on each quiz.

The results of this study are specific to my classroom and this group of 51 sixth-grade students. There is potential that the same study performed in a different classroom with different students would yield different results.

#### DATA AND ANALYSIS

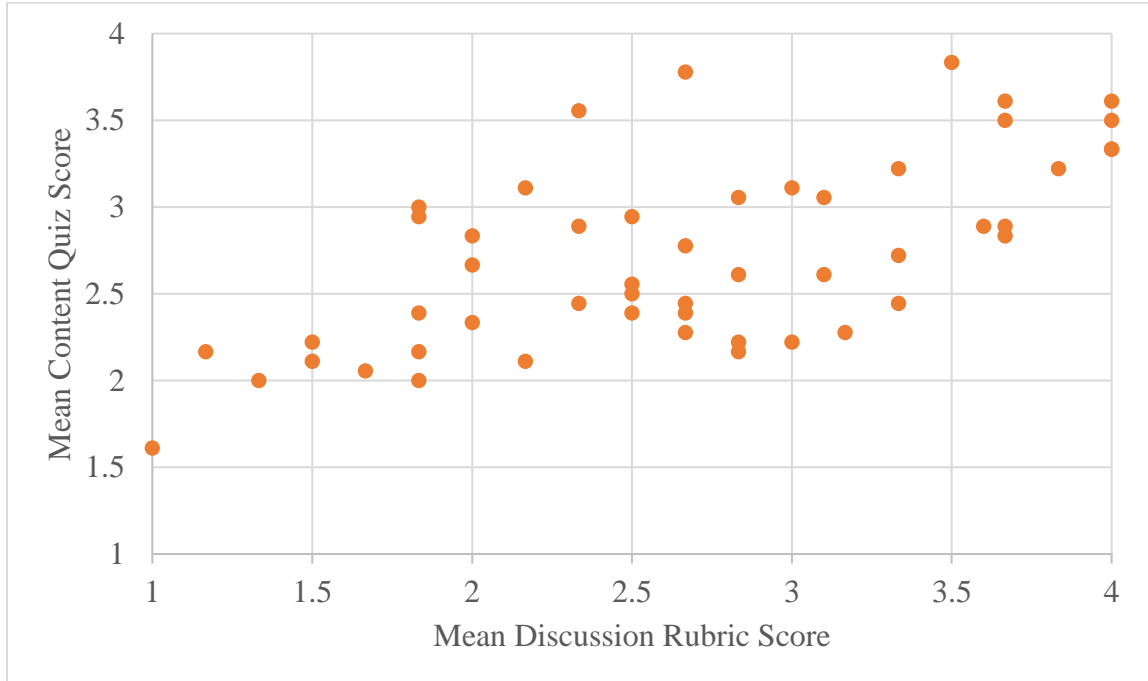
The primary research question of this study was, what are the effects of Socratic Seminars on student's depth of understanding of science content? To answer this question, I compared mean Content Quiz results for treated and untreated units, and correlated them with Discussion Rubric results. I sorted and analyzed interviews for themes. To address the secondary question, how does preparation for and participation in Socratic Seminars impact student confidence with science content? I compared Unit Reflection Survey results for treated and untreated units and sorted Weekly Reflection results and interviews. Finally, in response to the question, how does preparation for and participation in Socratic Seminars effect the achievement gap between ELL students and non-ELL students? I compared mean Content Quiz results for ELL and non-ELL students and correlated them with Discussion Rubric results.

Content Quiz results indicated that Socratic Seminars have no significant impact on student performance on level three and four depth of knowledge assessment questions (Figure 4). The mean Content Quiz score from treated units for all students was 2.72 and the mean Content Quiz score from untreated units for all students was 2.84 ( $N=51$ ). The  $t$  statistic of -1.85 and  $t$  critical value of 2.01 indicates no statistically significant difference.



*Figure 4.* Comparison of mean Content Quiz scores, ( $N=51$ ). Blue indicates untreated units and orange indicates treated units.

However, comparison of Discussion Rubric and Content Quiz results for treated units indicated a positive correlation and significant dependent relationship between Socratic Seminar scores and content knowledge assessment scores (Figure 5). The correlation coefficient of mean Discussion Rubric scores and mean Content Quiz results for treated units is .65 ( $N=51$ ). The Fischer Exact statistic value is 0.0437 where the result is significant at  $p<.05$ .



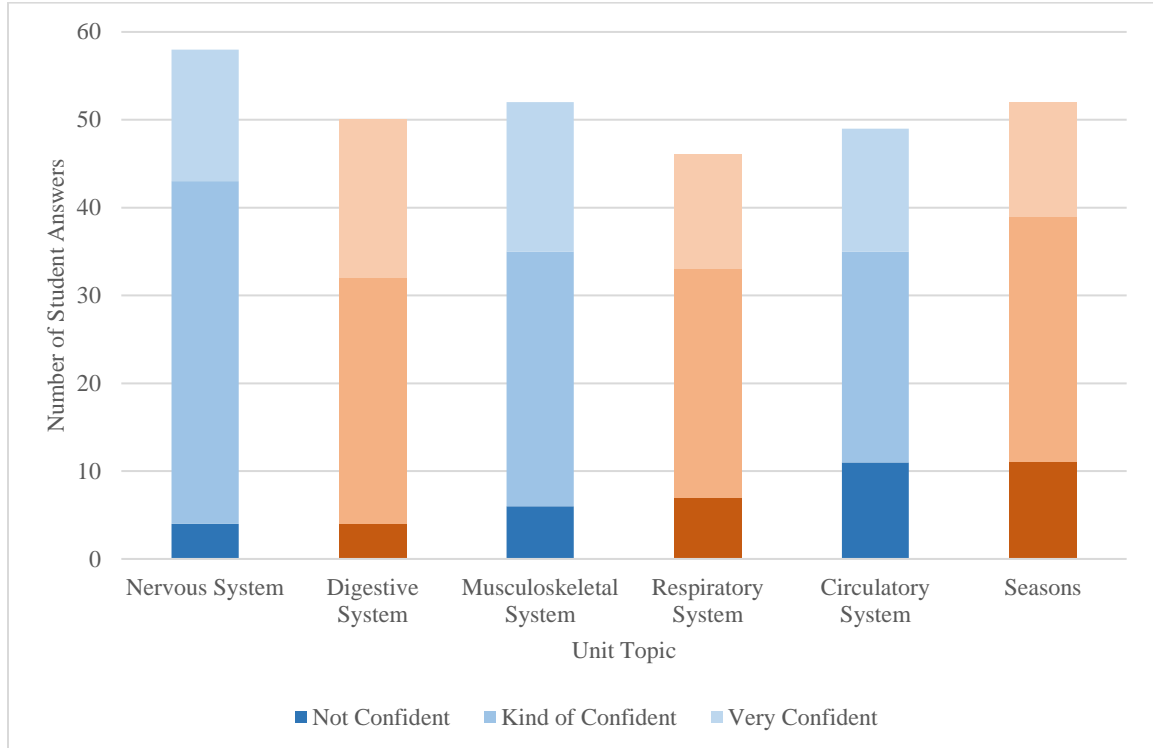
*Figure 5.* Correlation of mean Content Quiz scores and mean Discussion Rubric scores, ( $N=51$ ).

Additionally, interview results indicated increased content knowledge as a result of preparation for, and participation in, Socratic Seminars. When asked to share the most important things they learned from an untreated unit, student's responded with level 1 and level 2 depth of knowledge information such as listing the organs in a body system or providing an interesting fact that corrected a misconception. Students explained that they learned this information from videos, readings, and labeling activities. One student said the most important thing she learned was "the different types of joints and muscles and bones [from] mostly articles and readings." Student answers to the same question for treated units elicited level 3 and 4 depth of knowledge information such as how organs in a system function and work together and what changes to Earth's tilt and orbit mean for the seasons. Student's said they learned this information from reading articles, the Socratic Seminar, doing experiments, and watching demonstrations. One student said,

“The most important things [I learned] were probably like how the digestive system works, and how food goes through the digestive system. [I learned this from] the activities where you read with partners, like all articles and stuff and when we did the seminar.”

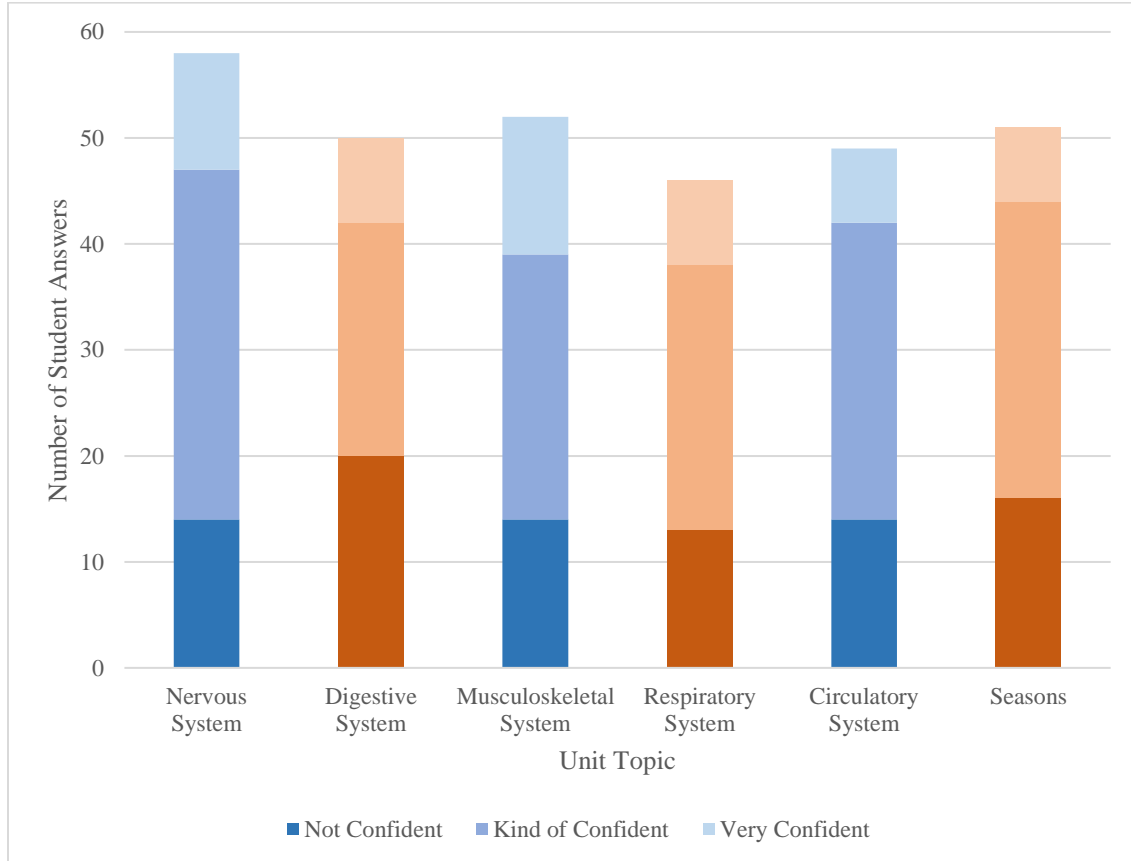
When asked how well students understood the content from treated units, 10 out of the 15 students interviewed answered with at least one full, detailed sentence in comparison to one-word answers or general statements. One student said, “Okay, I guess. I understand that you chew it up then it goes down your esophagus gets broken down more into the stomach goes down into your small intestine and it gets transported to the large intestine in a mushy milkshake like form and then it comes out the rectum.” Many students referenced information from the Socratic Seminar. For example, after a Socratic Seminar about whether junk food should be allowed at school, one student said, “I think I understand a lot and I learned a lot more than I did, like a lot more, because I didn’t really know anything about the digestive system and how junk food and stuff affected it.” In untreated units, all students answered in one word or general statements ( $N=15$ ). A long response was, “Pretty well since we learned a lot on it.”

Unit Reflection Survey results indicated no effect of preparation for and participation in Socratic Seminars on student confidence with test answers (Figure 6). In response to the question, “How confident are you that your answers on the unit test are correct?” 85.21% of students responded *Kind of Confident* or *Very Confident* during treated units compared to 86.37% of students during untreated units ( $N= 46-58$ ).



*Figure 6.* Unit Reflection Survey results for the question, “How confident are you that your answers on the unit test are correct?” Orange represents treated units and blue represents untreated units, ( $N=46-58$ ).

Unit Reflection Survey results indicated a negative effect of preparation for and participation in Socratic Seminars on student confidence with verbal explanation of content (Figure 7). In response to the question, “How confident do you feel about explaining what you learned to others?” 66.79% of students responded *Kind of Confident* or *Very Confident* during treated units compared to 73.46% of students during untreated units ( $N= 46-58$ ).

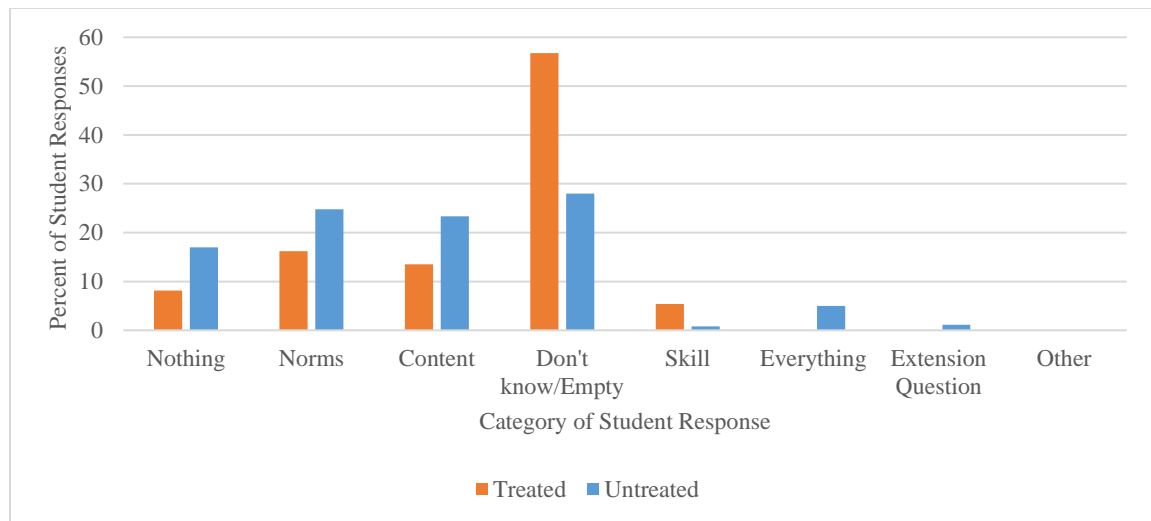


*Figure 7.* Unit Reflection Survey results for the question, “How confident do you feel about explaining what you learned to others?” Orange represents treated units and blue represents untreated units, ( $N=46-58$ ).

In contrast, interview results indicated that preparation for and participation in Socratic Seminars increased student confidence with content and with talking about content. After untreated units, 33.33% of student responses indicated a preference to write about content as opposed to speaking about it ( $N=15$ ). After treated units, only one student response indicated a preference to write about content instead of speaking about it and 46.7% of student answers indicated equivalent confidence during writing and speaking about content. During untreated units, 40% of student answers described a positive level of confidence compared to 60% during treated units ( $N=15$ ). Therefore, preparation for and participation in Socratic Seminars increased student confidence with

speaking to the same level as student confidence with writing, and increased the number of positive responses regarding confidence.

Results of Weekly Reflections also indicated that Socratic Seminars increased student confidence. Of the 51 student reflections each week, 56.76% of them said that they did not know what they could improve on after a week with a Socratic Seminar compared to 27.96% during weeks without a Socratic Seminar (Figure 8). Additionally, only 13.51% of students listed specific content as an area for improvement during treated weeks and 23.34% of students listed specific content as an area for improvement during untreated weeks.



*Figure 8.* Categorized Weekly Reflection responses to the question, “What do you still feel confused about from this week’s science work?” ( $N=50$ ).

Content Quiz results indicated no significant impact of Socratic Seminars on the achievement gap between ELL and non-ELL students (Figure 9). The mean Content Quiz score from treated units for ELL students was 2.52 and the mean Content Quiz score from untreated units for ELL students was 2.60 ( $N=10$ ). The mean Content Quiz score from treated units for non-ELL students was 2.77 and the mean Content Quiz score from

untreated units for non-ELL students was 2.93 ( $N=41$ ). T values and t critical values for ELL and Non-ELL students indicate no statistically significant difference between treated and untreated Content Quiz scores (Table 2). Additionally, comparison of Discussion Rubric and Content Quiz Results for treated units for ELL students indicated an independent relationship between Socratic Seminar scores and content knowledge scores. The Fischer Exact statistic value is .52 where results are not significant when  $p < .05$ .

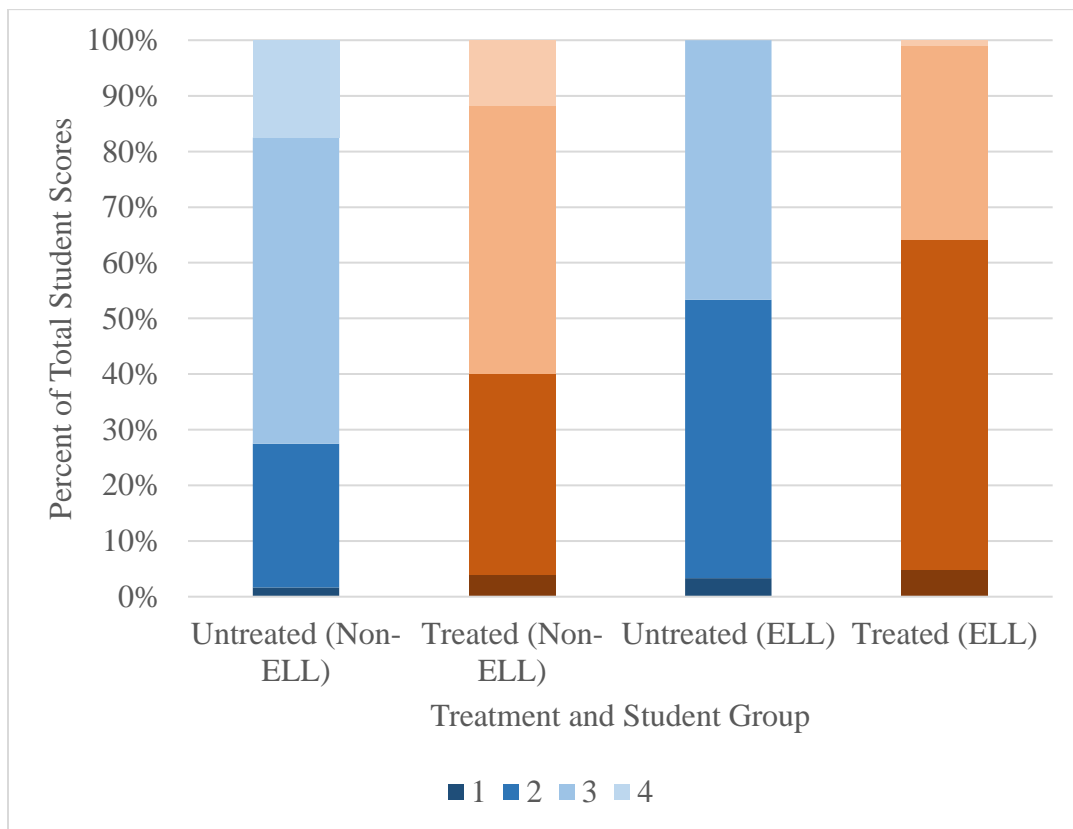


Figure 9. Comparison of Content Quiz scores for ELL and non-ELL students, ( $N=51$ ).

Table 2

*Comparison of Content Quiz Score Means and Their Statistical Significance*

	Mean Content Quiz Score (Treated)	Mean Content Quiz Score (Untreated)	T-Statistic vs. T-Critical	Significance
All students ( $N=51$ )	2.72	2.84	-1.85 < 2.01	None

Non-ELL students ( $N=41$ )	2.78	2.93	$-2.08 < 2.02$	None
ELL students ( $N=10$ )	2.52	2.60	$-0.64 < 2.26$	None

However, comparison of Discussion Rubric and Content Quiz Results for treated units for ELL and non-ELL students indicated a positive correlation between Socratic Seminar scores and content knowledge assessment scores (Figure 10). The correlation coefficient of mean Discussion Rubric scores and mean Content Quiz results for ELL students is .83 ( $N=10$ ) and the correlation coefficient for non-ELL students is .63 ( $N=41$ ).

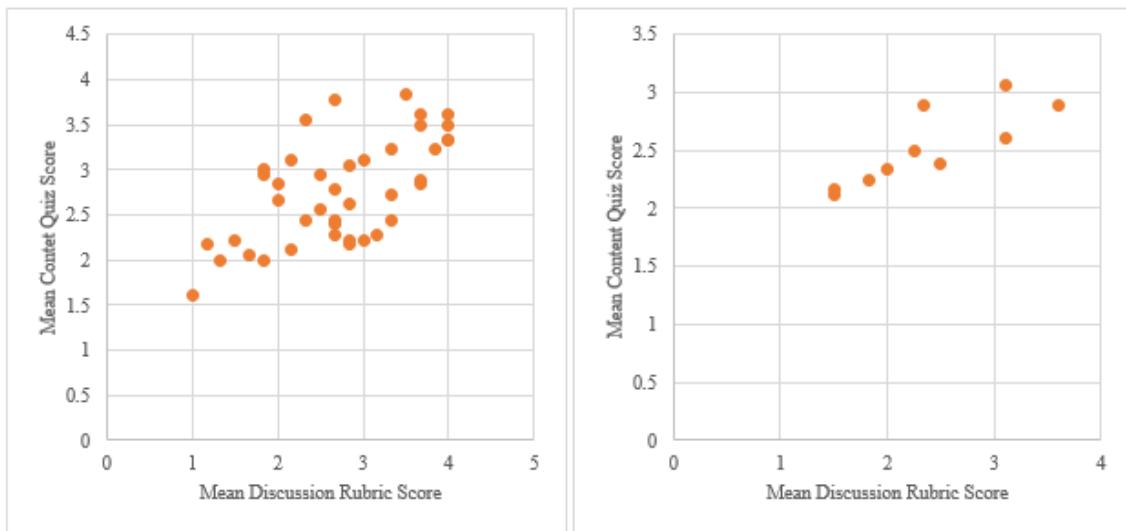


Figure 10. Correlation of mean Content Quiz scores and mean Discussion Rubric scores for non-ELL students, (left;  $N=41$ ) and ELL students, (right;  $N=10$ ).

Additionally, interview results indicated an increase in ELL content knowledge after preparation for and participation in Socratic Seminars. After untreated units, ELL students identified level 1 content knowledge, such as the location of an organ or the color of blood, as the most important things they learned ( $N=3$ ). One student said, “That people thought that we had blue blood on the inside of our bodies but later on we found out that there isn’t actually blue blood, only red.” Non-ELL students listed level 1 and

level 2 information such as the location of an organ, the color of blood, and the function of organs ( $N=12$ ). For example, one student said, “I learned that our blood is always red and it’s never blue and I also learned that our blood helps exchange not exchange but helps bring nutrients to our organs and help our organs function.” After treated units, ELL students and non-ELL students identified level 3 content knowledge as the most important things they learned during a unit and cited the Socratic Seminar as the activity from which they learned the information. One ELL student said the most important thing they learned was, “About our bodies and how they work together.” A non-ELL student said, “I think how the respiratory system brings the...oxygen into the blood.”

Overall, Content Quiz results indicated no significant impact of Socratic Seminars on student’s depth of content knowledge. However, comparison of Content Quiz results and Discussion Rubric scores indicated a positive correlation and dependent relationship between the two. Additionally, interviews indicated an increase in content knowledge during units with a Socratic Seminar. Unit Reflection Survey responses indicated that there was no effect of Socratic Seminars on student confidence with test answers and a negative impact of Socratic Seminars on student confidence with verbal explanation. However, interviews and Weekly Reflection responses indicated a positive effect of Socratic Seminars on student confidence with and ability to talk about content. Finally, Content Quiz results indicated no impact of Socratic Seminars on closing the achievement gap between ELL and non-ELL students. However, comparison of ELL Content Quiz results and Discussion Rubric scores indicates a positive correlation

between the two and interview results indicate an increase in ELL achievement with science content during units with a Socratic Seminar.

### INTERPRETATION AND CONCLUSION

This study provides mixed results as to the effect of Socratic Seminars on science content learning. Comparison of Content Quiz results indicated that there was no significant impact of Socratic Seminars on content knowledge. T-test results indicated no significant difference in the mean Content Quiz scores of treated and untreated units. However, a comparison of Discussion Rubric and Content Quiz results indicated a positive correlation between the two and a Fischer Exact test indicated a dependent relationship. Additionally, interview results indicated that students had greater content knowledge after units that included Socratic Seminars because student responses were longer and discussed higher level content.

Student's statements and questions during seminars, in addition to interview results showed that Socratic Seminars did promote deep exploration of ideas and helped students to understand difficult concepts. This finding is similar to that of the study by Applebee et al. (2003) which found that well-facilitated dialogic discussion helped students comprehend difficult text. It is therefore a worthwhile extension activity format in a science classroom. It is not, however, more valuable than other extension formats in terms of developing content knowledge. Although Socratic Seminars required students to grapple with and make sense of complex ideas, my results showed that Socratic Seminars do not have an impact on science content. There was no statistically significant difference between the mean Content Quiz scores of 2.71 for treated and 2.84 for untreated units (t

statistic = -1.85; t critical value = 2.01;  $N=51$ ). I believe this is because Socratic Seminars are not a content teaching tool. Instead, Socratic Seminars teach students crucial reading, speaking, and critical thinking skills. The skills emphasized by preparation for Socratic Seminars are finding the main idea of a text, developing an opinion and supporting it with textual evidence, and developing questions. Participating in Socratic Seminars requires students to question the ideas of others, state ideas and support them with evidence, and listen to other people with whom they might disagree. The content of the unit and the topic of the Socratic Seminars served as the vessel through which students built reading, speaking, and critical thinking skills.

The correlation between Discussion Rubric and Content Quiz results as well as the indication from the Fischer Exact test of a significant dependent relationship between the two, leads me to believe that Socratic Seminars and written questions are equally valid assessment tools (Fischer Exact statistic value is 0.0437 where the result is significant at  $p<.05$ ). The Discussion Rubric based student scores on their ability to read, write, and speak about a text. As evidenced by the correlation coefficient of .65 for Discussion Rubric and Content Quiz results, students who performed proficiently preparing for and participating in the discussion were also able to perform the writing necessary to generate a proficient score on their test ( $N=51$ ).

While Content Quiz and Discussion Rubric results did not show an impact of Socratic Seminars on content knowledge, interview results did. Student descriptions of the most important things they learned from an untreated unit included level one and two depth of knowledge information whereas descriptions from a treated unit included level

three and four depth of knowledge information. Additionally, 10 out of 15 students used at least one full, detailed sentence when describing how well they understood the content from treated units versus the 15 one word or general statements students made when describing their understandings in untreated units. These findings are similar to those from a study by Roncke (2016) which found that Socratic Seminars expanded student thinking. I believe this is because students were given the opportunity during interviews to discuss their choice of content. On the Content Quiz students were asked specific questions about content. When students had a choice, they discussed the content they found most engaging which encouraged them to speak more freely and with more knowledge about the topic.

The results of the Unit Reflection Survey indicated that Socratic Seminars had no significant impact on student confidence with test questions and decreased confidence explaining what they learned to others. In response to the question, “How confident are you that your answers on the unit test are correct?” 85.21% of students responded *Kind of Confident* or *Very Confident* during treated units compared to 86.37% of students during untreated units ( $N= 46-58$ ). Interview results and Weekly Reflections, on the other hand, showed an increase in student confidence with content and verbal explanation after treated units. I think this discrepancy is due to the fact that sixth-grade students are unable to reliably determine and relate their confidence level. Middle school students are in the process of determining what it means to feel confident about most things in their lives. This was evidenced by the decreased confidence with verbal explanation. In response to the question, “How confident do you feel about explaining what you learned

to others?” 66.79% of students responded *Kind of Confident* or *Very Confident* during treated units compared to 73.46% of students during untreated units ( $N= 46-58$ ). Socratic Seminars required students to explain their thinking and therefore forced students to confront whether or not they were confident doing so. Additionally, their perception of confidence is highly impacted by social and emotional factors throughout their day.

A more reliable measurement of confidence was the Weekly Reflections. These results showed that students gained confidence with science content during treated units. The percentage of students who claimed that they did not know what they could improve on increased from 27.96% for weeks without a Socratic Seminar to 56.76% during weeks with a Socratic Seminar and more students (23.34%) listed specific content as an area for improvement during untreated weeks than during treated weeks (13.51%;  $N=51$ ). Weekly Reflections tracked what students felt confident about and what they felt confused about without asking them to determine their confidence and therefore retrieved more valid, less socially impacted data. Analysis of interview results also showed an increase in overall student confidence and confidence with verbal explanation. The percentage of student answers that described a positive level of overall confidence increased from 40% during untreated units, to 60% during treated units and the percentage of students who indicated a preference to write as opposed to speak about content decreased from 33.33% during untreated units to 6.67% during treated units ( $N=15$ ). Again, I believe this is a result of analyzing how students described what they understood instead of relying solely upon student choice of a level of confidence.

Finally, results show that Socratic Seminars have no significant impact on closing the achievement gap between ELL and non-ELL students. T-tests indicate no significant difference in treated and untreated mean test score values for ELL or non-ELL students (Table 2). Additionally, a Fischer Exact test indicated an independent relationship between Discussion Rubric scores and Content Quiz results. These results are likely the cause of the difference in N value between ELL and non-ELL students. Forty non-ELL students is a number on which certain tests can be performed with validity. I only taught ten ELL students and therefore each student had a much larger impact on averages and correlation. Additionally, even though I provided numerous accommodations for ELL students throughout each unit, and especially during Socratic Seminars, both Content Quizzes and Socratic Seminars assessed reading, writing, and speaking skills that ELL students are still developing. It is possible that they had content knowledge that they could not demonstrate.

Interview results indicated that Socratic Seminars increased content knowledge for ELL students. When describing the most important things they learned, ELL students listed level one content knowledge for untreated units and level three content knowledge for treated units. Similar to the whole group results, this is possibly the result of interviews allowing students to discuss content of their choosing. Additionally, interviews are a one-on-one speaking opportunity that is paced by the students. Unlike in a class discussion, interview questions can be repeated and students feel more comfortable sharing their ideas. Regardless, interview results were from such a small

sample of students I think it unlikely that Socratic Seminars had a significant impact on the achievement gap between ELL and non-ELL students.

### VALUE

I originally developed this project to determine what effect Socratic Seminars have on the learning of science content. Although it seems to have no impact on the depth of student content knowledge, as demonstrated on a written assessment, I believe it is an incredibly valuable format for teaching many other skills that students need to develop. The length and depth of student answers regarding content during interviews, as well as the conversations students had during their Socratic Seminars, leads me to believe that there is a positive impact of Socratic Seminars on the Next Generation Science Standards', Science and Engineering Practices of *Engaging in Argument from Evidence and Obtaining, Evaluating, and Communicating Information* (NGSS Lead States, 2013). Alozie et al. explains that students who have the opportunity to discuss scientific ideas will mimic and adapt scientific discourse practices (2009). Additionally, a study by Boyd and Markarian found that dialogic discussion structure encourages students to analyze one another's ideas and challenge themselves and their peers (2011). My experience with this study supports these findings. Through preparation for and participation in Socratic Seminars I saw students improve their ability to synthesize information, improve speaking skills, develop openness to new ideas, question peers, respectfully disagree with peers, develop a capacity to think for oneself, support ideas with evidence, find the main idea of a text, listen to others, and build on other's ideas. After observing two Socratic Seminars in my classroom, my principal said, "Your students have having conversations

in a way that most adults can't talk in our country right now." This not only validates the use of Socratic Seminars as a teaching tool, but also validates the inclusion of *Engaging in Argument from Evidence* and *Obtaining, Evaluating, and Communicating Information* as critical components of science standards.

In the past, I focused my planning solely on the science content I needed to teach. This study reminds me that the skills listed above are equally if not more important for students as they become citizens in our society. Socratic Seminars will be a constant part of my teaching from here on out and I believe they hold value as part of any science teacher's toolbox for teaching critical thinking, reading, writing, and speaking skills.

Socratic Seminars also hold value because of how they engage and empower students. I observed that this format was especially important for students who struggle with disruptive behavior. Not only were students engaged in the discussion itself, but they were focused and engaged in the preparation work. They seem to love the opportunity to direct the conversation and share their ideas without input from a teacher. Unit Reflection Survey data showed that Socratic Seminars were student's favorite activities in addition to the investigations and lab work that we did.

Socratic Seminars also proved to be an incredibly valuable assessment tool. Since my data showed that Socratic Seminars are as valid an assessment tool of content knowledge as a written test, I believe that they provide an opportunity to assess student's content knowledge verbally. For students who struggle with taking written tests, this is an excellent substitute as an assessment format. Listening to students talk during Socratic

Seminars allowed me to have a great understanding of their depth of understanding and areas of confusion surrounding the topic of discussion.

While developing this project, I researched three primary discussion formats: Socratic Seminars, Pinwheel Discussions, and Philosophical Chairs. I chose to use only Socratic Seminars so that my students and I could refine our use of that discussion format and hopefully delve deeper into discussion topics instead of struggling to understand a new discussion format with each new topic. My results are therefore focused upon the impact of Socratic Seminars on the depth of student content knowledge, student confidence, and the achievement gap. After completing my study, I wonder whether a similar study using only Pinwheel Discussions or Philosophical Chairs would yield similar results.

One of the biggest ways that this action research process changed my teaching has been in recognizing the importance of collecting and using student feedback to change and update learning tools, formats, and processes. After each Socratic Seminar students completed a reflection and we had a class discussion about how we could improve our next Socratic Seminar. Each time, I made small changes to how I ran the discussion and the preparation materials that I provided for students. Not only did this provide students with even more ownership over their learning and experience with Socratic Seminars, but it also allowed me to understand what worked for them and better respond to their needs.

Having gone through this action research process, my mindset surrounding data collection shifted. I was originally unsure of how valuable my interview and survey results would be in comparison with the quantitative data I collected for this study. When

analyzing all of my data I found that my interview and survey data was more valuable than the quantitative data in understanding the nuances surrounding my focus question. I got a much better sense of how students felt about my class, Socratic Seminars, and content from these collection instruments than from my test results and discussion grades. I will be sure to include surveys and interviews in future research I may do in my classroom, and also as opportunities to check-in with students and see how they are doing and what I can do to improve as a teacher.

Overall, I did this study to help develop the Socratic Seminar format for discussion in my classroom. I also wanted to understand the effects of them on student learning with the hopes of becoming a better teacher. I believe I now have a strong understanding of the impact that Socratic Seminars can have on teaching content as well as reading, writing, critical thinking, and speaking skills. I also believe that my students and I both made growth as we worked together to refine the use of Socratic Seminars in class and this study was therefore a worthwhile effort.

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APPENDICES

APPENDIX A  
INSTITUTIONAL REVIEW BOARD EXEMPTION



**INSTITUTIONAL REVIEW BOARD**  
For the Protection of Human Subjects  
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**MEMORANDUM**

**TO:** Fiona Smith and Marcie Reuer

**FROM:** Mark Quinn *Mark Quinn Crj*  
Chair, Institutional Review Board for the Protection of Human Subjects

**DATE:** October 12, 2018

**RE:** "A Study of the Impact of Formalized Discussion Practices on a Sixth-Grade Science Classroom" (F-5101218-EX)

The above research, described in your submission of October 11, 2018, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B  
DISCUSSION RUBRIC

## Discussion Rubric

4- Exceeds Expectations/ Mastery of Learning	Met expectations <u>and</u> did all of the below or did any of the below requirements more than once
3- Meets Expectations/ Proficient in Learning	Completed the preparation packet <u>and</u> four of the <b>five requirements</b> : <ul style="list-style-type: none"> <li>• Asked a question</li> <li>• Responded to a question with an insightful comment</li> <li>• Cited evidence from the text</li> <li>• Used academic vocabulary</li> <li>• Read the group (asked questions at the appropriate time, balanced speaking and listening, drew out others thoughts)</li> </ul>
2- Partially meets expectations/ Progressing in Learning	Did two or three of the above requirements; rarely participated; partially completed the preparation worksheet
1- Did not meet expectations/ No evidence of learning	Did one of the above requirements; did not complete the preparation worksheet; did not participate (includes being absent)

APPENDIX C  
DEPTH OF KNOWLEDGE WHEEL



APPENDIX D  
SHORT ANSWER RUBRIC

## Short Answer Rubric

4- Exceeds Expectations/ Mastery of Learning	<ul style="list-style-type: none"> <li>• Answers the question with correct information</li> <li>• Includes sentence starters or transition words</li> <li>• Includes an example which more completely allows the reader to understand reasoning</li> </ul>
3- Meets Expectations/ Proficient in Learning	<ul style="list-style-type: none"> <li>• Answers the question with correct information</li> <li>• Includes sentence starters or transition words</li> </ul>
2- Partially meets expectations/ Progressing in Learning	<ul style="list-style-type: none"> <li>• Attempted to answer the question</li> <li>• May have fully explained their thoughts, but with incorrect or partially correct information</li> <li>• May include sentence starters or transition words</li> </ul>
1- Did not meet expectations/ No evidence of learning	Did not attempt an answer

APPENDIX E  
UNIT REFLECTION SURVEY

## Unit Reflection Survey

Participation on this survey is voluntary. Your grade will not be affected by your answers to this survey.

\* Required

Unit name \*

Your answer \_\_\_\_\_

What was the most interesting thing you learned in this unit?

Your answer \_\_\_\_\_

What was your favorite activity during this unit?

Your answer \_\_\_\_\_

If you do not know the answer to a question in science, how do you feel? \*

- Excited- it means there's more to learn!
- Anxious- there's something I probably should have done better.
- Defeated- it makes me feel stupid.
- Other: \_\_\_\_\_

Please indicate how confident you feel about each of the situations below. \*

	Not confident	Kind of confident	Very confident
How confident are you that your answers on the unit test are correct?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How confident were you when you spoke during the discussion?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How confident do you feel about explaining what you learned to others?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How confident do you feel speaking when your teacher calls on you in science class?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How confident do you feel about explaining what you learned to others?

How confident do you feel speaking when your teacher calls on you in science class?

How confident do you feel coming up to present the answer to questions or to share an idea during science class?

How confident do you feel raising your hand to ask a question in science class?

**SUBMIT**

Never submit passwords through Google Forms.

APPENDIX F  
INTERVIEW QUESTIONS

## Interview Questions

“Participation in this interview is voluntary. Your grade will not be affected by your answers to this interview.”

1. At the beginning of the unit we posted questions about the unit. How many of those questions do you feel were answered?
2. What are the most important things you learned during this unit?
3. Which activities taught you these things?
4. *How prepared did you feel for the Socratic Seminar? What did you do to prepare?*
5. *Did you participate as much as you wanted to in the seminar? Why or why not?*
6. *Describe the role you played in the Socratic Seminar?*
7. *What new things did you learn from somebody else during the discussion?*
8. *What new things did you learn during the week of the Seminar?*
9. *Describe how the Socratic Seminar was different than other discussions we have in class.*
10. How well do you feel like you understand the content from this unit?
11. How confident do you feel writing about the content from this unit?
12. How confident do you feel talking about the content from this unit?
13. How confident do you feel talking during science class?
14. Do you consistently speak a language other than English at home?

*\*Italicized questions will be asked online in treated units that include a Socratic Seminar*