

SHIFTING TO SCIENCE AND ENGINEERING PRACTICES  
THROUGH INSTRUCTIONAL COACHING

by

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in

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## ABSTRACT

As Iowa continues forward with Next Generation Science Standards (NGSS), many teachers have little knowledge about how best to teach this new shift. This study looked at what how instructional coaching practices helped facilitate growth for NGSS in science classrooms. Many teachers do not have the knowledge, confidence and resources to shift to the new science thinking of NGSS. This action research paper looked at instructional coaching and its impact for teacher efficacy in the area of the eight Science and Engineering practices (S&E). Teachers were coached through a 4-week coaching cycle to learn, plan, and implement the eight S&E practices. Teachers were given pre- and post- surveys as well as interviews. Classroom observations were also done. Students also received pre- and post- surveys along with interviews to gauge their understanding of the S&E practices. The results indicated that instructional coaching had a positive impact on teachers' knowledge and efficacy of the practices. Post classroom observations done one month after coaching also showed a continuation of the use and implementation of the S&E practices. Surveys given to students also indicated a positive shift to understanding the S&E practices. However, interviews given to students were inconclusive.

## INTRODUCTION AND BACKGROUND

Central City Community Schools is a rural school located in southeastern Iowa. The small town is located 20 minutes from Cedar Rapids, Iowa. The population of this town is 1,274. It is a rural community with about 443 students K-12. The school consists of one building. Many students work on family farms. There is little diversity of race, ethnicity or religion. The population is predominately Caucasian. Central City Schools has a 24% population of “at-risk children” and 70% “free and reduced lunch.” Most families within the district are middle to low income.

This is my 6<sup>th</sup> year in the district. The last four years I was responsible for teaching all of the science curriculum to both 5<sup>th</sup> and 6<sup>th</sup> graders. In the 2016-2017 school year I took a new role as a K-12 Instructional Coach. This year my role focused on 6-12 Instructional Coaching as well as the K-12 At-Risk Coordinator. I have had a chance to work with teachers in their classrooms and many have expressed lack of expertise, professional development, and resources needed to help shift to NGSS. In fact, many teachers are not even aware that a shift has occurred. Many teachers have not had any training on how to adjust the traditional way of teaching science to NGSS. As an Instructional Coach with an emphasis in science, I feel that there is need to provide assistance in this area for many of our teachers.

### Purpose

The purpose of this study is to identify how instructional practices help teachers shift to NGSS. The intervention will consist of working on a weekly basis during a 4-week coaching cycle with teachers to help them gain knowledge, expertise, and strategies

to better instruct in the areas of NGSS, particularly in the area of the eight Science and Engineering practices.

### Focus and Research Questions

My action research focuses on how I, as an instructional coach, can help teachers feel better equipped, confident, motivated, and ready with NGSS in their classroom. My research questions include:

- How does individualized instructional coaching impact teacher knowledge and implementation of the eight Science and Engineering practices?
- Does the individualized instructional coaching have an effect on the longevity of use and implementation of Science and Engineering practices in the classroom?
- How does instructional coaching impact students' knowledge of the eight Science and Engineering practices?

### CONCEPTUAL FRAMEWORK

NGSS was originally conceived as a result of dissatisfaction with how science has been traditionally taught. Science, in its current form, is typically taught as a rigid body of facts, theories, and rules which are to be memorized and practiced, rather than learning and understanding natural phenomena (van Driel, Beijaard, & Verloop, 2001). Most of these traditional teaching methods of the sciences have been a subject of criticism among policy makers, teachers, educators, and researchers. Student engagement and success in science has decreased as a result of using traditional methods. In specific, research has shown that this approach results in students having a poor understanding of scientific

concepts. This outdated model of teaching is not adequately preparing our future citizens to understand the continuously changing science and technology issues of our world (van Driel et al., 2001). This lack of understanding in science has caused a nationwide effort to change the standards taught and the pedagogy behind science learning.

The final draft of NGSS was released on April 9, 2013. The collective works of NGSS are a set of standards that would describe “what all students should know and be able to do by the time they graduate from high school” (Haag & Megowan, 2015). NGSS was “in response to major national reports that have focused on the need to improve science, technology, engineering, and mathematics (STEM) education in the United States” (Lehman, Kim, & Harris 2014). NGSS has three building blocks referred to as three-dimensional learning. These building blocks are scientific and engineering practices, crosscutting concepts that partner both science and engineering, and core ideas from the areas of physical science, life science, earth/space science, and engineering/technology (Lehman, et al., 2014).

Studies have been done to look at teacher preparedness and motivation to implement NGSS. A mixed-method study done on in-service teachers across the nation tried to answer the questions of preparedness and motivation. The research question that guided the study looked to find out how motivated and how well prepared a group of 7-12 grade teachers felt in using NGSS and Science and Engineering (S&E) practices. The study found that high school teachers were more motivated and felt more prepared to use NGSS and S&E practices than middle school teachers. However, qualitative data showed that although middle school and high school teachers are positive about NGSS, many

teachers are anxious about aforementioned issues of inadequate training, limited instructional time, and not having sufficient resources to teach NGSS. Many respondents of this study indicated both concerns and anxiety about being able to effectively teach and be successful with S&E practices (Haag, & Megowan, 2015). The same result was found in a study done on elementary teachers who voiced concerns such as insufficient preparation, limited instructional time (specifically devoted to science), and lack of resources for effective science education (Trygstad, Smith, Banilower, & Nelson, 2013).

Along with a shift in science learning, large numbers of schools around the country are asking teachers to provide support and guidance for colleagues through a challenging new role called “coaching” (Denton & Hasbrouck, 2009). The Center for Early Childhood Professional Development at the University of Oklahoma defines an instructional coach as an “onsite professional development providers and change agents who use differentiated coaching to increase teacher effectiveness by teaching educators how to successfully implement effective, research-based teaching techniques and practice” (Center for Early Childhood Professional Development, n.d.). The increased use of coaches is due in part to the professional development requirements contained in the No Child Left Behind (NCLB) Act (Kowal & Steiner, 2007). NCLB required professional development programs to be put in place for schools that failed to make adequate yearly progress for two years or more. These professional development programs incorporated some form of instructional coaching. In 2005-2006, nearly ten percent of schools were required to have a school improvement plan in place. Therefore, the nationwide increase in the use of coaching as a professional development strategy

was not surprising (Kowal & Steiner, 2007). In December 2015, President Obama signed an overhaul of the NCLB law (Kerr, 2015). With this overhaul, schools were not required to mandate professional development. However, coaches have already been put in place and there is little talk that instructional coaching will be going away anytime soon.

Specific studies done on the readiness of teachers to effectively implement NGSS and S&E practices call for an increase in professional development. Instructional coaching is one way to bridge this gap. However, there is limited research on best practices for instructional coaches and which models are best for increasing teachers' pedagogical or methods approach. Most of the studies done, however, have been focused on math and literacy, and research on these methods in regards to science is scarce. However, intensive professional development supplemented with instructional coaching has been shown to be effective for both teacher development and student achievement, regardless of content area (Devine, Houssemand & Meyers, 2013). One model of coaching, labeled "cognitive coaching," is to help build teacher efficacy as they move towards best teaching practices in their own classrooms. In order to do so, "coaches need to focus on specific content, model techniques and instructional practices observe teacher practices, and dedicate consultative hours to working with teachers when children are not present in order to better facilitate reflection" (Shidler, 2009).

Coaches work teacher to teacher to help shift a teacher's thinking and practices toward a specific goal. Shidler (2009) stated,

Coaches need to see their role in the classroom as supporting and facilitating the ‘dialogical dimensions to teachers’ learning as well as facilitating new practices.’ Instructing teachers in content area, while facilitating and supporting new practices, enables teachers to move theory into practice. In order for new methods and enhanced instruction to be applied they must be organized around specific bodies of knowledge as opposed to general abilities (p. 459).

Teachers also benefit from contact which has been tailored to their individual situation as they are encouraged to engage in critical reflections (Teemant, 2014).

Some of the studies that have focused on instructional coaching and its impacts have shown significant pedagogical shift and sustainability in practices. In a mixed-methods study on teachers of diverse learners, coached teachers were instructed through seven cycles of research-based principles of learning called the Standards for Effective Pedagogy. The results showed high levels of fidelity at the end of coaching cycles (Teemant, 2014). Four major themes of best practices of instructional coaching emerged from this study. The importance of individualized support, student learning, valued changes and shared challenges. Individualized support focused on coaching conversations that were very individualized. Instructional coaches helped guide on specific growth targets geared to the individual teacher rather than generic goals. Teachers stated that the second theme of student learning was valued by teachers because coaching sharpened the focus specifically on student learning and differentiation. When teachers talked about change teachers felt more reflective and self-aware when working with an instructional coach. Teachers identified specific challenges that came with sustaining the use of the five standards instructional model (Teemant, 2014).

Another study looked at the impact of time coaches spent with teachers to build their efficacy and how it impacted student achievement. The study showed a significant

positive correlation between student achievement and time spent with coaches. However, gains were most significant with coaching in specific content and teaching methods. This study was done over a three-year period, and even though gains were made in year one, there was no correlation for gains and coaching in years two or three (Shidler, 2009). Some recent research has provided a promising body of evidence that coaching has a positive impact of teacher instruction. However, the evidence is small. The areas of these studies that have found positive teacher impact include: practical knowledge (craft knowledge), teacher efficacy, and improved practices in special education, writing instruction, mathematics instruction, and preservice science teacher education. Although, there have been mixed reviews in how coaching impacts student outcomes (Sailors, & Shanklin, 2010).

Instructional coaching has the support of multiple professional organizations such as National Council of Teachers of English, Council of Teachers of Mathematics, National Science Teachers Association, and National Staff Development Council, to name a few (Sailors & Shanklin, 2010). Originally, coaches were added to schools to help improve literacy levels. However, the original implementation lacked strong research about best practices, pedagogies, and strategies (Sailors & Shanklin 2010). As NGSS continues to be adopted as curriculum for more and more states, there is a call for more studies to be done in the area specifically on science and instructional coaching.

One study done over a five-year period looked at science instructional coaching in a single school district set out to answer such questions as, “What is the effectiveness of particular coaching models?” and “Why does coaching work when it does?” This

study found strong positive correlations between teacher practice improvements and time spent with the instructional coach (at least ten hours), especially when the focus of their work was narrow, a valid quality professional relationship exists (including relational trust), and role synchrony was present (Anderson, Feldman, & Minstrell, 2014). Prior research by Gibbons and Cobb has also examined if content-focused coaching supports development and long-term use of specific instructional strategies. However, the findings of these studies have been mixed. The studies done believe the results may be due to the varying amount of time teachers spend with coaches and the differing types of activities that coaches and teachers engage in across schools (Gibbons & Cobb, 2016).

In conclusion, research on educators shows that teachers feel unprepared for implementing NGSS. Many teachers indicate that lack of professional development, resources, and knowledge of the sciences hinders their ability to teach science using best practices. Schools understanding this have looked for new initiatives to support teachers in this shift to NGSS. Instructional coaching has been a new way to deliver professional development to teachers by working one-on-one to create professional growth. There are still gaps in the research as to what best practices and strategies instructional coaching should use to help facilitate teacher support for science implementation. However, there is growing evidence that more time spent with coaches, a narrowed content focus when coaching, and good relationships may be the answer to a smooth transition to NGSS.

## METHODOLOGY

The treatment of this study will include individualized instructional coaching for all three of the Middle and High school Science teachers. This individual 4-week

instructional coaching cycle will look at the impact of teacher efficacy using the Science and Engineering practices within the NGSS. This study will also look at teachers' longevity of using and implementing the Science and Engineering practices along with how this effects student growth in Science. Each teacher will elect one specific class period to apply the instructional coaching. This project was reviewed by the Montana State University Institutional Review Board (Appendix A).

### Participants

My participants consist of three Science teachers. Teacher A exclusively teaches only middle school science. Teacher A graduated from the University of Northern Iowa in 2012. His degree is a Bachelor of Art in Elementary Education. He also has a Middle School endorsement that is a dual major in both Science and Social Studies. This is his overall fifth year teaching but only his second year of teaching 6<sup>th</sup> grade Science. The demographics of his class included 24 students, 62.5% were girls, 37.5% were boys, 16% have IEPs, 16% are identified as TAG, 33 % are on free and reduced lunch, and 49% are At-Risk. Twenty-three of the students are Caucasian and one student is Asian.

Teacher B teaches a mix of both middle school and high school. She is in her third year of teaching and her course load includes integrated 7<sup>th</sup>/8<sup>th</sup> General Science, Freshman Physical Science, Biology, and Environmental Science. Teacher B graduated from University of Northern Iowa in 2014. She graduated with a Bachelor of Science in Secondary Science Education. Her endorsements include: middle school science, 5-12 Biology, Earth Science, and Physical Science. Her three years of teaching have all been done in middle/high school. The four-week cycle took place in her Freshman Physical

Science class. The demographics for this class included a total of 22 students. 50% were boys and 50% were girls, 14% had IEPs, 36% were considered At-Risk students, .09% were identified as Talented and Gifted and 41% were on Free/Reduced Lunch.

Teacher C teaches only high school. He is in his eighth year of teaching and teaches Chemistry, Physics, Robotics and Forensic Science. The four-week cycle took place in his Junior/Senior Chemistry class. Teacher C graduated in 2003 with a Bachelor of Science in Sports Management from the University of Illinois. He then graduated with a Bachelor of Science in Teaching Physics in 2009 from the University of Illinois – Chicago. He received an additional endorsement in Chemistry and Physics grades 5-12 when he moved to Iowa. The demographics for this class were a total of 17 students, of which 16 were juniors and only one senior. 71% of the class were girls while 29% were boys, there were not students with IEPs or identified as Talented and Gifted. Eleven percent of students were considered At-Risk and on Free and Reduced lunch. These three teachers make up our entire middle school/high school science department. Combined, they see a total of approximately 248 students in grades 6-12. In addition to these three instructors, I will also be conducting direct interviews (pre and post) with a total of 12 students, taking four from each instructor. Lastly, I will administer a pre- and post-coaching survey to the students in all three classes.

### Intervention

My intervention will consist of a four-week coaching cycle which includes face to face contact with the teacher once a week for 60 minutes. These 60 minutes will be structured as follows: a 15-minute introduction or review of the practices, 30 minutes of

lesson planning/discussion of implementation in classroom, and 15-minute post-reflection over current progress of implementation. Each week, the teacher and I will look at two of Science and Engineering practices within the NGSS and strategies for implementation. Throughout this four-week cycle, the teacher and I will look at all eight practices. The goal is to incorporate terminology and ideas of the S&E practices within their classroom lessons.

Teachers will be observed once per week and will be examined for how often they incorporate and use the S&E practices into their classroom. Due to the size of our school district, not all classes are taught to more than one section. Therefore, the data collected will be for the implementation group. Since not all teachers are familiar with S&E practices, I also am going to gauge their level of comfort before and after coaching. Before and after implementation, I will evaluate student understanding of the S&E practices to see if coaching had a direct impact on their learning. A month after the coaching cycle has ended, I will observe the teacher once more to assess longevity of integration.

#### Data Collection

Prior to instructional coaching cycle with each teacher, I will assess each class to purposefully pick students to interview. I want to make sure I have interviews that reach across age, gender, academia and ethnicity. Student interviews will be conducted prior to teacher instructional coaching cycle and after coaching cycle.

My first data collection will consist of a pre-coaching survey to both teachers about their knowledge of the eight S&E practices, their comfort level, and their current

practice with S&E practices (Appendix B). I will also conduct a semi-structured interview about these practices to get a clearer picture of teachers' learning and teaching styles (Appendix C). This will help me for the instructional coaching process.

My second data collection strategy will consist of a pre-survey to all students about their knowledge of S&E practices (Appendix D). I will also conduct student interviews about their feelings of science and the specific S&E practices (Appendix E). Students will be specifically picked to include ethnicity, academic level, at-risk status, and gender.

Before instructional coaching starts, I will observe teachers to get a baseline of their use of the S&E practices in class. This will be a quantitative data set that tallies how many times each practice is used in class, and it will be accompanied by qualitative data on the level of integration of each practice into the lesson (Appendix F). Once instructional coaching has started, I will use the aforementioned method of collection. This classroom data will also give me a chance to observe students' use and knowledge of the practices. After the four-week cycle, I will use the same survey and interview questions for the teacher as I did prior to coaching (Appendices B and C). I will also conduct a post student interviews and a post-coaching survey using the same form prior to coaching (Appendices D and E).

One month after completion of each of the coaching cycles, I will follow up by observing the classroom and noting the frequency of use of the S&E practices. During these observations, I will again use my classroom observations notes on frequency and

level of integration (Appendix F). Table 1 summarizes the data collection strategies for this project.

Table 1  
*Data Triangulation Matrix*

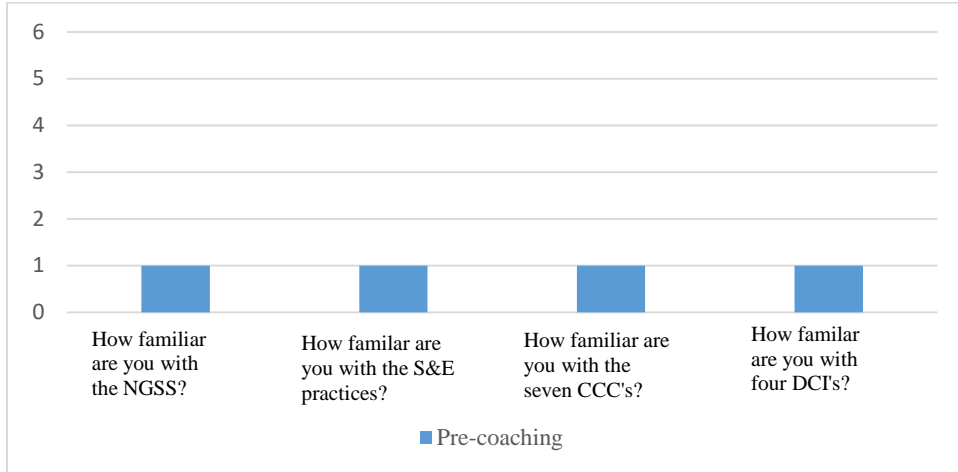
| Focus Question: How can instructional coaching effect teacher knowledge and instructional practices in the implementation of S & E practices in the classroom? |                        |                                                |                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------------------------------|------------------------|
| Sub-question                                                                                                                                                   | Data Source            |                                                |                        |
| <i>Sub-question 1:</i> How does individualized instructional coaching impact teacher knowledge and implementation of the eight S & E practices?                | Pre-survey - teachers  | Teacher interviews and classroom observations  | Post-survey - teachers |
| <i>Sub-question 2:</i> Does instructional coaching help with longevity of S&E practices in the classroom?                                                      |                        | Post-coaching Classroom observations and notes |                        |
| <i>Sub-question 3:</i> How does instructional coaching effect students understanding of S&E practices?                                                         | Pre- Survey - students | Student interviews                             | Post-survey - students |

## DATA AND ANAYLYSIS

The first part of my analysis will focus on two of my three research questions: “How does individualized instructional coaching impact teacher knowledge and implementation of the eight S&E practices?” and “Does instructional coaching help with the longevity of the S&E practices in the classroom?” The next three subsections will include what was learned from the data of the teachers’ pre-coaching and post-coaching surveys, pre-coaching and post-coaching interviews, four weeks of classroom observations and notes, and longevity data one month after the conclusion of each coaching cycle. Following the data about the individual teachers, I will then describe the analysis for my second research question: “How does instructional coaching effect students understanding of S&E practices?” The aforementioned section will focus on data

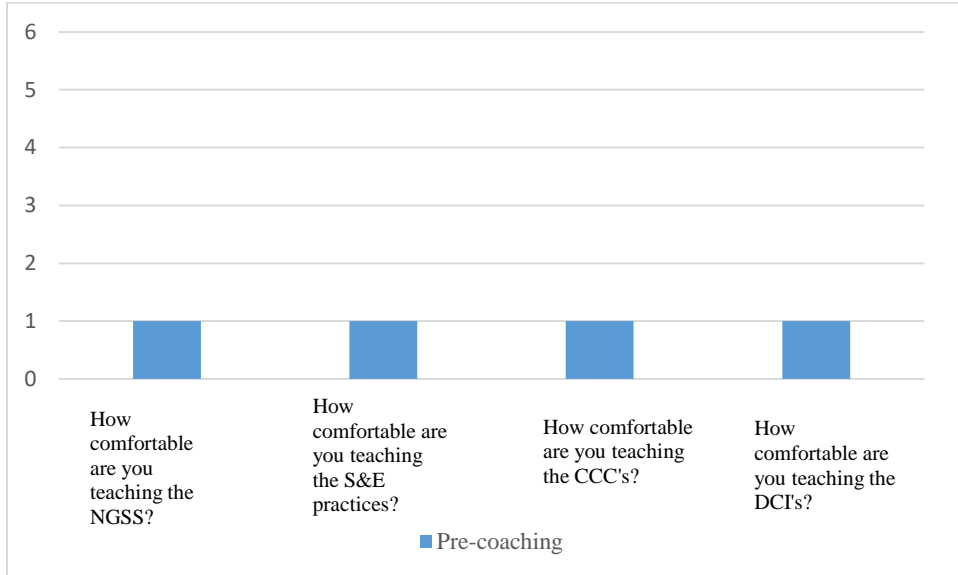
gathered from a pre-coaching and post-coaching surveys, and student interviews. Finally, the last section will be an overall analysis of the research project in its entirety.

This first teacher in my research was Teacher A. For each teacher, I began my data analysis before their four-week coaching cycle began. I used the results from their pre-coaching surveys and interviews to help drive my preparation for each individuals' coaching needs. Qualitative data from Teacher A's pre-coaching interview showed that he was very unfamiliar with NGSS standards, S&E practices, the Crosscutting Concepts, and the Disciplinary Core Ideas. When asked about the NGSS standards, he stated, "I am not familiar with them nor did I think about them." He also stated that he had never been to any professional developments involving the NGSS, so he had little knowledge about them. This qualitative data was consistent from his pre-coaching survey that showed that he felt very unfamiliar with all aspects of the NGSS standards, specifically, the S&E practices, which was the focus of this research (Figure 1). Knowing Teacher A had very little knowledge or experience with the S&E practices, I expected to see some growth in his familiarity after his coaching cycle.



*Figure 1.* Teacher A: Pre-coaching survey familiarity with NGSS. Scale 1- Very Unfamiliar, 2- Unfamiliar, 3- Slightly Unfamiliar, 4- Slightly Familiar, 5 – Familiar, 6- Very Familiar.

Quantitative data from his pre-coaching survey showed that he was very uncomfortable teaching all aspects of the NGSS. This included the standards as well as the S&E practices, the Crosscutting Concepts and the Disciplinary Core ideas (Figure 2). This was consistent with his pre-coaching interview where he admitted that didn't provide any kind of opportunities for student to engage in the practices, therefore, he did not feel comfortable teaching what he didn't know.



*Figure 2.* Teacher A: Pre-coaching survey comfort with NGSS. Scale 1- Very Uncomfortable, 2- Uncomfortable, 3- Slightly Uncomfortable, 4- Slightly Comfortable, 5 – Familiar, 6- Very Comfortable.

Prior to coaching, I asked about his use and implementation of the S&E practices in the classroom. The pre-coaching survey asked how often he used the S&E practices in the previous week of class. He indicated never more than one to two times a week. This again was consistent with his pre-coaching interview in which he stated he never thought about using the NGSS beyond what was in the Science Foss kits (Figure 3). Foss Science kits are the Science curriculum used for grades 6-8. Foss stands for Full Option Science System (The Lawrence Hall of Science, 2018).

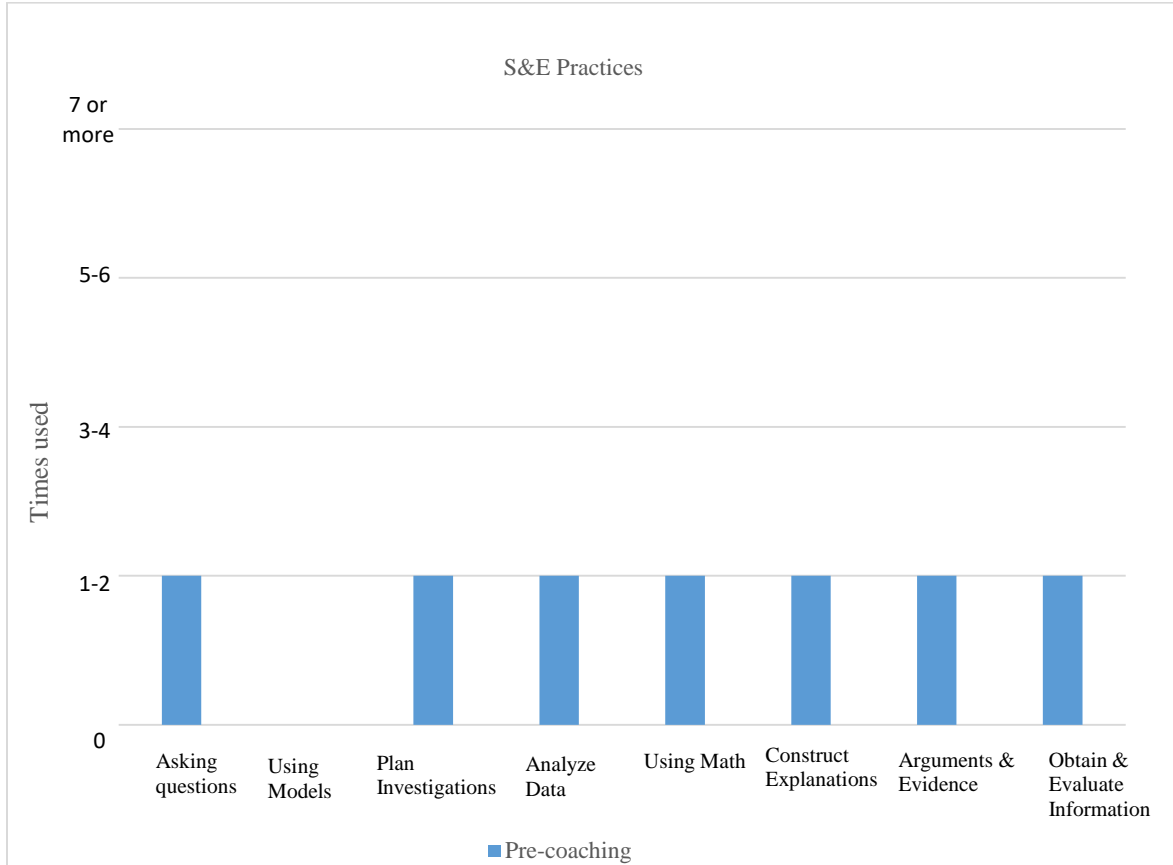
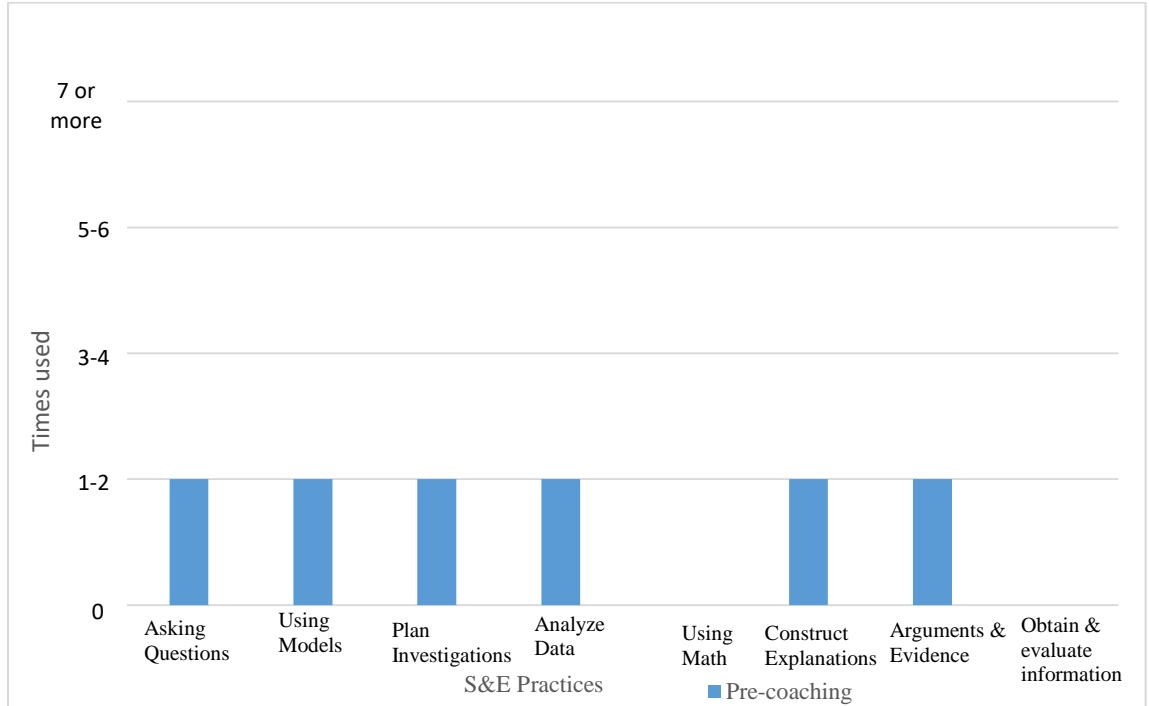


Figure 3. Teacher A: Pre-coaching survey teacher use (frequency) of S&E practices.

Data was also collected prior to coaching about the actual number of times Teacher A used the S&E practices in class. I observed Teacher A during one 44-minute class. Along with tallying the number of times he used each practice, I also indicated the level of integration of the S&E practices (see Appendix F). If the number indicated on the scale was zero, this indicated the practice was used but, no mentioned of the S&E practice. If the number on the scale was one, it indicated a brief mention of the title of the S&E practice. When a two was indicated, there was some application of S&E practices into part of instruction. When a three was tallied, it meant full integration of S&E into the instruction with the students using the S&E practices. During Teacher A's pre-coaching

observation, he used one S&E practice (Obtaining, Evaluating, and Communicating information) with an integration scale level of zero.

When collecting data from Teacher A about how often he asked his students to use the S&E practices in his classroom, he indicated in his survey that he never asked them to do any of the S&E practices more than one or two times (Figure 4). This data was consistent with Teacher A's pre-coaching interview when asked how often he used the terminology of the practices in a classroom he stated that he never intentionally used them that he was aware of. He also felt that his students would not be familiar with using them in class due to his instruction. In addition, he indicated that his students asked him many questions about what each of the practices meant while he gave the pre-coaching survey to his students.



*Figure 4.* Teacher A: Pre-coaching survey S&E practice use by students asked by teacher.

Since Teacher A had very little knowledge about the S&E practices, we started week one with an overview of the NGSS website (NGSS Lead States, 2013). I was able to give him information about how the NGSS is set up in terms of the standards, S&E practices, Crosscutting Concepts and the Disciplinary Core Ideas. Giving him a general overview allowed him to see how the NGSS worked. Following cognitive coaching structure, we then looked specifically at the eight S&E practices and read through each of them together (Lee et al., 2013).

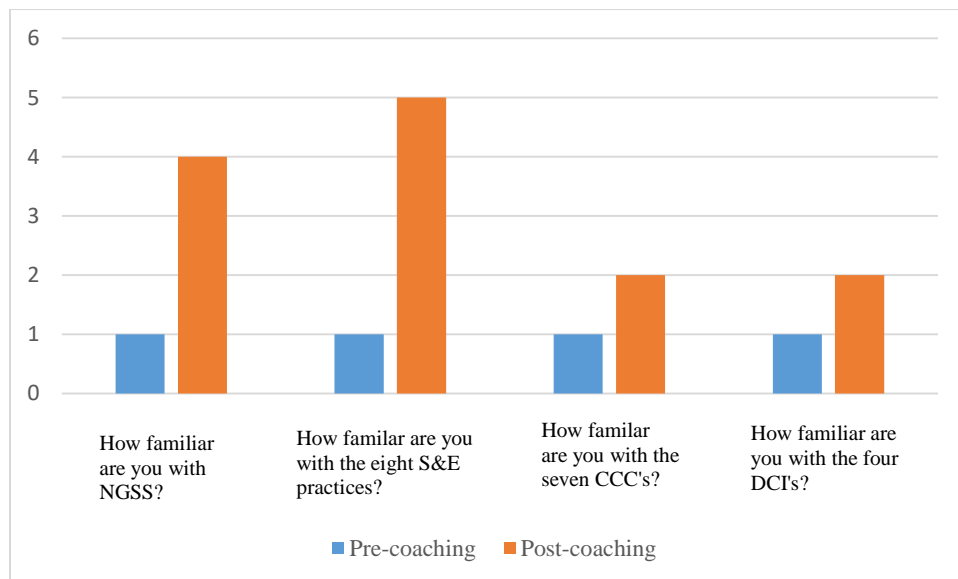
As we discussed the practices, we had a back and forth dialogue about what he thought they meant. I asked probing questions to make sure he understood the fundamentals of the practices and to find out any misconceptions or confusion. He did state during our first week planning session that he wanted to go “from simply telling

students information they need to know (about S&E practices) to letting them figure it out.” He also wanted to create awareness of the S&E practices to make sure kids realized that they are a focus in all science classes, and not just the science content itself. We then looked at what he would be teaching that week and again allowed Teacher A some autonomy. We discussed which two practices he felt went with his lesson plans and which ones he wanted to focus on week one. Week one focused on the practice Planning and Carrying Out Investigations and Using Mathematics and Computational Thinking. Because those were the practices he focused on, our goal was to see the practices being implemented in class along with both teacher and students using language from the standard. After observing week, Teacher A and I reflected on how the lesson went. Teacher A specifically stated he focused on the specific practices and felt that it was one of his more organized labs he had ever done. He said, “these kids rocked it and they were totally on point.” As we were reflecting and thinking about moving forward to week two, he wanted to make sure he was using the specific language as well as stressing that these practices are an integral part of any science lesson.

During week two, I gave Teacher A some additional resources to read through about helping shift to NGSS. The first was an article from NSTA President Karen L. Ostlund (2013) speaking about reflecting on the NGSS conceptual shifts. We met again and followed the same procedure as week one except we focused on two other practices. Teacher A decided his focuses of week two would be Developing and Using Models and Analyzing and Interpreting Data after our discussion. Again, after observing and recording data we met for a post lesson reflection. Following the same format as week

one and two, week three's focuses were on Constructing Explanations (for Science), Designing Solutions (for Engineering), and Developing an Argument from Evidence. Finally, week four's focus was on the practices we had not covered: Asking Questions (for Science) and Designing Problems (for Engineering).

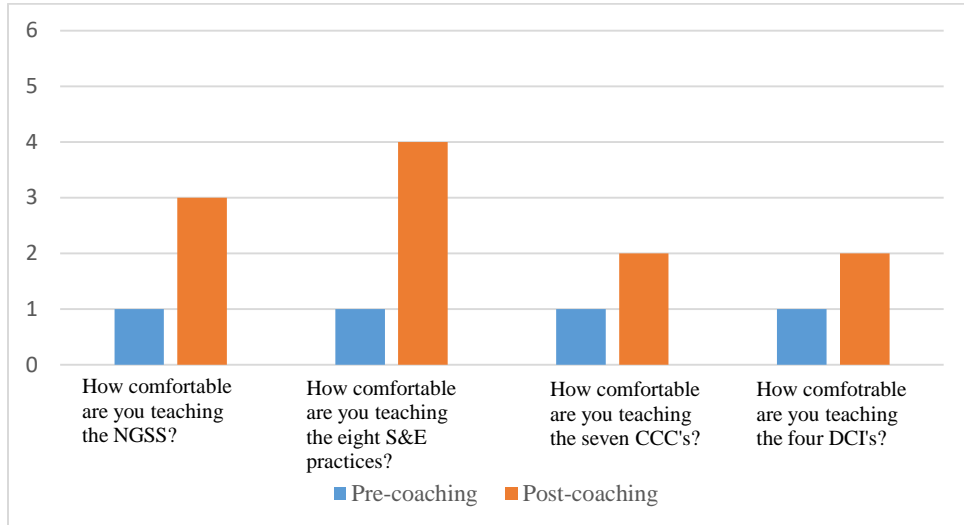
Following the four week coaching intervention, I collected a post-coaching survey as well as an interview. Seeing a shift in his level of familiarity and knowledge was consistent with the intervention being focused on the S&E practices (Figure 5). In Teacher A's post-coaching interview, he stated that he felt "the S&E practices went from no understanding to solid understanding." When asked how the coaching cycle impacted his teaching he said, "[Initially] I wasn't emphasizing the S&E practices at all; this opened up 30% more of the curriculum in a meaningful way."



*Figure 5.* Teacher A: Post-coaching vs. post-coaching survey familiarity with NGSS. Scale 1- Very Unfamiliar, 2- Unfamiliar, 3- Slightly Unfamiliar, 4- Slightly Familiar, 5 – Familiar, 6- Very Familiar.

As well as seeing an increase of his familiarity with all aspects of the NGSS, Teacher A also indicated an increase in his comfort level of teaching the NGSS,

specifically the S&E practices (Figure 6). He stated in his post-coaching interview that he was starting to get comfortable with the NGSS.



*Figure 6.* Teacher A: Pre-coaching vs. post-coaching survey comfort with NGSS. Scale 1- Very Uncomfortable, 2- Uncomfortable, 3- Slightly Uncomfortable, 4- Slightly Comfortable, 5 – Comfortable, 6- Very Comfortable.

In his post interview, Teacher A said that the focus on the terminology and implementation during the four-week cycle helped him to implement the practices on a more regular basis. He also stated in his post interview, “I use the terminology of the S&E practices when they come up in class now and that I use the language differently than before.”

During classroom observations, Teacher A’s baseline for using the S&E practices in class were one and on the integration scale it was a zero (Appendix F). In the first week alone, Teacher A used the practice Incorporating Planning and Carrying Out Investigation six times. He also implemented four other practices during this lesson. Of all the practices used during week one, only one was a zero on the integration scale with everything else being a one or two. Throughout weeks two through four, Teacher A

specifically worked on integrating practice and terminology into his lessons depending on which practice was focused on that week. In week two every practice he used was either a 2 or 3 on the integrations scale. In week three all practices except one were a two on the scale. Week four shows two practice using a 3 on the integration scale but dips down to a one on the scale for practice Obtaining, Evaluating, and Communicating Information.

The graph below shows the frequency of times he used the individual S&E practices in his four-week cycle (Figure 7).

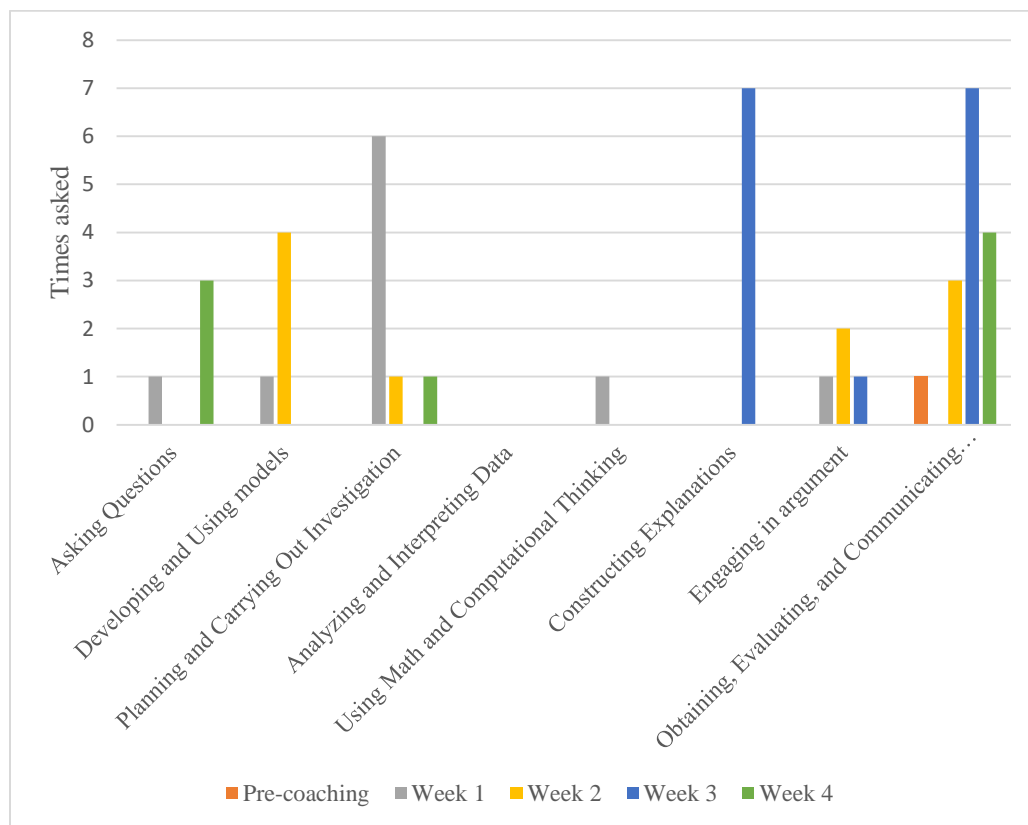
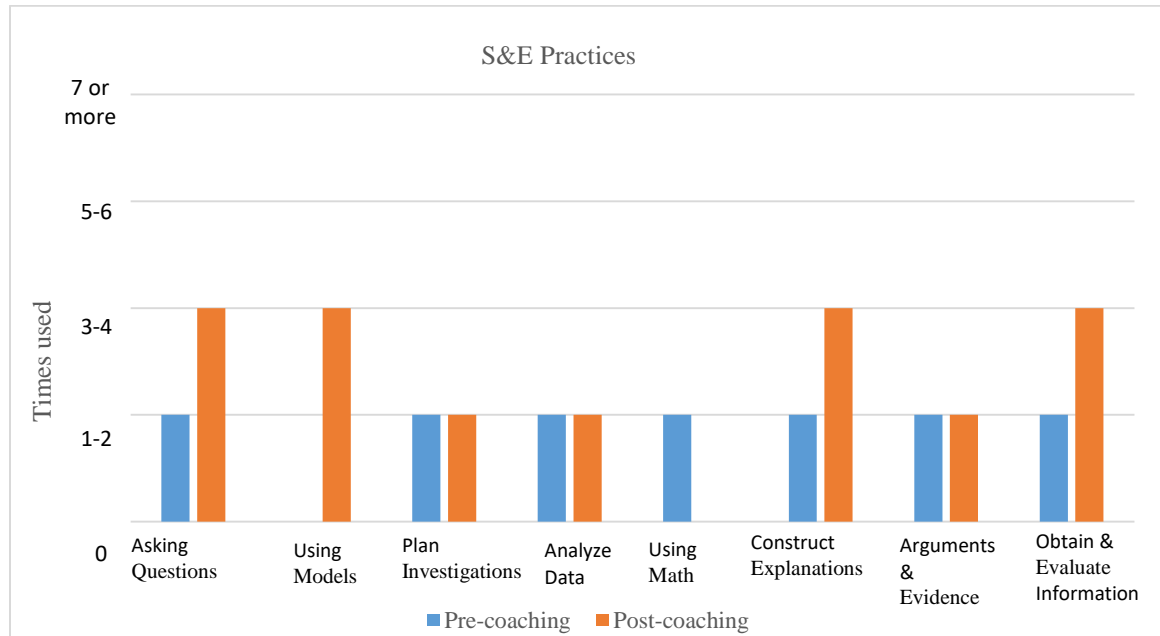


Figure 7. Teacher A: Frequency of observed use during four-week coaching cycle.

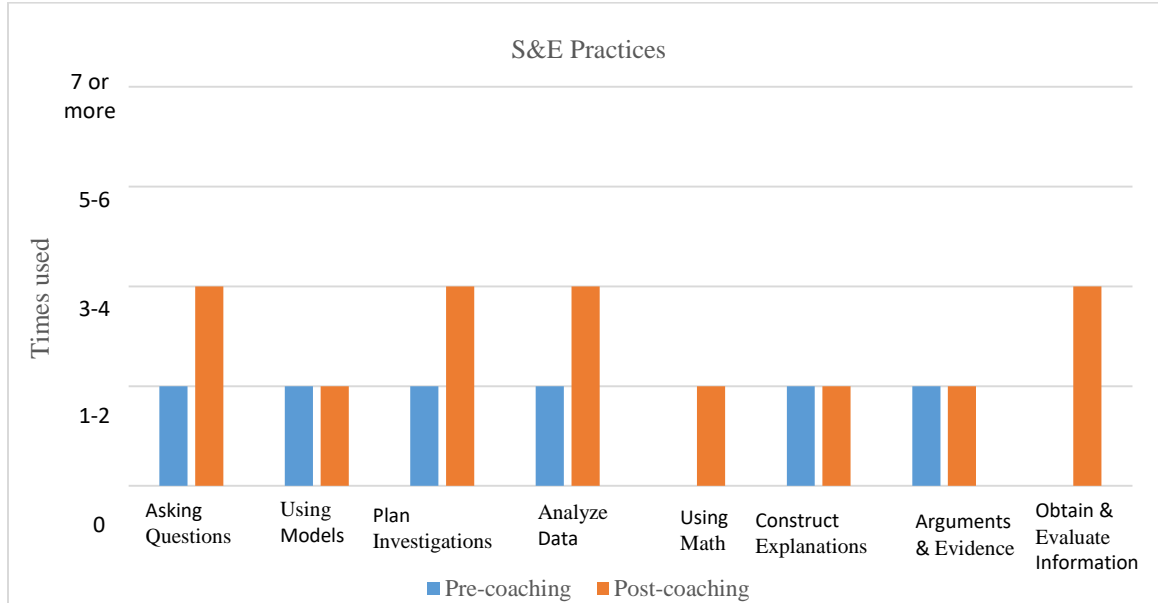
When looking at the data after coaching and knowing that the focus of the intervention was providing information and the implementation on the S&E practices,

Teacher A had a slight increase in the number of times he used the S&E practices in class (Figure 8).



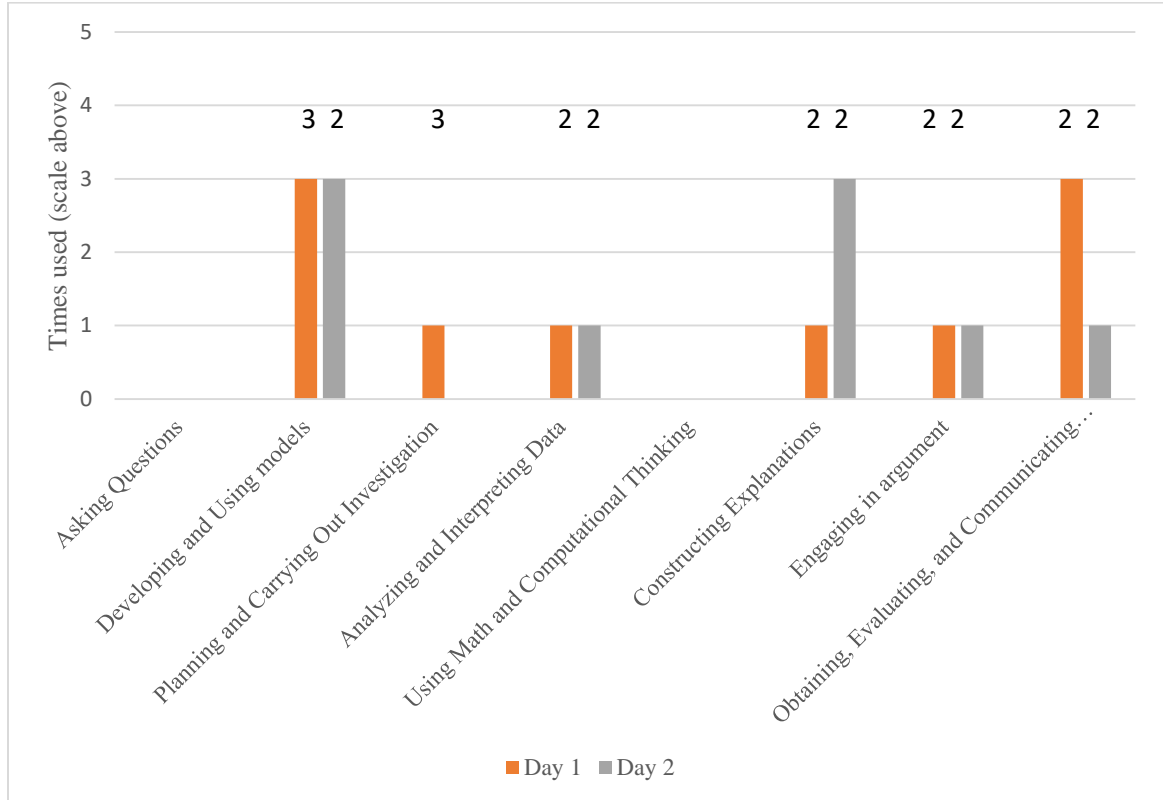
*Figure 8.* Teacher A: Pre-coaching vs. post-coaching survey teacher use (frequency) of S&E practices.

There was also a slight increase in how often he asked his students to use the S&E practices in his classroom (Figure 9). Although there was an increase in the number of times Teacher A asked his students to use four of the eight practices, there was not a significant increase.



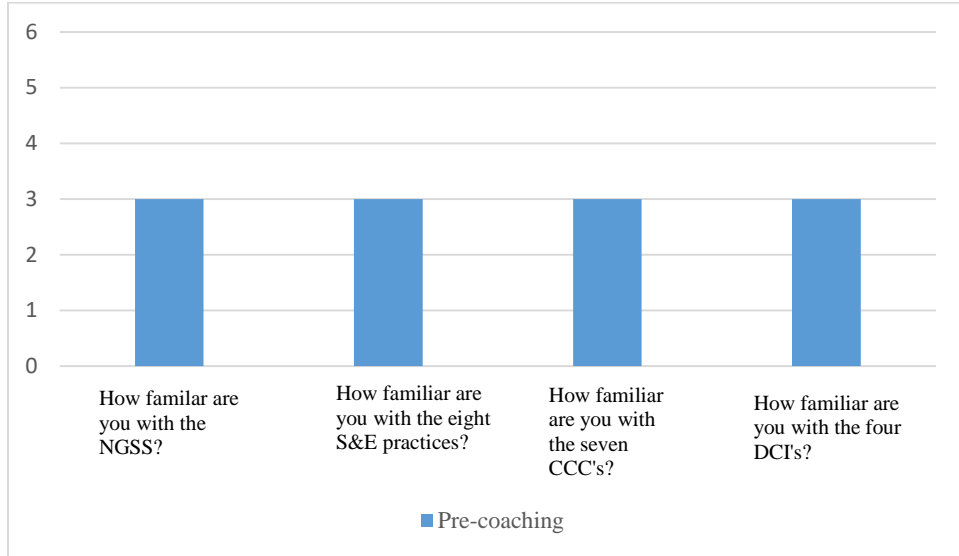
*Figure 9.* Teacher A: Pre-coaching vs. post-coaching survey S&E practice use by students asked by teacher.

To observe the longevity Teacher A's use of S&E practices, two classroom observations were done one month after the coaching cycle. The observations show that Teacher A continued to use the S&E practices in his class. His average for weeks one through four was 10.75. On day one of my one-month post observation he used the practices ten times and was a 2 or 3 on the integration scale. On day two he used the practices nine times again with a 2 or 3 on the integration scale.



*Figure 10.* Teacher A: Post-observation 1 month for frequency and integration scale.

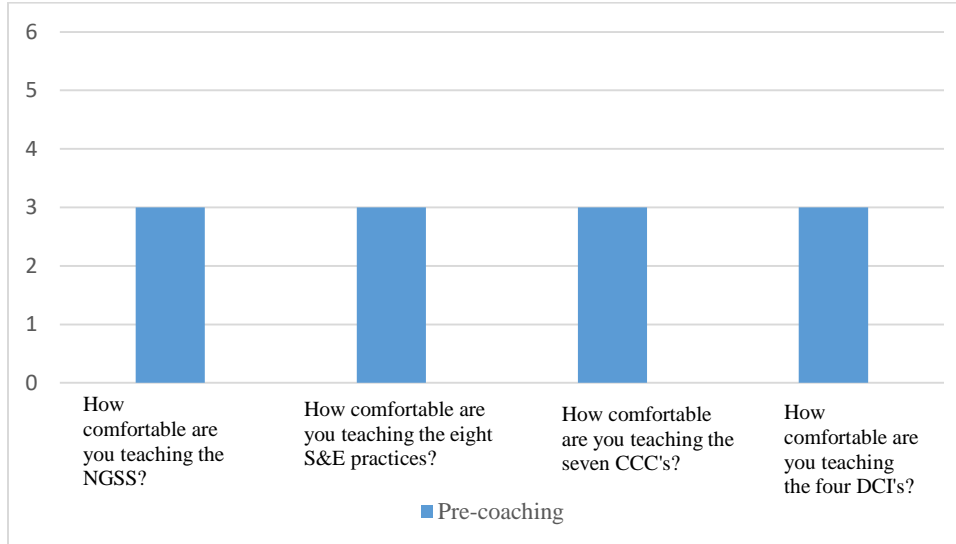
Following the same format as Teacher A, I started my next coaching cycle with Teacher B. Her intervention took place in her 9<sup>th</sup> Grade Physical Science class. Like with Teacher A, I did a pre-coaching interview and a pre-coaching survey to gauge her understanding of the S&E practices and her comfort level teaching them. Her pre-coaching survey showed that she was only slightly unfamiliar with all aspects of the NGSS (Figure 11).



*Figure 11.* Teacher B: Pre-coaching survey: familiarity with NGSS. Scale 1- Very Unfamiliar, 2- Unfamiliar, 3- Slightly Unfamiliar, 4- Slightly Familiar, 5 – Familiar, 6- Very Familiar.

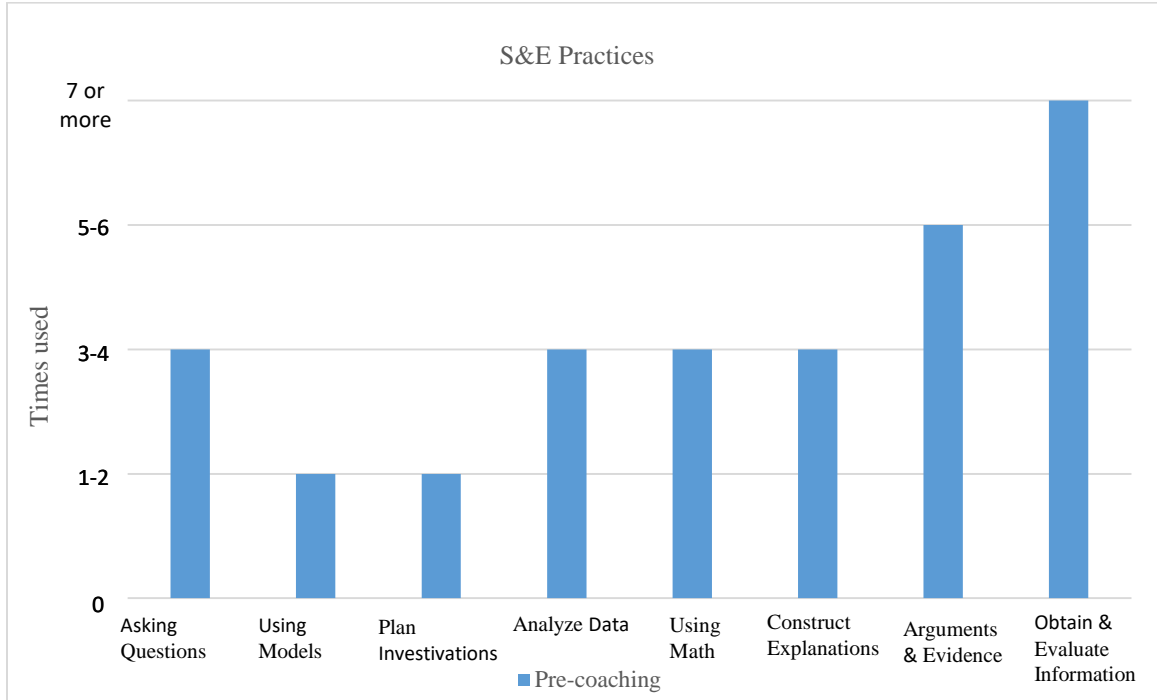
When asked about how she felt using the NGSS she said, “It’s been awhile since I have looked at them, I originally thought they were concepts but they are more like skills, such as using models.” She also said that she had never had any official professional development about NGSS except for what she received from the FOSS kit training.

When asked about how comfortable she is with teaching NGSS and all aspects of it, she again stated that she was slightly uncomfortable (Figure 12). This data was consistent with her pre-coaching interview in which she admitted she did not understand them well, so it’s logical she wasn’t comfortable teaching them. She also stated that if she was teaching them in class that she was doing it unintentionally.



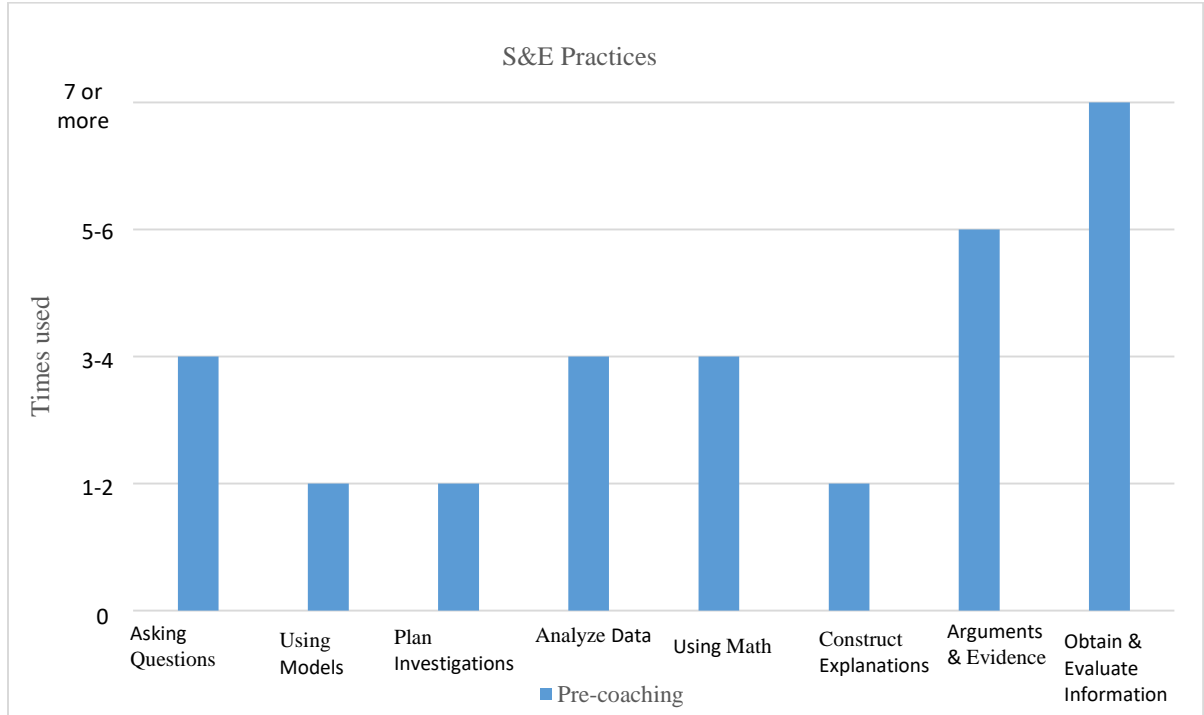
*Figure 12. Teacher B: Pre-coaching survey comfort with NGSS. Scale 1- Very Uncomfortable, 2- Uncomfortable, 3- Slightly Uncomfortable, 4- Slightly Comfortable, 5 – Comfortable, 6- Very Comfortable.*

When looking at how often she uses the S&E practices in class, her survey indicated that four out of the eight practices she felt she used three to four times (Figure 13). She again stated in her pre-coaching interview that if she was using them in class she was doing so unknowingly. Although she did mention two of the practices specifically being used in her class; Models and Analyzing Graphs. She did mention that she thought more of the S&E practices in terms of Engineering rather than Science.



*Figure 13. Teacher B: Pre-coaching survey teacher use of S&E practices.*

Teacher B responded exactly the same way when asked about how often she uses the S&E practices and how often she asks her students to use them (Figure 14). Her responses for how often she asked her students to use them was similar to her uses (Figure 13). She did feel that her students were aware of doing the practices whether they knew explicitly what they were called. She felt that if she asked them about a practice that most students would be able to give her an example.



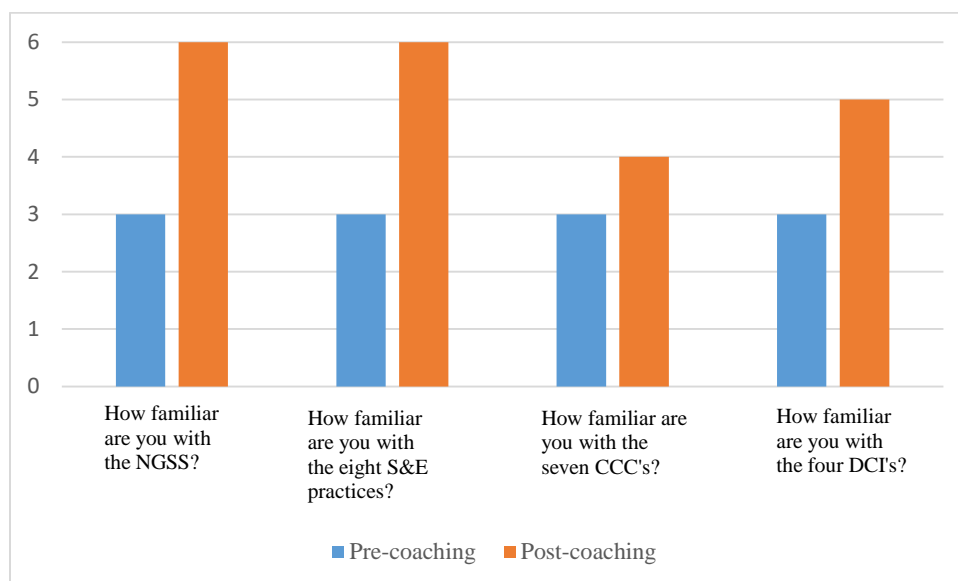
*Figure 14.* Teacher B: Pre-coaching survey of S&E practices use by students asked by teacher.

Based on Teacher B's pre-coaching data, my coaching focus was slightly different. Because Teacher B had some experience with the S&E practices, the intervention would differ slightly from Teacher A and focus on the finer parts of the practices. The format for the four-week coaching cycle was the same for Teacher B as it was for Teacher A. However, instead of looking at just the broad categories of the S&E practices we would look at the bulleted points in the framework (Lee et. al, 2013). Her goal for the 4-week cycle was to understand the S&E practices better so she can use them more intentionally in her class.

During our first week of coaching, knowing she indicated that she had not looked at the S&E practices recently, we spent time discussing and looking over the eight S&E practices. Like Teacher A, I gave her the NGSS website for her as a resource. Again

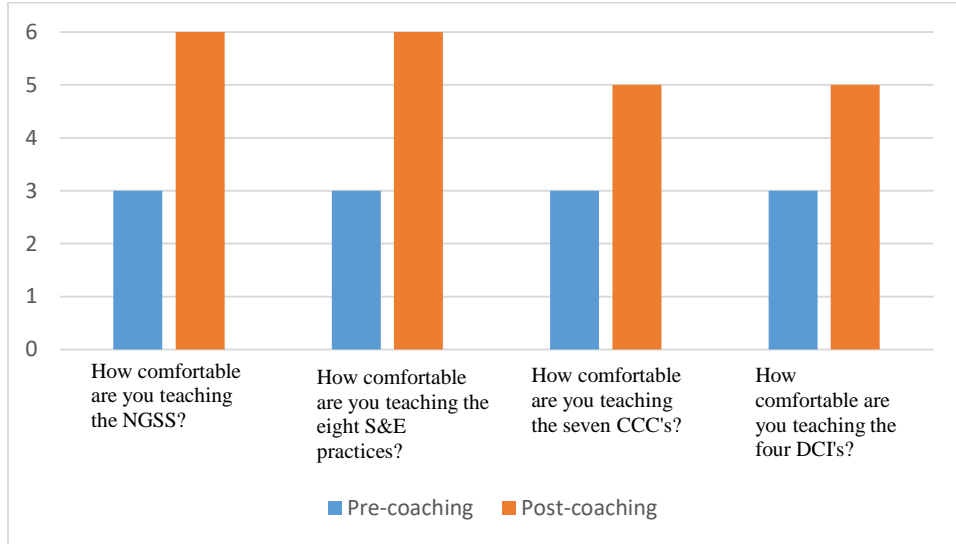
using cognitive coaching, we then discussed what she would be teaching for the next week. I gave Teacher B autonomy and allowed her to choose what practices she wanted to focus on with me giving input. For week one, she chose: Focusing on Asking Questions (for Science), Defining Problems (for Engineering), Constructing Explanations (for Science), and Designing Solutions (for Engineering). To supplement her focuses, I gave her an additional resource. This resource was from Montana State University Podcast in which Paul Andersen talks about asking questions and defining problems specifically (Andersen, date unknown). Following the same procedure as Teacher A, I observed frequency of practice use as well their position on the integration scale followed by a post-lesson reflection. For week two, she focused on Developing and Using Models and also Using Mathematics and Computational Thinking. She wanted to specifically use the terminology for the mathematics practice so that students could relate math to everyday science. For week three, she focused on three of the practices as a result of our discussion. She felt that these practices overlapped and should be used together: Developing and Using Models, Planning and Carrying Out Investigations, Constructing Explanations (for Science), and Designing Solutions (for Engineering). Even though she had focused on two of these practices in prior weeks, she felt strongly that she wanted to focus her lesson on these. In week four, she focused on three of the practices to fit a reading activity. The reading activity, along with the simulation, focused on: Analyzing and Interpreting Data, Engaging in Argument from Evidence, and Obtaining, Evaluating and Communicating information.

After the four-week coaching cycle I again collected data in the form of a post-coaching survey and interview. When looking at her data about her familiarity with NGSS, she indicated that she became very familiar with both the NGSS standards and the S&E practices (Figure 15). She was slightly comfortable with the Crosscutting Concepts and the Disciplinary Core Ideas. This fits with the intervention of focusing on the S&E practices. This also fits with her post-coaching interview in which she stated, “I know better what they are and what they look like.”



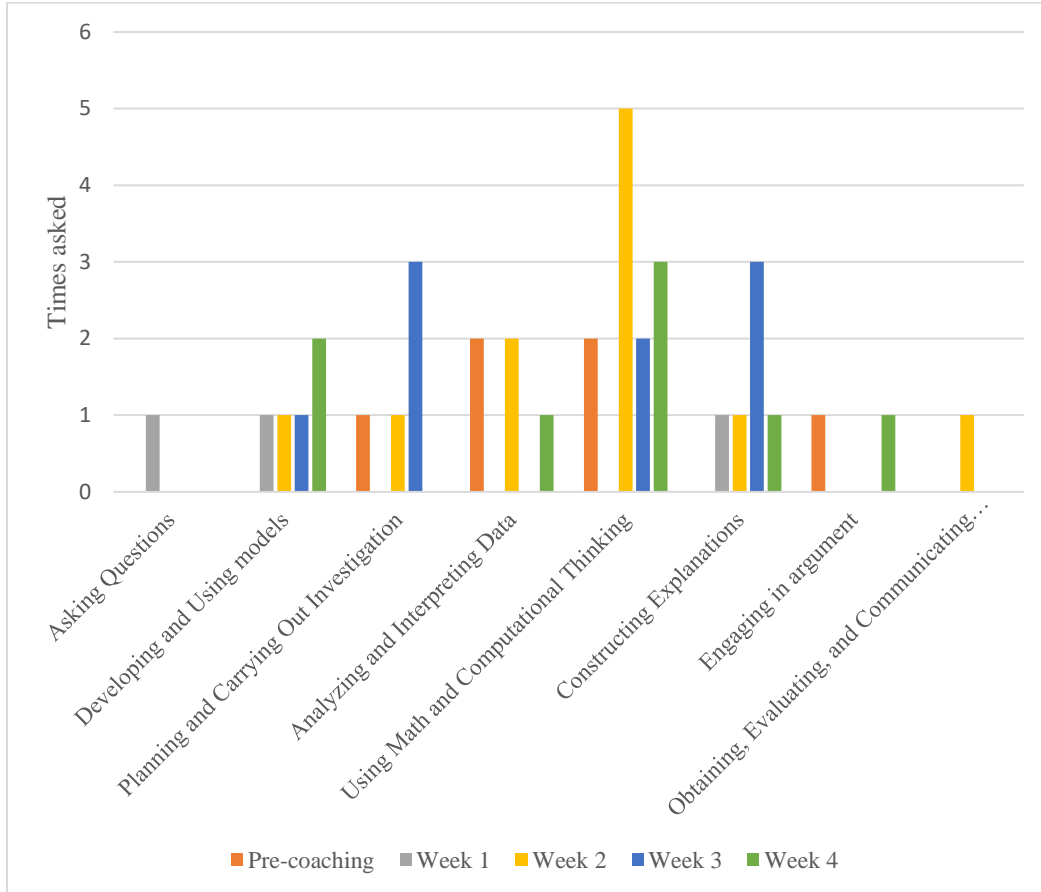
*Figure 15.* Teacher B: Pre-coaching vs. post-coaching survey familiarity with NGSS Scale 1- Very Unfamiliar, 2- Unfamiliar, 3- Slightly Unfamiliar, 4- Slightly Familiar, 5 – Familiar, 6- Very Familiar.

When looking at the data for her comfort level in teaching the parts of the NGSS, she shifted to very comfortable for the NGSS and S&E practices and comfortable with the Crosscutting Concepts and Disciplinary Core Ideas (Figure 16). In her post-coaching interview, she was much more purposeful with her lessons specifically about the S&E practices, so she felt more comfortable teaching them.



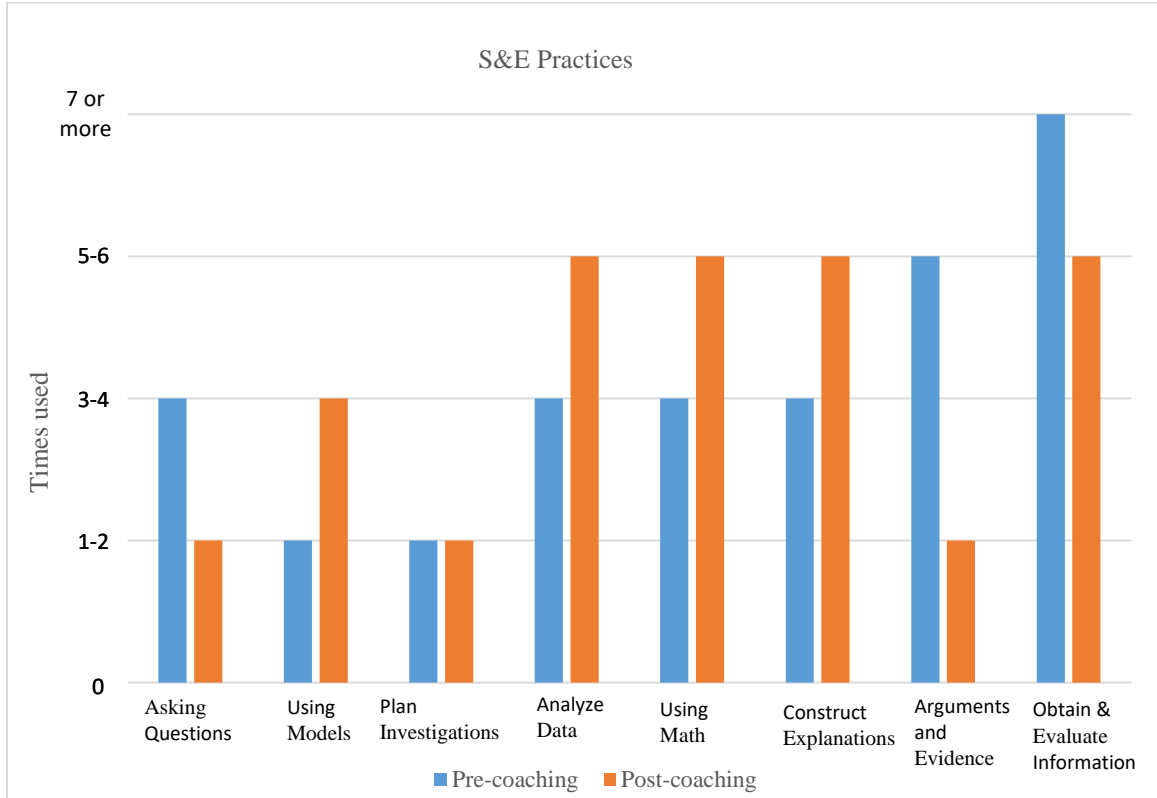
*Figure 16. Teacher B: Pre-coaching vs. post-coaching survey comfort with NGSS. Scale 1- Very Uncomfortable, 2- Uncomfortable, 3- Slightly Uncomfortable, 4- Slightly Comfortable, 5 – Comfortable, 6- Very Comfortable.*

During the four-week coaching cycle, Teacher B explicitly worked to incorporate the terminology and the implementation of the practices in her class. During my pre-observation of her class, Teacher B used four of the practices, yet all four practices were rated a zero on the quantitative scale of integration (see Appendix F). Progressing through the four weeks, there was a shift in the level of integration of her practices. All practices she used after coaching started were always at least a one on the scale (Figure 17). At least three of the times she used a practice, she was three on the scale with full integration of the S&E practice. The frequency of the practices used in her class dipped in week one and then increased weeks two, three, and four. Again, however the level of integration was higher in weeks one through four than in her pre-observation.



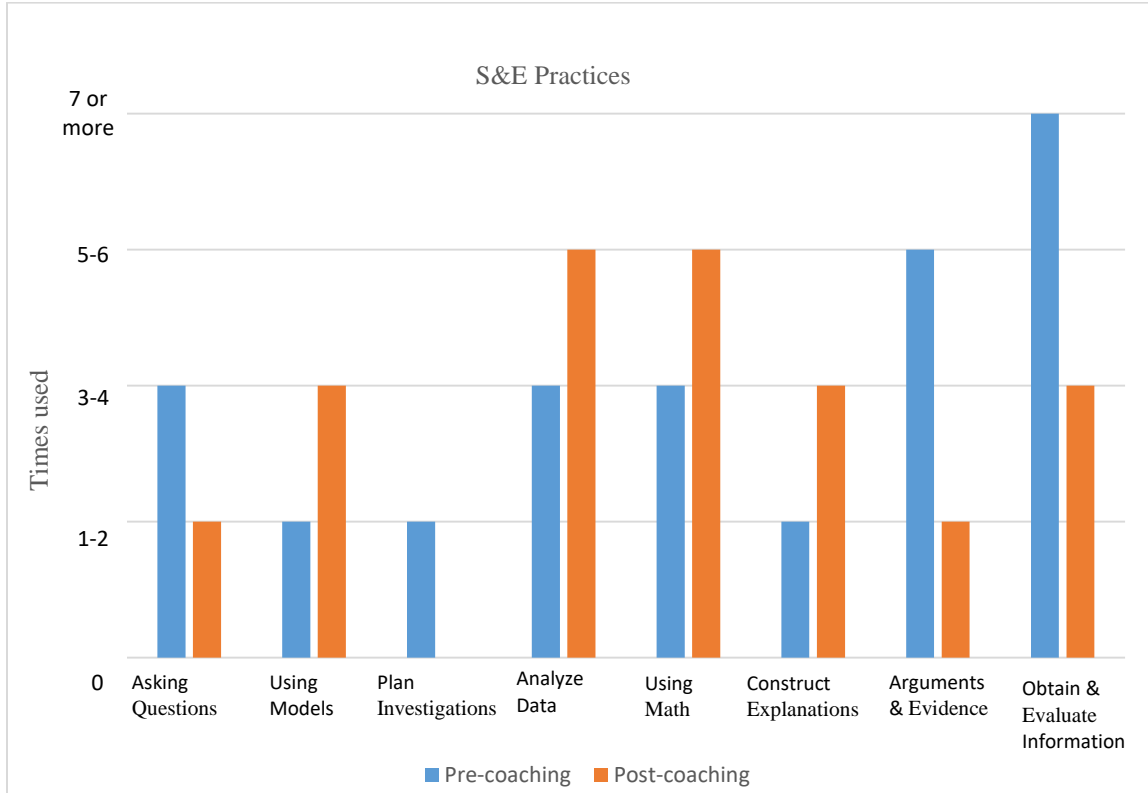
*Figure 17.* Teacher B: Frequency of observed use during four-week coaching cycle.

On her post-coaching survey, when asked about how often she used the practices in her class, she indicated that she used five of the practices more frequently. However, one of the practices did not change in its frequency and one practice she felt she actually used less (Figure 18). In her post interview, she said that just having the awareness of the S&E practices helped her to use them more frequently.



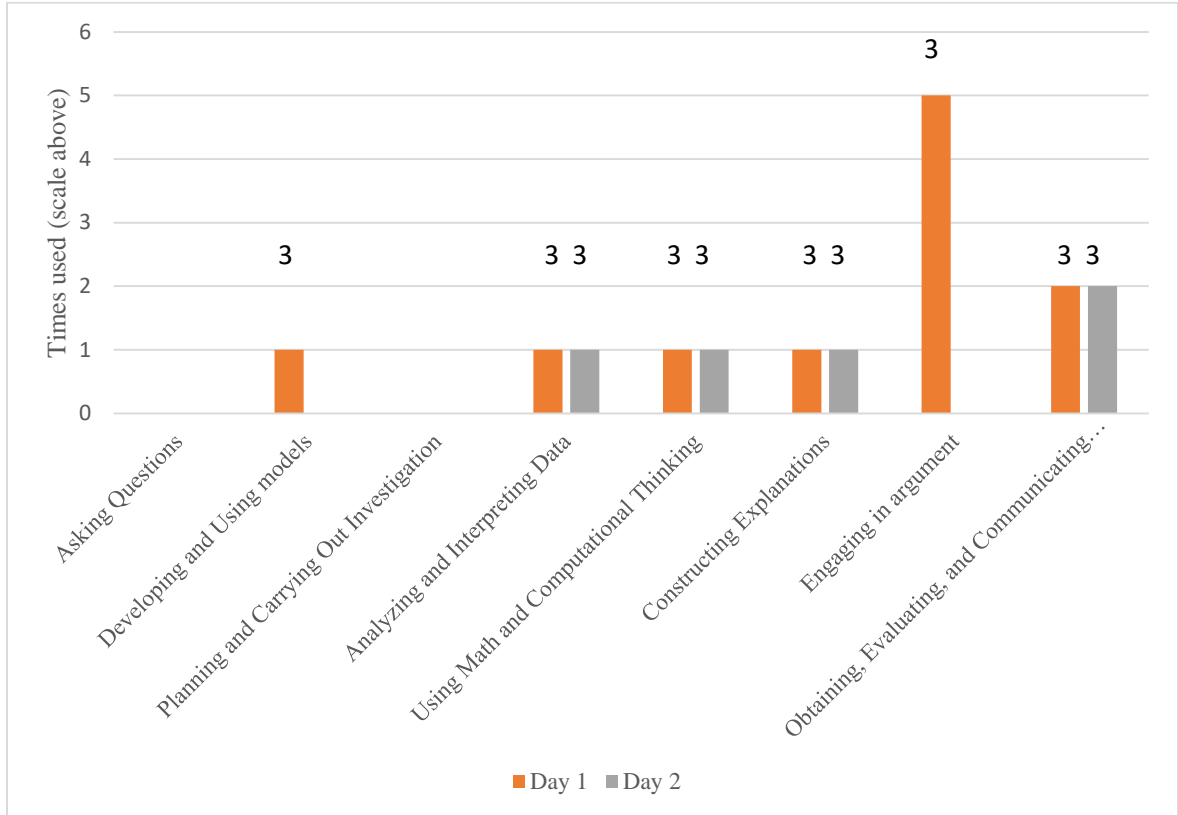
*Figure 18.* Teacher B: Pre-coaching vs. post-coaching survey teacher use (frequency) of S&E practices.

The data from her pre and post-coaching survey on how often she asked students to use the practice was a little less positive. She felt that she used only asked her students to use four of the practices more after the coaching cycle. Three of the practices she felt she asked her students to use less (Figure 19).



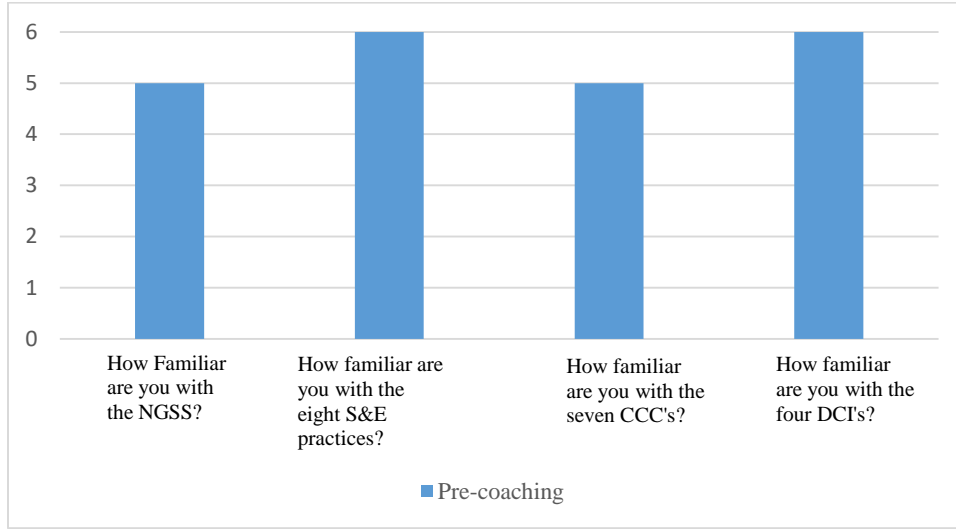
*Figure 19.* Teacher B: Pre-coaching survey vs. post-coaching of S&E practice use by students asked by teacher.

For the one-month post-coaching observation, the data showed that Teacher B was still using the S&E practices in class (Figure 20). Day one she used the practices ten times with a scale integration of three. She was specifically using the terminology in her lesson. On the second day of observations she used the practices five times. Calculations from weeks one through four showed an average of 7.75 practices per class. Compared to day one, she was above her average during the coaching intervention. On day two, she was below her average. Again, her scale integration was a three except for Using Mathematics, which was a two on the integration scale.



*Figure 20.* Teacher B: Post-observation 1 month for frequency and integration scale.

Teacher C's coaching cycle took place in his Chemistry course for Juniors and Seniors. Following the same procedure as Teacher A and B, I found that on his pre-coaching data Teacher C was already very familiar with all aspects of NGSS (Figure 21).



*Figure 21. Teacher C: Pre-coaching survey: familiarity with NGSS. Scale 1- Very Unfamiliar, 2- Unfamiliar, 3- Slightly Unfamiliar, 4- Slightly Familiar, 5 – Familiar, 6- Very Familiar.*

This was consistent with his pre-coaching interview in which he felt perfectly confident with NGSS. He had taught previously in the state of Illinois and they were one of the first to adopt the NGSS. He also did extensive training of curriculum mapping with conjunction of the NGSS. In addition, he took an online graduate course specifically related to the NGSS. He also attends the Science Teacher Conference annually and gets professional development from there as well.

His pre-coaching data also showed he was comfortable teaching all aspects of the NGSS (Figure 22). This was consistent with the information that he provided for all his professional development he had been involved in with the NGSS over his teaching career.

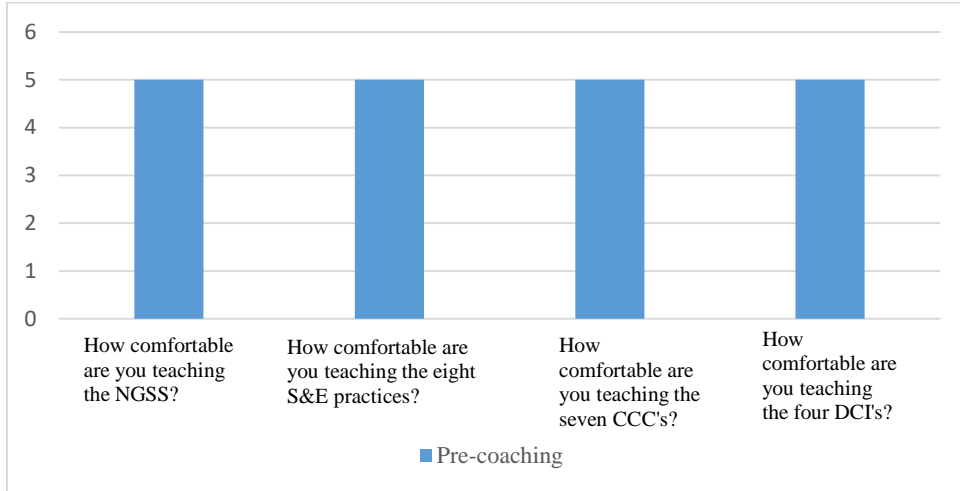


Figure 22. Teacher C: Pre-coaching survey comfort with NGSS. Scale 1- Very Uncomfortable, 2- Uncomfortable, 3- Slightly Uncomfortable, 4- Slightly Comfortable, 5 – Comfortable, 6- Very Comfortable

When asked about how frequently he used the practices in his classroom, he indicated that he used two of the practices 7 or more times but two of the practices zero times. The remaining four he said he used one to two times (Figure 23).



Figure 23. Teacher C: Pre-coaching survey teacher use of S&E practices.

He indicated the same data when asked about how often he has his students to do the practices except for the practice Obtaining, Evaluating, and Communication Information. He indicated that he asked his students to do it three to four times where as he only used the practice one to two times in his class (Figure 24).

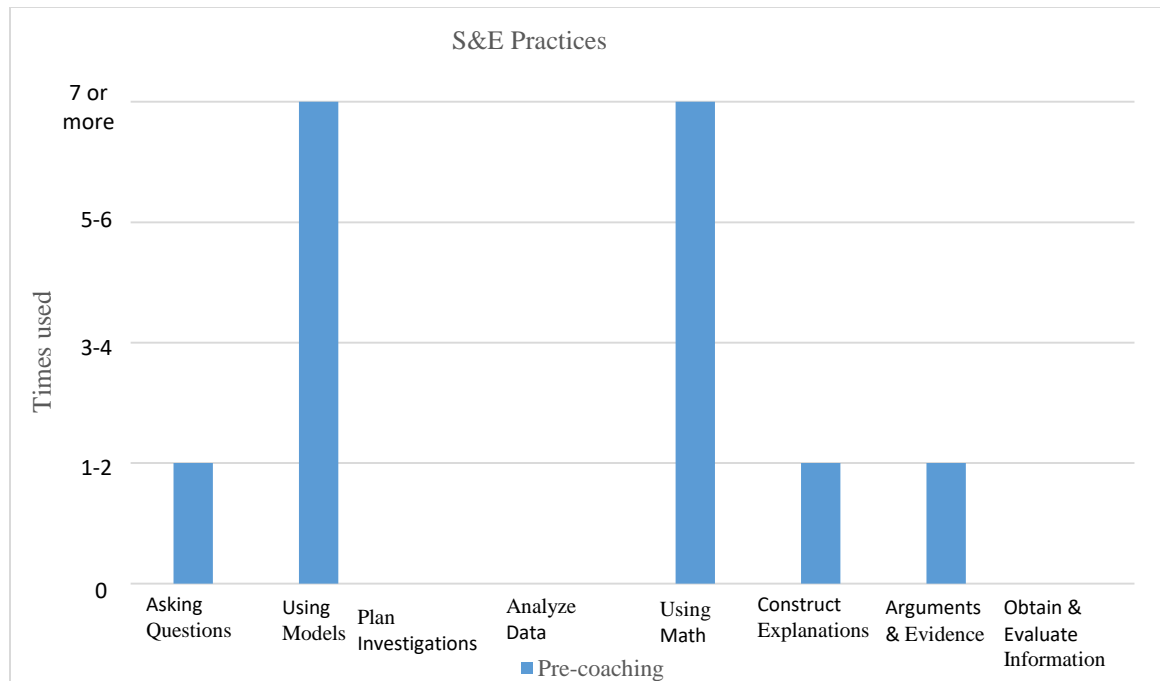


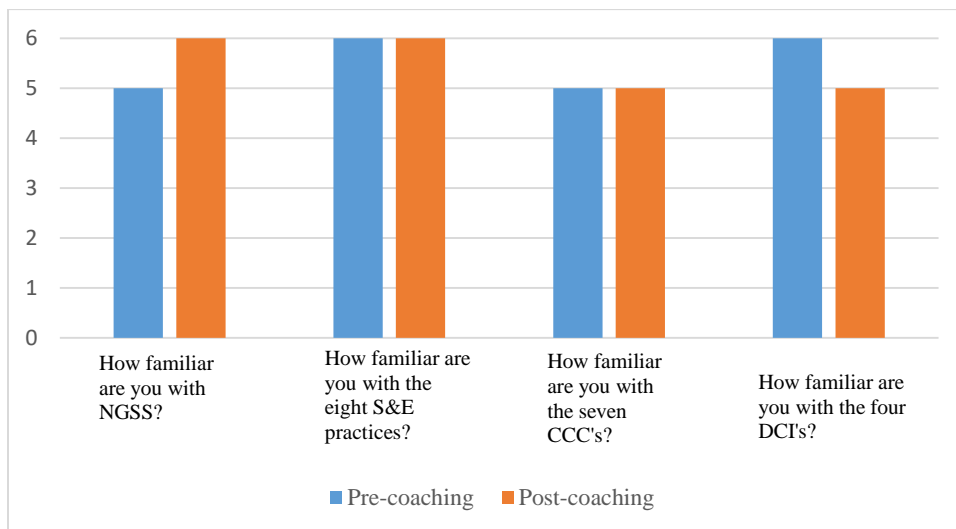
Figure 24. Teacher C: Pre-coaching survey of S&E practices use by students asked by teacher.

Again, based on Teacher C's pre-coaching data, my coaching intervention focus was again different than with Teachers A and B. Teacher C already had an in-depth knowledge of the S&E practices. The focus for his intervention would be helping Teacher C match the lesson to the practice where he used traditional teaching methods, such as lecturing, to non-traditional methods where students lead the conversations and explanations. His goal was to scaffold the practices. He did tell me in his pre-coaching interview that working with the practices in the past, he rarely used the NGSS specific language of the S&E practices but used more "student friendly terms." Therefore, his

focus wasn't on explicitly talking about the practice, but more on aligning his lessons with the practices. Even though he had significant knowledge of S&E practices, I used the same format as with Teacher A and B. Teacher C also received the same resources as Teachers A and B. We did reference an additional resource during Teacher C's coaching cycle. We used the NGSS standard about Matter and its Interaction (National Academy of Science 2013). Due to the fact that Teacher C had background knowledge on the S&E practices, his goal was to focus the practices very specifically to his lesson. His wealth of background knowledge let us hone in on several practices each week. During week one, Teacher C focused on the practices: Developing and Using Models, Analyzing and Interpreting Data, and Engaging in Arguments from Evidence. With the science practices in mind, Teacher C asked me to look for other things as well. He asked me to specifically pay attention to the science vocabulary that the students were using. He wanted data on the students using domain specific vocabulary and their ability to create conversations on the topic. In week two, he focused on: Using Mathematics and Computational Thinking, Constructing Explanations (for science), and Designing Solutions (for engineering), and Obtaining, Evaluating and Communication information. For this week, he asked me to focus on if groups were relying on just one person to answer the questions or if they were working together to solve the problem. He also asked me again to listen for if the science terminology was being used and if it was being used correctly. In week three, we looked at: Planning and Carrying Out Investigations, Asking Questions, Analyzing and Interpreting Data, and again Using Mathematics and Computational Thinking. This week he asked me to see if students were actually grasping the idea that the atoms were

rearranging and not just plugging in a number for a formula. He wanted to see if there was application to the concept. He also wanted to see if they understood that a chemical reaction is actually the rearranging of atoms and not just moving numbers around. Week four revolved around Planning and Carrying Out an Investigation and again Using Mathematics and Computational Thinking. This week he wanted to check if students were bringing all prior knowledge together in order to do the Stoichiometry lab.

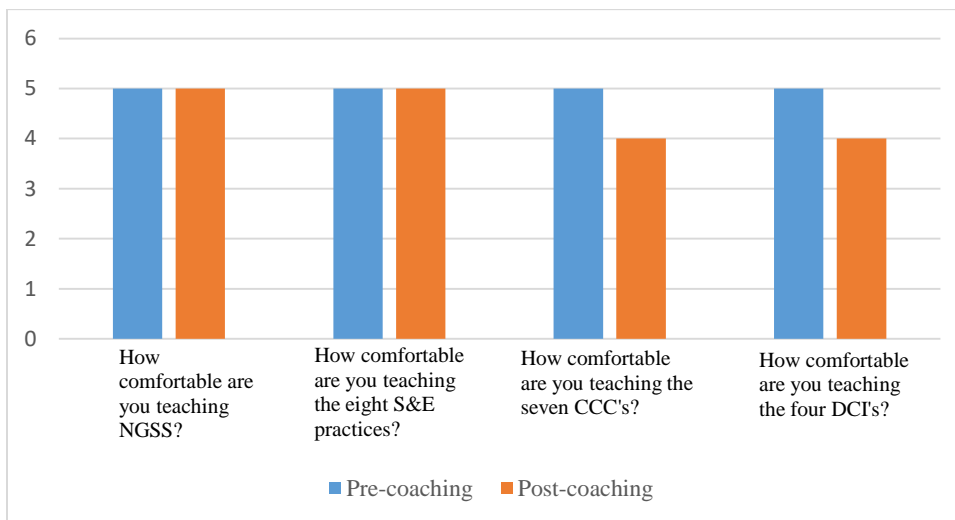
According to his post-coaching survey results, his data showed that he increased his familiarity with the NGSS standards but stayed the same in terms of the S&E practices (Figure 25). He also indicated that he was less familiar with the Disciplinary Core Ideas than before. Overall, the data changed very little from his pre-coaching to his post-coaching.



*Figure 25.* Teacher C: Pre-coaching vs. Post-coaching survey familiarity with NGSS Scale 1- Very Unfamiliar, 2- Unfamiliar, 3- Slightly Unfamiliar, 4- Slightly Familiar, 5 – Familiar, 6- Very Familiar.

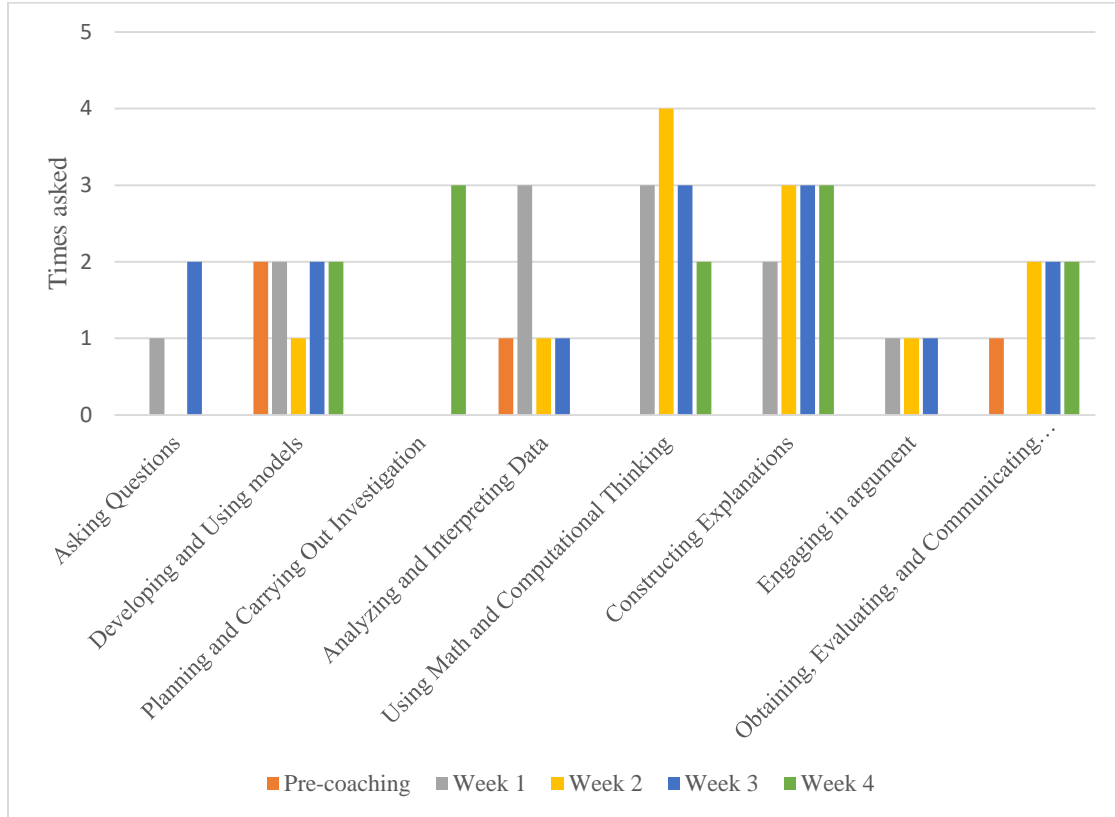
When looking at his comfort level, his post-coaching survey indicated that he was actually less comfortable with the Crosscutting Concepts and the Disciplinary Core Ideas

than before coaching (Figure 26). However, in his post-interview, he stated that he had gotten complacent with his teaching of the same material and was glazing over the practices. The coaching cycle helped him think more about the practices and focus on them specifically. He also stated that with each week he specifically focused his lessons on the practices with more specific goals in mind, whereas before he just “threw everything at them at once.”



*Figure 26.* Teacher C: Pre-coaching vs. post-coaching survey comfort with NGSS. Scale 1- Very Uncomfortable, 2- Uncomfortable, 3- Slightly Uncomfortable, 4- Slightly Comfortable, 5 – Comfortable, 6- Very Comfortable.

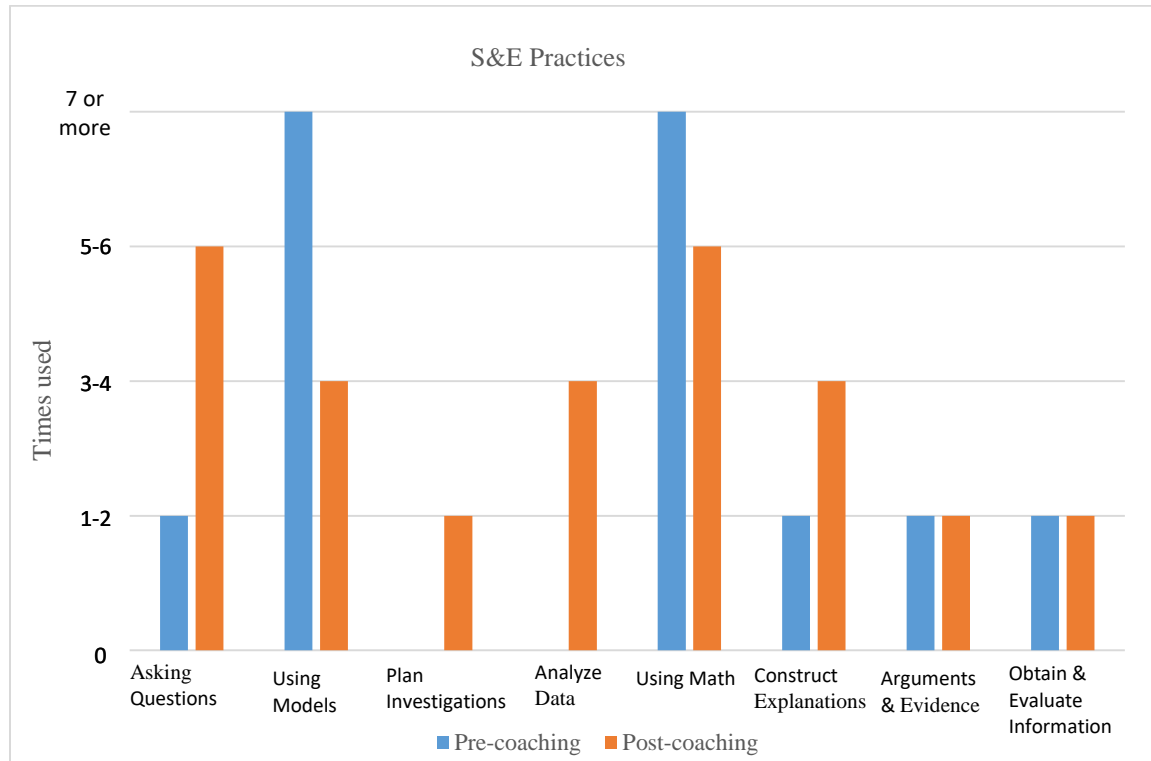
On his pre-coaching classroom observation in terms of the frequency, he used the practices while teaching four times. During the four-week cycle, the number of times he used the practices increased (Figure 27). His average for the four weeks was 11.75 uses per observation. During his pre-observations, the scale integration was 1 or 2. During the coaching cycle, all practices were integrated with a scale of 2 or 3.



*Figure 27. Teacher C: Frequency of observed use during four-week coaching cycle.*

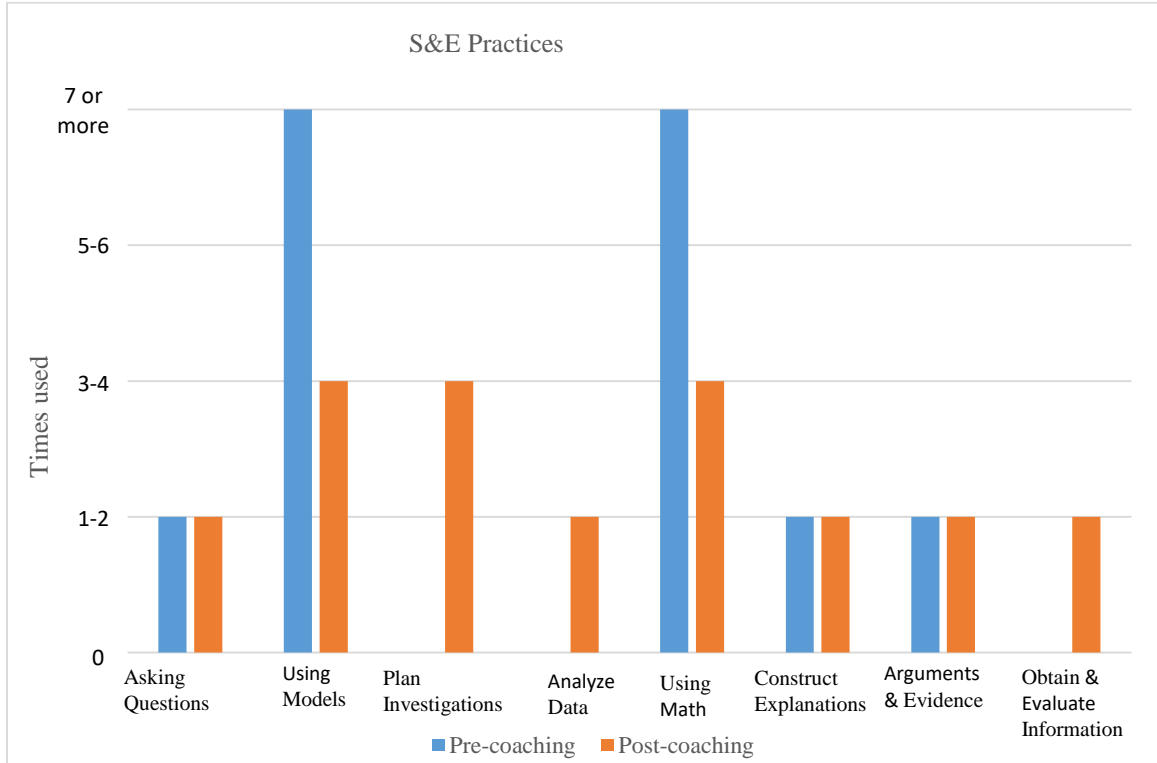
When looking at the data of how often he used the practices in his class, he brought to my attention a couple of things. First, while students were taking the post-coaching survey about how often their teacher asked them to do the practice, they asked why there was a choice of seven or more. They understood my survey to mean that if he asked them to do it once during class, it counted as one, even if he brought up the practice in class later. He also felt the same when he was doing his survey. I, however, would count each time a practice was brought up in class. He brought to my attention that a clear definition of what a “count” was for the teachers and students might have helped to make sure that my data was not skewed based on misinterpretation. His post-coaching data

showed that of the eight practices, he felt he used three of them more, two less, and three of the practices stayed the same (Figure 28).



*Figure 28.* Teacher C: Pre-coaching vs. post-coaching survey teacher use (frequency) of S&E practices.

When asked on his post-coaching survey about the frequency he asked his students to use the practices in class, three of the practices stayed the same, three went down (Figure 29). This data could be skewed due to the misinterpretation of the survey brought to my attention by Teacher C. In his post-survey he again stated that the coaching cycle helped him to reinforce the S&E practices. He also stated he feels he teaches better when there is another adult in the room. He felt that was the true value of the coaching is that he feels he is able to teach something to that other adult in the room.



*Figure 29.* Teacher C: Pre-coaching survey vs. post-coaching of S&E practice use by students asked by teacher.

For the one-month post-coaching observation, the data showed that Teacher C was still using the S&E practices in class (Figure 30). Day one of the post observation he used the practices fifteen times with a scale integration of two and three. On the second day of observations he used the practices ten times with a scale integration of two and three. Calculations from weeks one through four showed an average of 11.75 practices per class. Compared to day one, he was above his average during the coaching intervention using fifteen. On day two, he was just below his average with ten. Again his scale integration was either a two or a three.

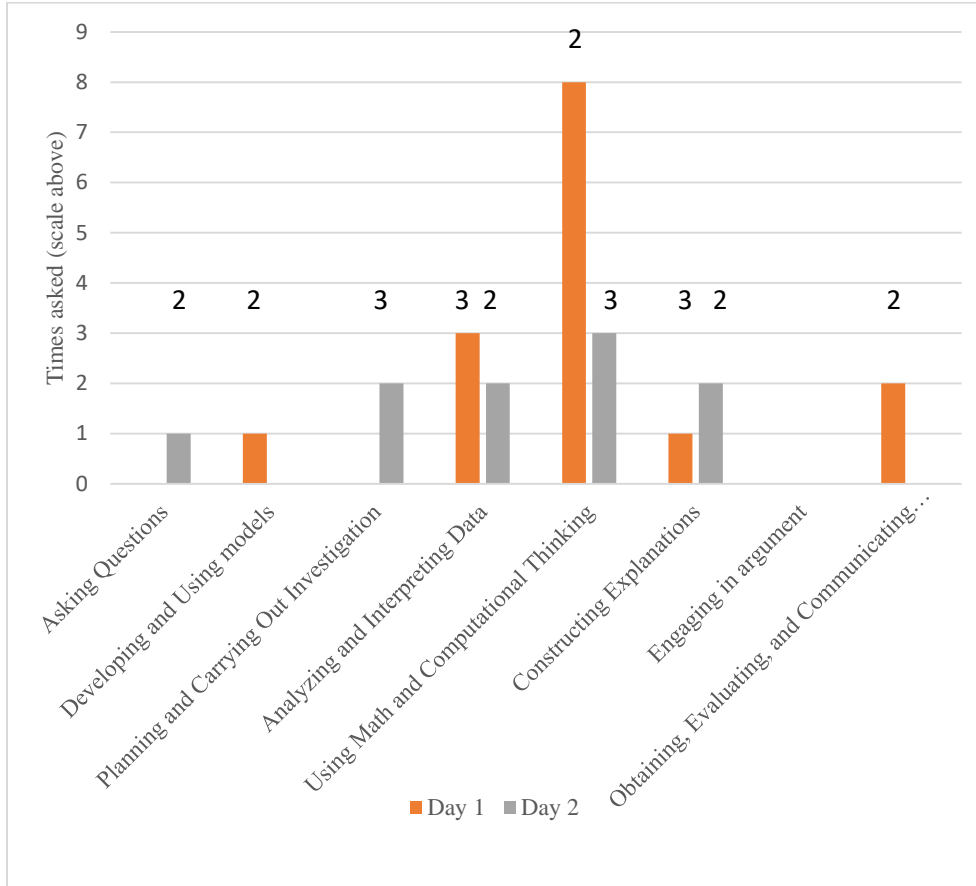
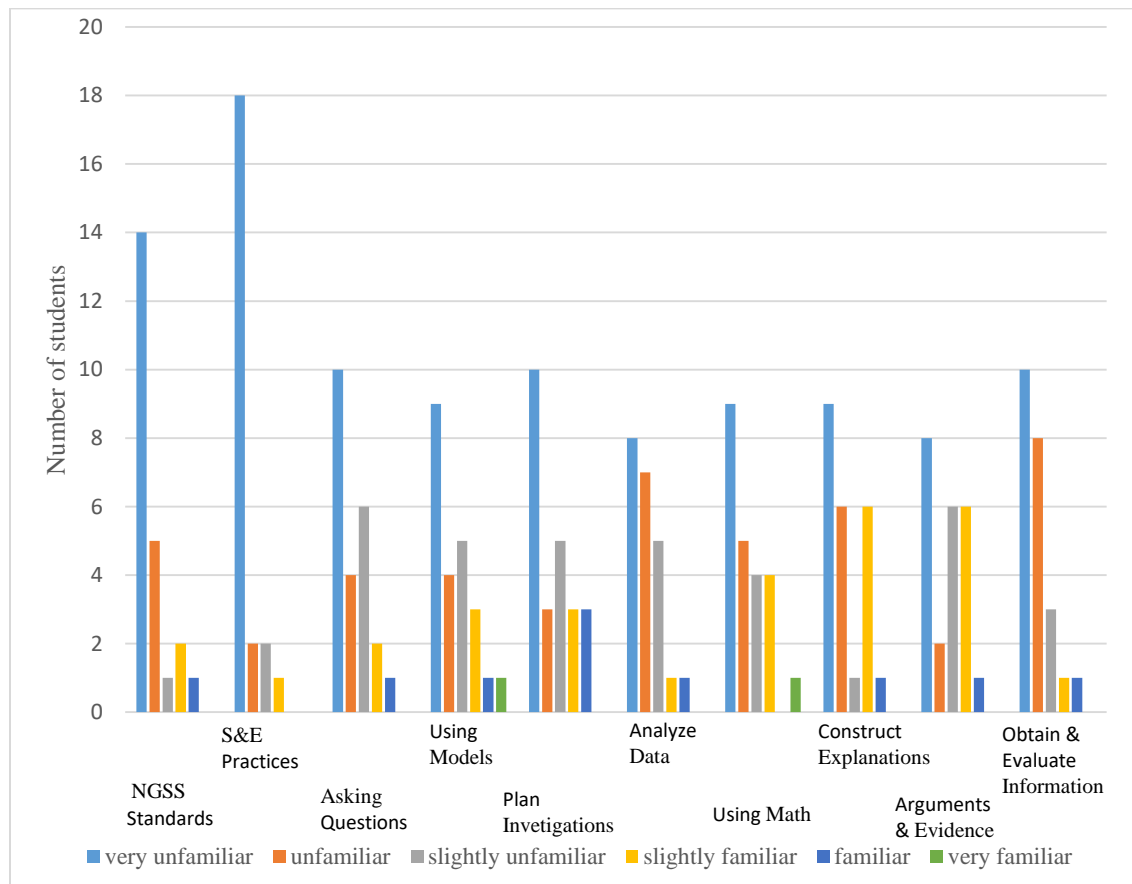


Figure 30: Teacher C: Post-observation 1 month for frequency and integration scale.

The following section is the data collection analysis from the students during the intervention. Teachers A, B, and C were asked to give surveys to their students before and after their coaching cycles. The number of students polled in Teacher A's class was 23, Teacher B surveyed 22 students, and Teacher C surveyed 13 students. In addition, a total of 12 interviews were done by me, four from each class. Students were carefully selected to include a wide range of academic, economic, social, and ethnic backgrounds. The overall number of student surveyed was 58.

Ten questions were asked about the NGSS and eight questions were asked about the S&E practices (Appendix D). Figure 31 shows the results of how familiar or unfamiliar students were with the S&E practices.



*Figure 31:* Pre-coaching survey given to students in Teacher A's classroom ( $N=23$ ) about familiarity with NGSS and the S&E practices. (Appendix D).

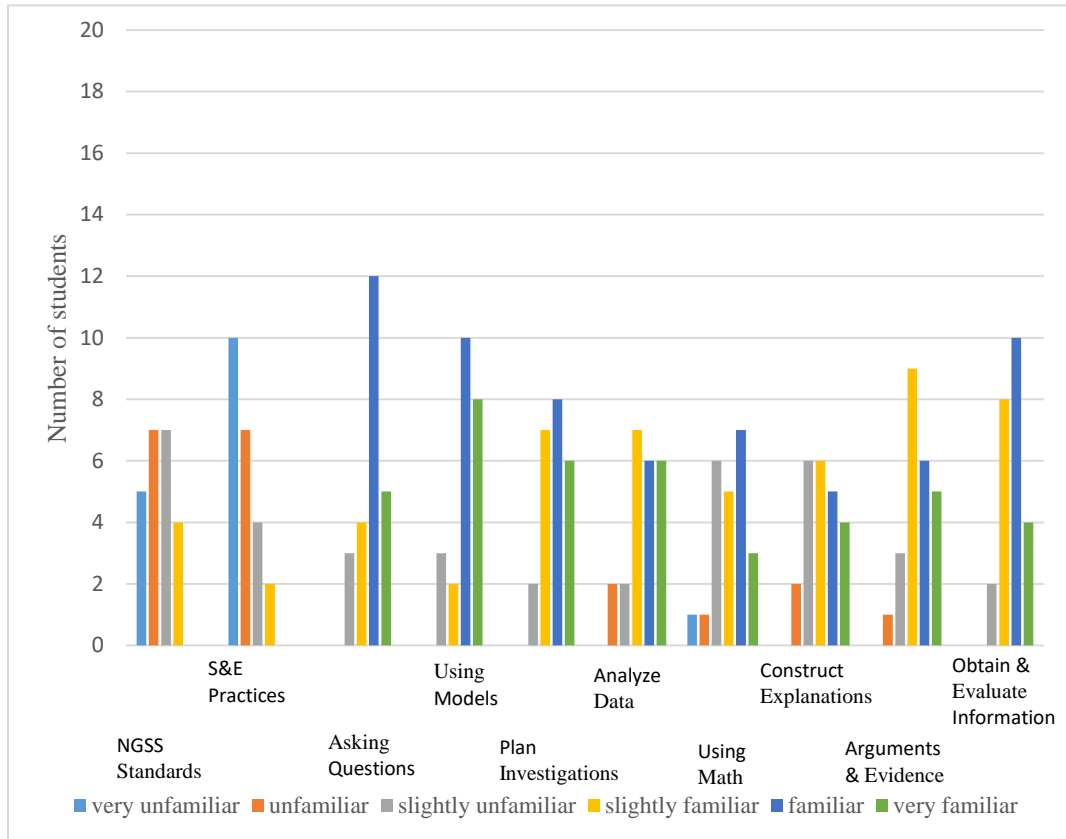
In Teacher A's classroom, the majority (60%) of students were very unfamiliar with the NGSS standards (question 1). When asked about their familiarity with the S&E practices, 78% said they were very unfamiliar (question 2). When asked specifically about the practice Asking Question (for Science) and Defining Problems (for Engineering) 43% were very unfamiliar (question 3). When asked about the practice Developing and Using Models 39% were very unfamiliar (question 4). The practice

Planning and Carrying Out Investigations found that 43% were very unfamiliar (question 5). When looking at the data for Analyzing and Interpreting Data only 35% were very unfamiliar (question 6). Question 7 asked about the practice Using Mathematics and Computational Thinking again 39% were very unfamiliar. Question 8 asked about the practice Constructing Explanations (for Science) and Designing Solutions (for Engineering) the survey indicated again that 39% were very unfamiliar. When looking at the practice Engaging in Argument from Evidence (question 9) only 35% were very unfamiliar and question 10 the practice of Obtaining, Evaluating, and Communicating information showed 43% of students were unfamiliar. However, when looking at if students were slightly familiar, familiar, or very familiar with any of the practices the highest percentage was 26%.

These data were consistent with the pre-coaching interviews which students did before intervention (Appendix E). When I asked the four students to give me a definition and an example of each of the practices, many stated that they didn't know or gave an explanation or an example that didn't fit the practice. Specifically, when asked about practice number 1, Asking Questions, all four students stated that this meant that if they didn't know how to do something they asked their teacher for clarification. Only one student was able to give me a decent answer about Developing and Using Models. She said that it meant, "creating miniature versions of something." Three of the four students did not have any idea what Planning and Carrying Out Investigations and the four students stated that it was like a "murder investigation and figuring out who the suspect is by getting fingerprints." Only one of the four students was able to give me an adequate

definition and example of Analyzing and Interpreting Data, whereas the others stated they didn't know. There were two students who could give adequate answers for the Math practice, although all students told me they did not know what Computational Thinking was. All four were unsure about Construction Explanations, but two of the four could give a good example and definition about Engaging in Arguments from Evidence. In fact, one student said that you create a theory, listen to other peoples' theories, and then try and explain why you think your theory is correct based on your evidence. All four were unsure as to what Obtaining, Evaluating, and Communication Information meant.

After the four-week intervention, students again in Teacher A's class were given a post-survey asking about their familiarity with the S&E practices (Appendix C). Looking at the data, you can see a shift in students' familiarity with most of the practices (Figure 32). Before, only practice 4 and 7 had any students that said they felt very familiar with the practice. On the post-coaching survey, questions 3-10 had some students who indicated being very familiar with these practices. Question 3 (Planning and Carrying Out Investigations) had an increase of 51.59% in familiarity.

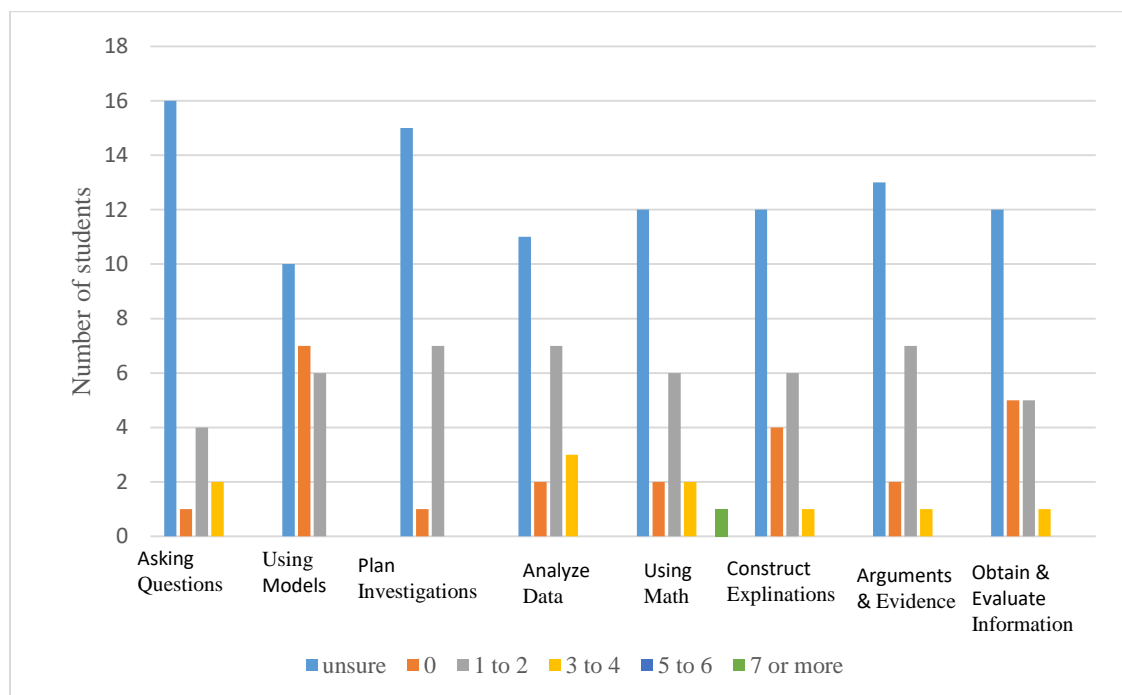


*Figure 32.* Teacher A: Post-coaching survey given to students ( $N = 23$ ) about familiarity with NGSS and the S&E practices.

However, during post interviews, there seemed to be only minimal gains in being able to explain and give examples. Again, for the practice Asking Questions, no students were able to revise their answer to what the practice actually meant. Again, all four stated that it was when you needed help you asked the teacher. All students were able to give adequate answers for Developing and Using Models, but all were unsure of a definition or example of Planning and Carrying Out Investigations, even though during the post-coaching survey, there was a significant increase in how familiar the students felt about this practice. In practices 4-7, students actually were less sure about definitions and examples, but were able to provide good explanations about Engaging in Arguments

from Evidence. No gains were made for the final practice of Obtaining, Evaluating, and Communicating Information.

Data was also collected on the number of times the teacher asked the student to do each S&E practice in class in the last week (Figure 33). Data here was also consistent with the interviews particularly with practice one, Asking Questions, 70% were unsure. Most of the practices had high percentages of



*Figure 33.* Teacher A: Pre-coaching survey given to students about how often they were asked by teacher to use the S&E practices in class in the last week ( $N=23$ ).

students who were unsure if their teacher had asked them to do the practice in class. This would fit with the other data collected from students who seemed unsure about the practices.

Data collected after the four-week intervention showed an increase in the number of times students felt their teacher asked them to use the S&E practices in class (Figure 34).

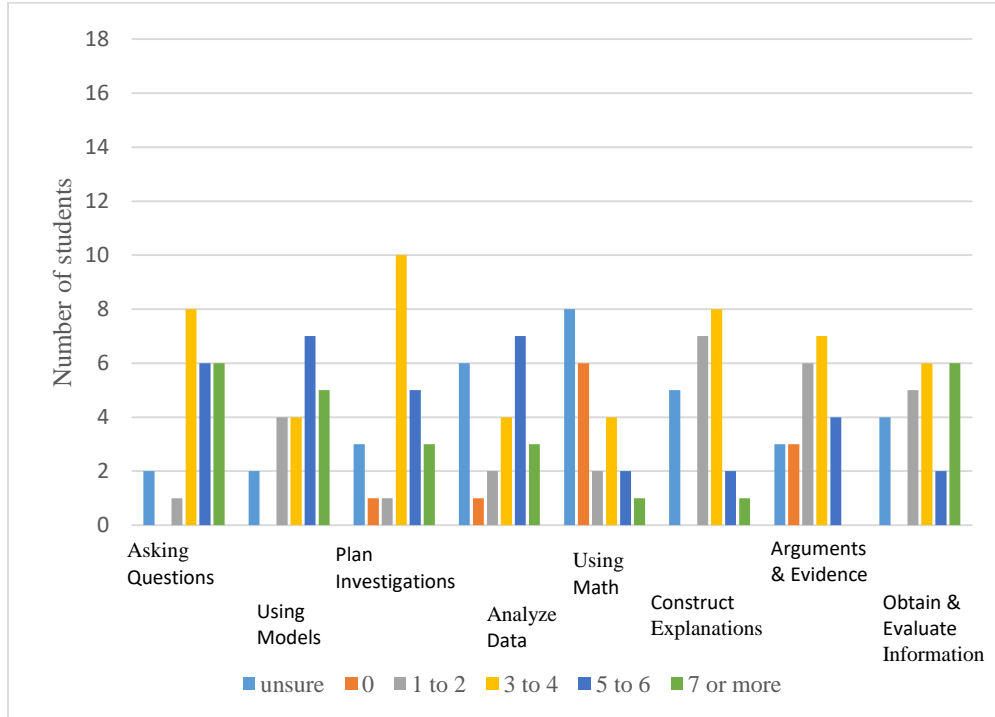
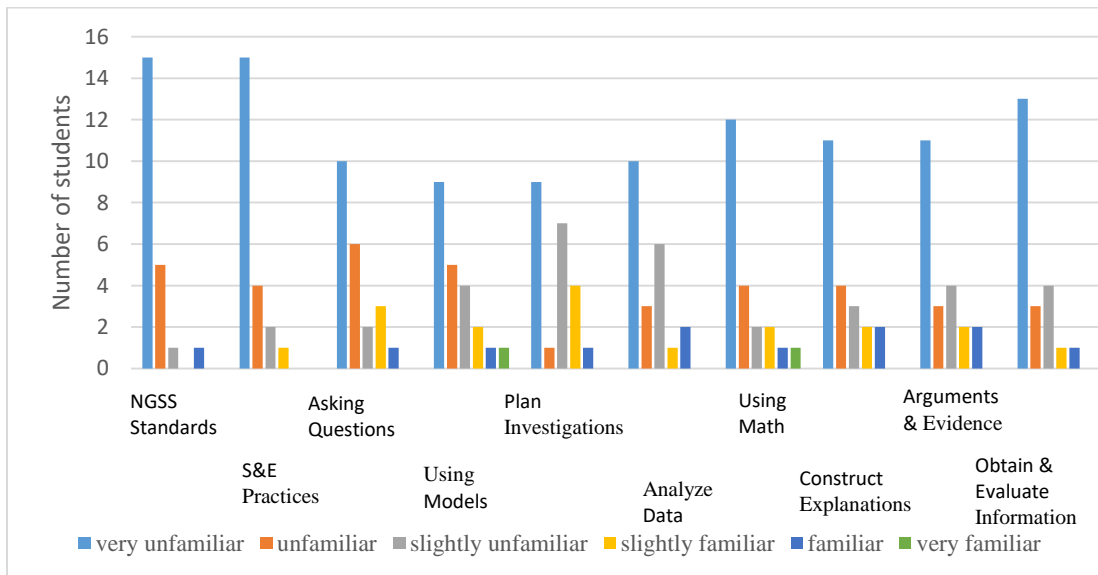


Figure 34. Teacher A: Post-coaching survey given to students about how often they were asked by teacher to use the S&E practices in class in the last week ( $N = 23$ ).

The same polling and interviewing procedure was used for Teacher B (Figure 35).

In Teacher B's classroom, the majority (36%) of students were very in some way unfamiliar with the NGSS standards (question 1). When asked about their familiarity with the S&E practices, 36% said they were very unfamiliar (question 2). When asked specifically about the practice Asking Questions (for science) and Defining Problems (for engineering), 36% were very unfamiliar (question 3). When asked about the practice Developing and Using Models, 27% were very unfamiliar (question 4). The practice Planning and Carrying Out investigations found that 22% were very unfamiliar (question 5). When looking at the data for Analyzing and Interpreting Data, only 22% were very unfamiliar (question 6). Question 7 asked about the practice Using Mathematics and Computational Thinking. Again, 32% were very unfamiliar. Question 8 asked about the

practice Constructing Explanations (for science) and Designing Solutions (for engineering). The survey indicated again that 22% were very unfamiliar. When looking at the practice Engaging in Argument from Evidence, (question 9) only 22% were very unfamiliar. Question 10, the practice of Obtaining, Evaluating, and Communicating information, showed 27% of students were unfamiliar. The data indicated that these 9<sup>th</sup> grade students had more knowledge of the practices than the 6<sup>th</sup> graders in Teacher A's class. This would make sense as this class has had more science experience. However, when looking at if students were slightly familiar, familiar, or very familiar with any of the practices, the highest percentage was 27%. This was only a 1% increase from Teacher A's students.



*Figure 35. Teacher B: Pre-coaching survey given to students ( $N = 22$ ) about familiarity with NGSS and the S&E practices.*

During the interviews with the four students, the answers given were only slightly better than the students in Teacher A's class (Appendix E). As with Teacher A, when specifically asked about practice number 1, Asking for Questions, all four students stated

that this meant that if they didn't know how to do something they asked their teacher for help. Three students were able to give me a decent answer about Developing and Using Models. One said that it meant "building the stuff that isn't the actual thing without the danger of the actual real stuff." None of the four students were able to give adequate answers to what Planning and Carrying Out Investigations. One student said that "it meant to be observant"; another said "to take notes." Three of the four students were able to give me an adequate definition and example of Analyzing and Interpreting Data. The three students all mentioned graphing and one student said that "it's making graphs and using the data to better understand what's related to the graph and what it means." Only one student was able to give an explanation of the practice Using Mathematics and Computational Thinking where they told me about multiplying and dividing for a lab. The other three stated they didn't know. Two students were able to explain and give examples about Constructing Explanations. A student gave an example of if there was a plane crash, you would have to figure out what happened, such as if a bridge failed that engineers would need to figure out the problem and find a solution. This was the only student in all the interviews that brought up an example of both the science and engineering to this practice. Three of the four could give a good example and definition about Engaging in Arguments from Evidence. One student said that "you think you are right and get facts to back up it with evidence." Two said were unsure as to what Obtaining, Evaluation, and Communicating Information. One felt it was writing stuff in a notebook and another thought it was talking to important people to get information.

Data from students for Teacher B on the post-coaching survey indicated that there was again a positive shift in their familiarity with the practices (Figure 36).

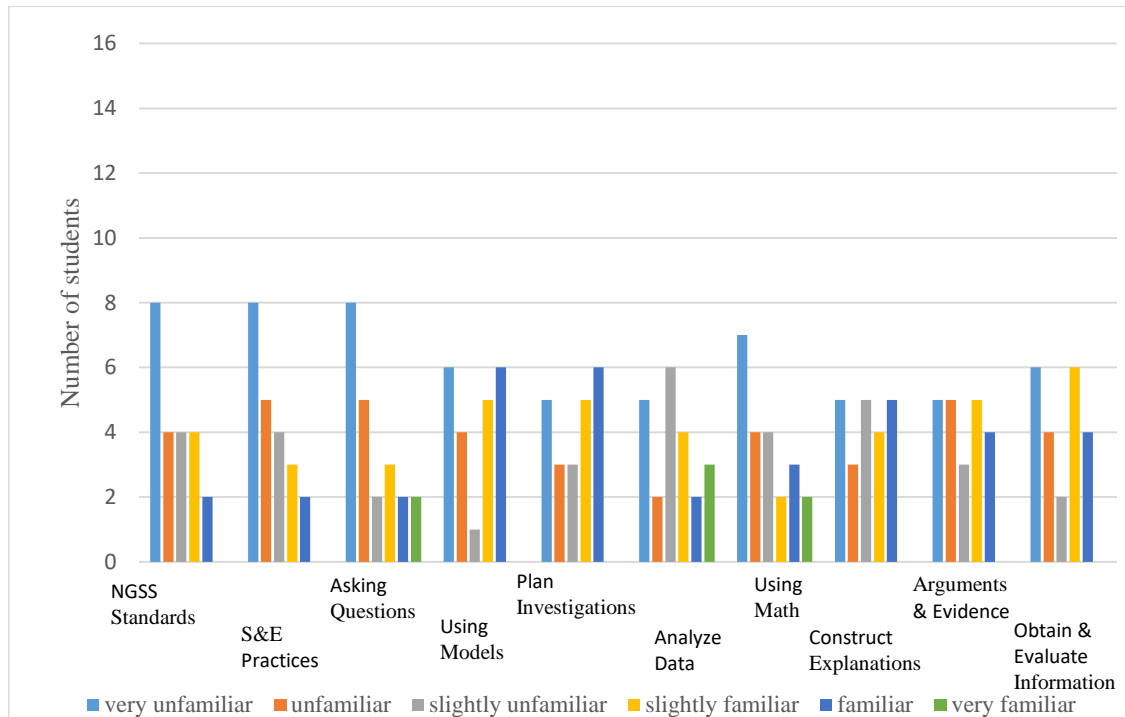
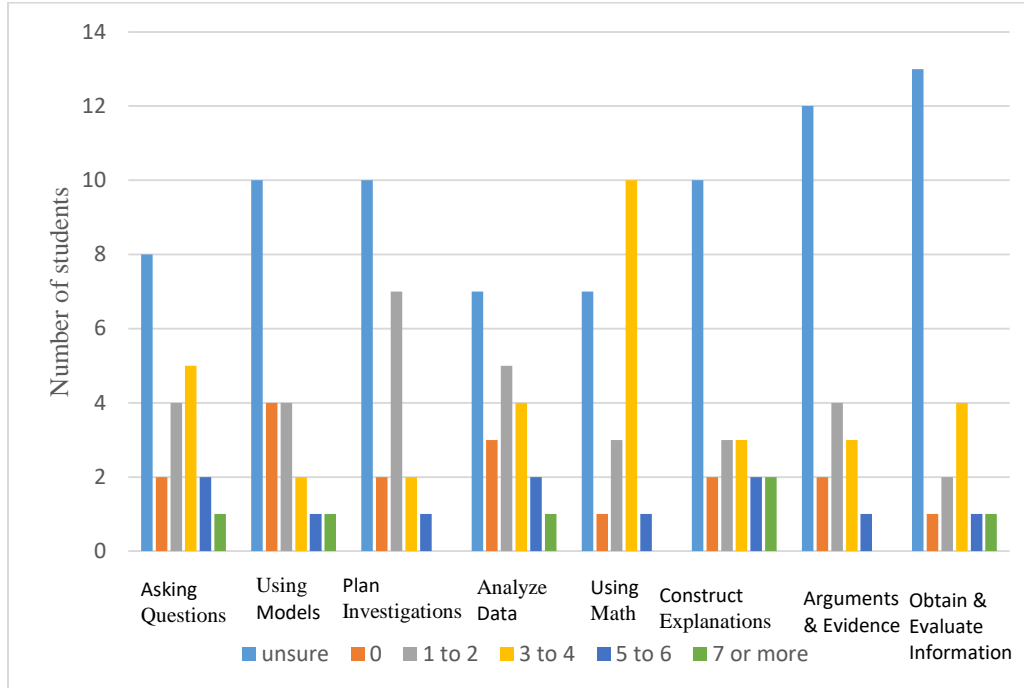


Figure 36. Teacher B: Post-coaching survey given to students ( $N=22$ ) about familiarity with NGSS and the S&E practices.

During post interviews, there seemed to be more gains in understanding of the practices than Teacher A's students. Again, for the practice Asking for Questions, only one student was able to revise their answer to what the practice actually meant. This student stated, "It was to create a problem and ask questions to solve it." This revised answer was more accurate than the previous answers given. All students were able to give adequate answers for Developing and Using Models and gave an example of the boat models they had been creating in class. All but one was unsure of a definition or example of Planning and Carrying Out Investigations. One student revised their answer that it meant "you see something, ask a question and answer your own questions by

testing to see if you are right.” Three of the four students were able to revise their answers for both Analyzing and Interpreting Data and Using Mathematics and Computational Thinking. Again, they were able to give examples about specific things they had been doing in class the last four weeks. Only one student was able to give a definition and example with the practice Construction Explanations. The student stated that “it means you look at something and how you want to design it. And then see if what you designed is the solution and if it works.” One student who seemed to struggle with the definition stated that it meant “finding a hard question and making your own answer.” Two of the four students had adequate revised answers on Engaging in Arguments from Evidence. Like Teacher A, no gains were made for the final practice of Obtaining, Evaluating, and Communicating Information.

When students were asked how often Teacher B asked them to use the S&E practices in class within the last week, the majority of students were unsure (Figure 37). This is similar to Teacher A’s students. This again would be consistent with the interview answers I received from the four students in class.



*Figure 37. Teacher B: Pre-coaching survey given to students about how often they were asked by teacher to use the S&E practices in class in the last week ( $N = 23$ ).*

After the four-week coaching cycle, students indicated that they were still unsure about how often their teacher asked them to use the S&E practices but seemed to have a slightly better understanding before coaching started (Figure 38). On practices 2-8, students indicated that the teacher asked them to use the practices at least once or twice and three to four times, whereas on the pre-coaching data on practices 2-8, the majority were unsure except for practice 5, Using Mathematics and Computational Thinking. More students indicated that they were asked to do the practices after coaching than before coaching.

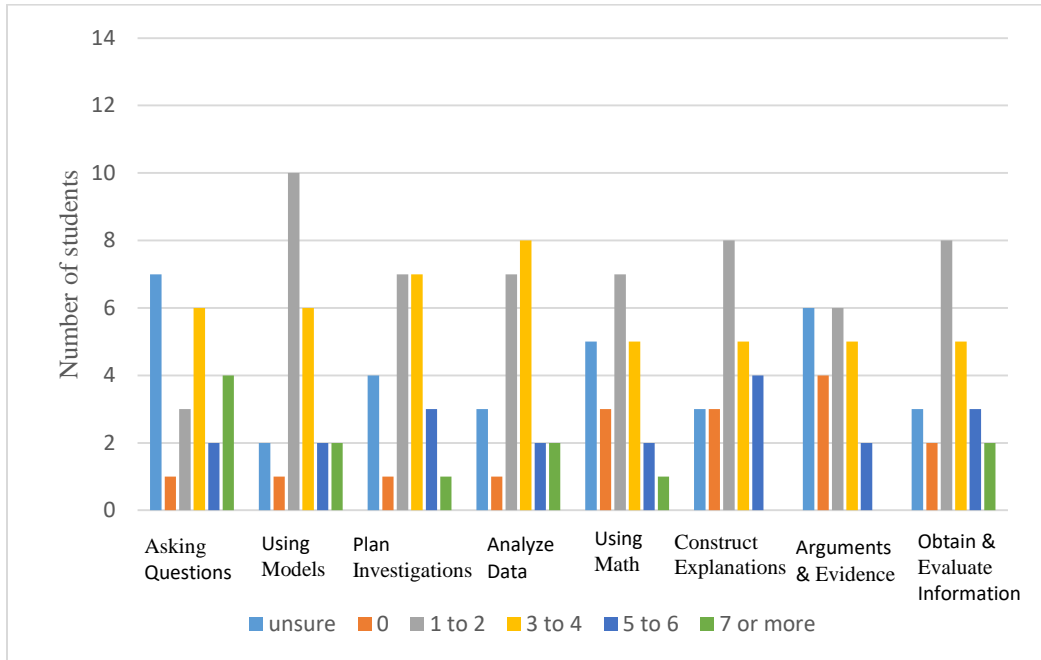


Figure 38. Teacher B: Post-coaching survey given to students about how often they were asked by teacher to use the S&E practices in class in the last week (N=23).

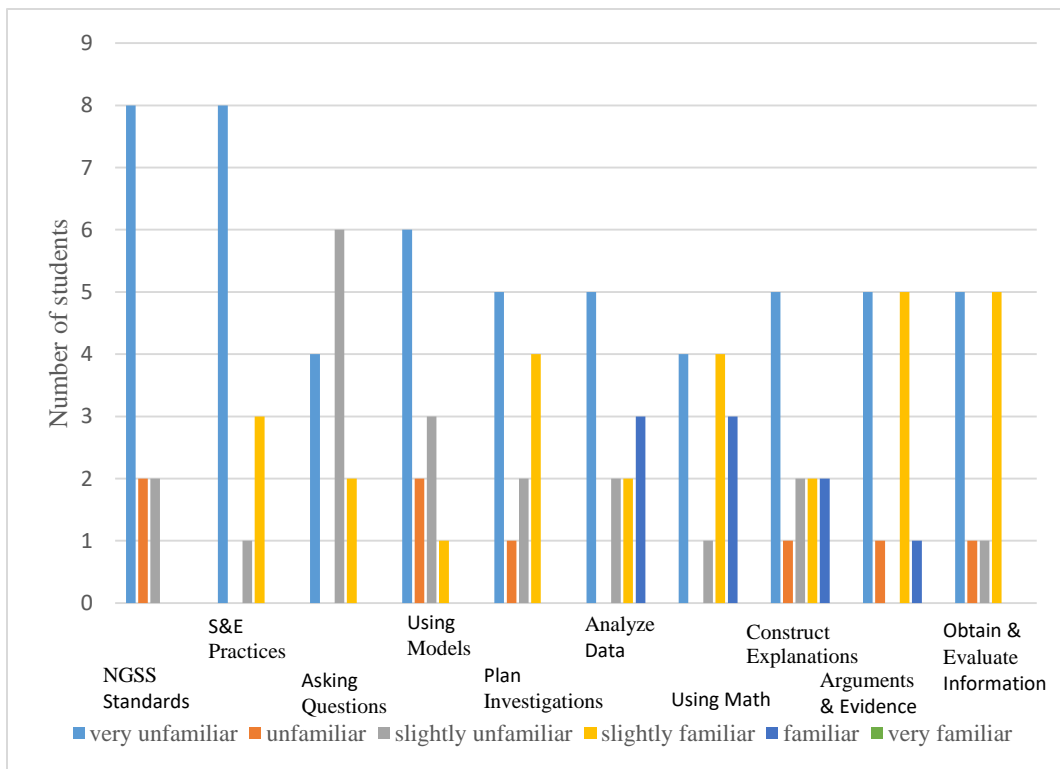


Figure 39. Teacher C: Pre-coaching survey given to students (N=13) about familiarity with NGSS and the S&E practices.

Data for Teacher C's students showed the majority (62%) of students were very in some way unfamiliar with the NGSS standards (question 1) (Figure 29). When asked about their familiarity with the S&E practices, again, 62% said they were very unfamiliar (question 2). When asked specifically about the practice Asking Question (for science) and Defining Problems (for engineering), 31% were very unfamiliar (question 3). However, 46% stated they were only slightly unfamiliar with the practice. When asked about the practice Developing and Using Models, 46% were very unfamiliar (question 4). The practice Planning and Carrying Out investigations found that 38% were very unfamiliar (question 5). When looking at the data for Analyzing and Interpreting Data, 38% were very unfamiliar (question 6). Question 7 asked about the practice Using Mathematics and Computational Thinking. Again, 31% were very unfamiliar. Question 8 asked about the practice Constructing Explanations (for science) and Designing Solutions (for engineering). The survey indicated 38% were very unfamiliar. When looking at the practice Engaging in Argument from Evidence (question 9), 38% were very unfamiliar. Question 10, the practice of Obtaining, Evaluating, and Communicating information, showed 38% of students were unfamiliar. Although for practices 9 and 10, 38% of students indicated that they were slightly familiar with the practice. The data indicated that these 9<sup>th</sup> grade students had more knowledge of the practices than the 6<sup>th</sup> graders in Teacher A's class. This would make sense as this class has had more science experience. However, when looking at if students were slightly familiar, familiar, or very familiar with any of the practices, the highest percentage was 38%, which was an 11% increase from Teacher B and was a 12% increase from Teacher A's students.

During the interviews with the four students, the answers given were very difficult to determine if there was any increase knowledge from these juniors and seniors than the 9<sup>th</sup> or 6<sup>th</sup> graders (Appendix E). As with Teachers A and B, when specifically asked about practice number 1, Asking for Questions, all four students stated that this meant that if they didn't know how to do something they asked their teacher for clarification or to help with the confusing parts. Two of the four students was able to give me an educational answer about Developing and Using Models. One said that it meant "models are things to help you understand things such as a periodic table or dot diagrams." Another student said that an example he could think of was the wooden element models they used in Chemistry class. Two of the four students were able to give an adequate answer to what Planning and Carrying Out Investigations meant. One student said that it "is a step-by-step procedure." One students said it was looking at laws. For example, Boyle's Law: testing it, finding its flaws, and how you can use it every day. Two of the four students were able to give me an adequate definition and example of Analyzing and Interpreting Data. These two students all mentioned graphing and looking at numbers and understanding what they meant. All four students were able to give an explanation of the practice Using Mathematics and Computational Thinking, such as using equations or weighing mass. Two students were able to explain and give examples about Constructing Explanations. One student stated it "is the reason of how/why something happens and figuring out solutions to those problems." Two of the four could give a good example and definition about Engaging in Arguments from Evidence. A student stated that this practice "is challenging what has been discovered or a belief and

doing tests to prove them wrong.” Four of the students interviewed had a good answer to what Obtaining, Evaluating, and Communicating Information. Some of the definitions were that it was talking to other people or evaluating what other people had to say. It was also an exchange of knowledge.

Following the four-week cycle, the post-coaching data showed that there was a positive shift in student familiarity with most of the practices (Figure 40). In practice one, there was a drop by 50% of students who felt very unfamiliar with this practice. On the pre-coaching survey, eight students indicated they were very unfamiliar, but only three felt the same way on the post-coaching survey for practice 2. For practice number 3, no students felt familiar with the practice on the pre-coaching survey, but four students felt familiar on the post-coaching survey. On practices 4-8, there was indication by some students that they felt comfortable with these practices whereas on the pre-survey there were fewer.

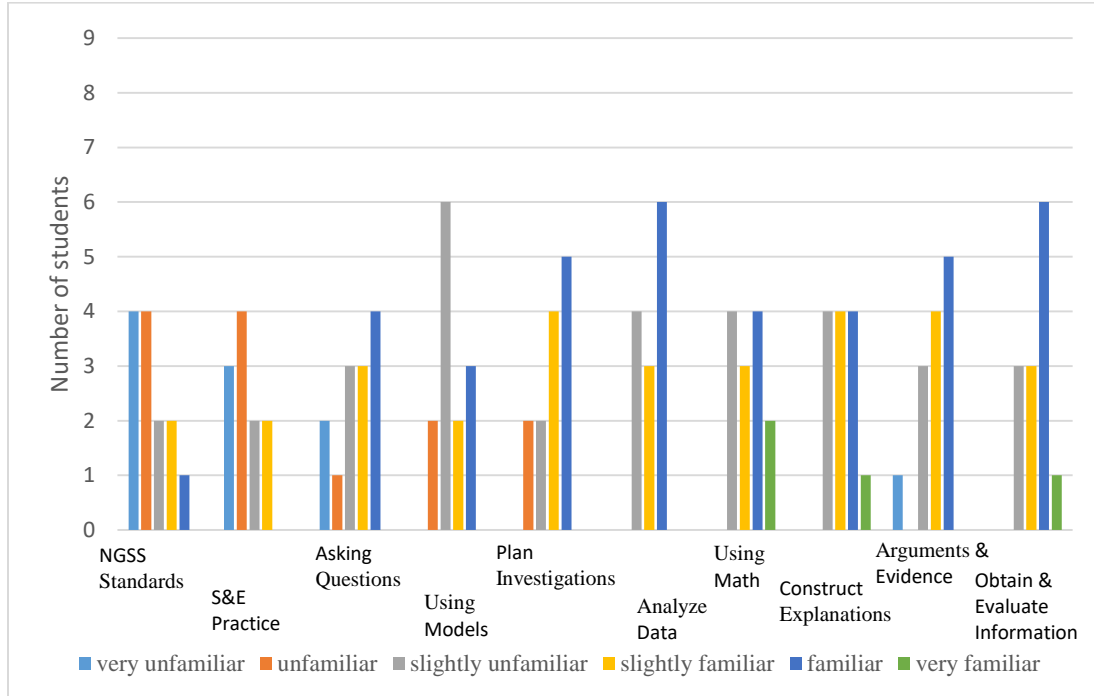


Figure 40. Teacher C: Post-coaching survey given to students ( $N = 13$ ) about familiarity with NGSS and the S&E practices.

Like with Teachers A and B, when the students were interviewed after the coaching intervention. It was difficult to decipher if there was an increase in student knowledge of the S&E practices. No student was able to explain practice 1, Asking Questions. Things that students said were when the teacher lectures or asks questions. Planning and Carrying Out investigations was the same on both pre-coaching and post-coaching surveys. One student stated that this meant figuring out what happens in a crime. There was very little change in any of the practices and the answers that were given for the explanation. However, there were some improvements in the types of examples they gave. For example, on Analyzing and Interpreting Data, an example given was looking at spreadsheets from a lab and figuring out what it meant. Another was

Constructing Explanations. The student said an example was when a certain chemical burns a certain color over a Bunsen burner and trying to explain why that happened.

Students in Teacher C's class were asked how often their teacher asked them to use the S&E practices in class within the last week (Figure 41). Only seven students indicated that any practices were used 7 or more times. There were fewer students in this age group that were unsure about this part of the practices than the other two groups.

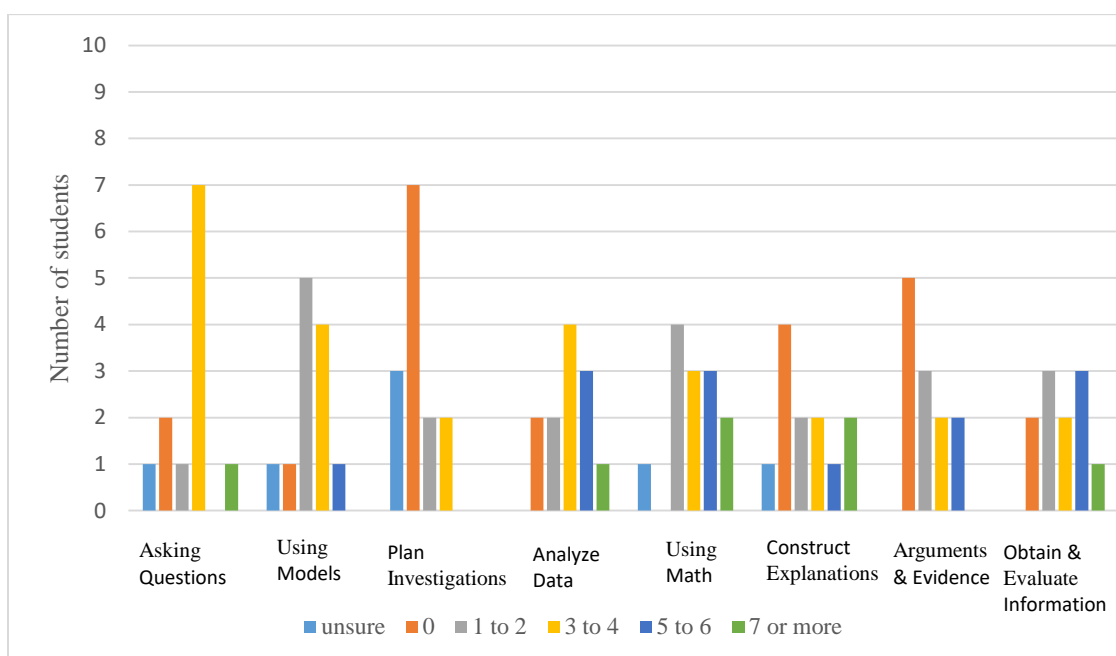
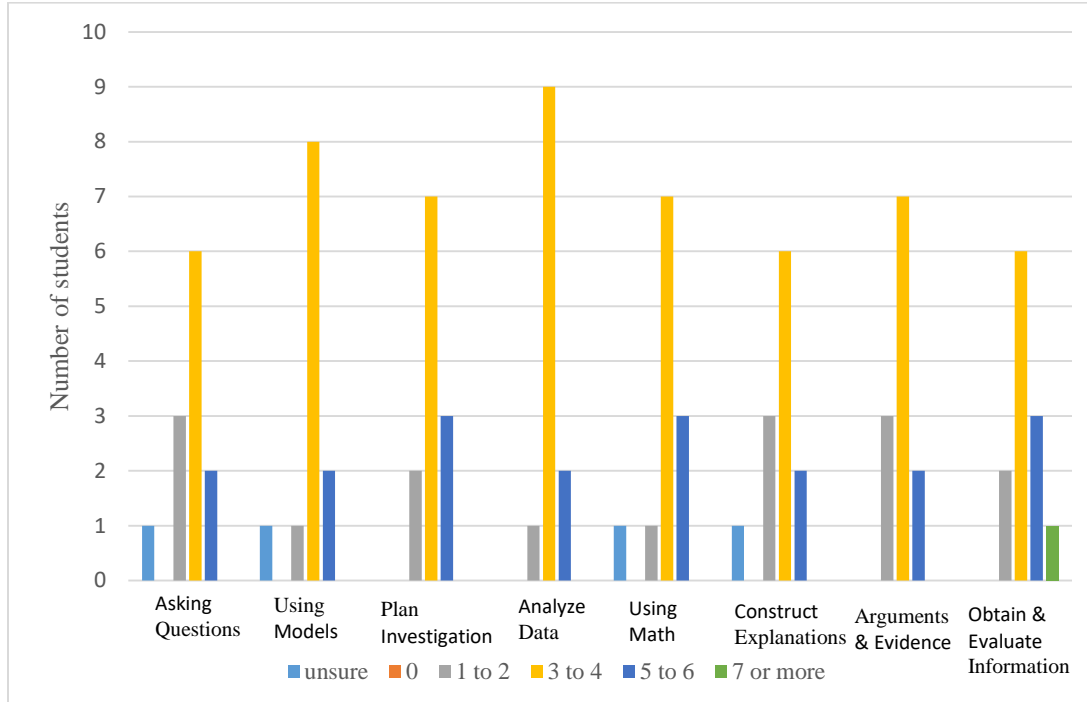


Figure 41. Teacher C: Pre-coaching survey given to student about how often they were asked by teacher to use the S&E practices in class in the last week ( $N = 13$ ).

On the post-coaching survey, when asked about number of times the teacher asked them to use the practice in the last week, seven of the eight practices indicated they were asked more often to use the practice than before coaching began (Figure 42).



*Figure 42.* Teacher C: Post-coaching survey given to students about how often they were asked by teacher to use the S&E practices in class in the last week ( $N=13$ ).

Overall data analysis showed a positive impact on teacher understanding, knowledge and implementation of the S&E practices in their classrooms. Data also showed that coaching played a positive role in the longevity of the S&E practices. Data was mixed when looking at how the coaching intervention impacted the students understanding of the S&E practices.

### INTERPRETATION AND CONCLUSION

I felt my intervention was successful. All three teachers seemed very engaged in the conversations and were very self-reflective about their own teaching. I do believe that my relationships with these teachers played a large role and helped significantly on how well the interventions went and their effect on the data. Research on instructional coaching has shown that relationships building and trust significantly help with positive

impacts on teachers (Anderson, Feldman, & Minstrell, 2014). I admit I was leery that teachers would gain little knowledge from this intervention. However, when doing the pre-coaching data, I found teachers had less knowledge about the S&E practices than I anticipated. Even Teacher C, who had significant background knowledge, gained from the coaching cycle by focusing specifically on the practices, which he felt was very successful for his teaching.

In regards to my first research question as to how individualized instructional coaching impacts teacher knowledge and implementation of the eight S&E practices, my data showed that it had a positive impact on all three teachers. Their prior knowledge of the practices influenced their end result on growth. For example, Teacher A who had little to no knowledge of the practices or NGSS, had a significant jump in how familiar and comfortable he was with them. Even Teacher C, who had significant background knowledge, explained how the coaching cycle helped him to specifically focus the practices in his classroom. Teacher C noted how he wanted to move away from the traditional methods of teaching science and that this coaching intervention helped him to do that and see gains from his students. This coincided with van Drie, Beijaard, & Verloop, who believe traditional methods of teaching Science have not helped prepare our students for learning and understanding natural phenomena of the real world (van Driel, Beijaard, & Verloop, 2001, p.138). Seeing the positive impact from the three Science teachers using the coaching cycle fits with what Teemant states about how instructional coaching has had positive impacts in pedagogical shifts and sustainability in practices (Teemant, 2014).

This corresponds with my results about my second research question that coaching had an impact on the longevity of use of the S&E practices for teachers. All three teachers continued to focus on the S&E practices even a month after coaching was finished. Also, the level of integration (according to the scale on Appendix F) was higher than pre-coaching. The cognitive coaching approach I used in my interventions focused on individualizing the conversations. This individual support helped the teachers work on specific goals geared towards their own needs. Teemant's study found this same positive impact in other studies involving individualized instructional coaching (Teemant, 2014). However, the practices are known as the Science and Engineering practices and most of the focus was on the science side of the practices. Teacher B did express that she felt she did a lot more with the Engineering aspects in her Physical Science class. This may be due to the fact that many classrooms are still not focused on the engineering side except for those specific classes in which they are already built in. Knowing that the full implementation of the NGSS is supposed to take place over a three year span, it fits that teachers are not fully integrating all aspects of the S&E practices into their classrooms yet.

Data on my third research question as to whether instructional coaching impacted students' knowledge of the practices showed mixed results. In all three classes, there was a positive shift in familiarity with the practices and students felt they were asked more to do the practices in class after the coaching cycle. However, the interviews showed little increase in understanding in the practices. It is possible that the language of the S&E practices is not student friendly, therefore having to explain them verbally was difficult. I

also believe that doing a survey was much easier than having to explain what the practices meant.

## VALUE

Instructional coaching takes intensive focus and planning. In order to be a successful instructional coach, there must be a relationship of trust and confidence between coach and teacher. Planning and implementing the coaching cycles for three very different science teachers was a challenge. However, through the intense planning and reflecting, there were several big takeaways for me as an Instructional Coach and as a science teacher. As an Instructional Coach, I realized how much impact I can have on a teacher's pedagogy, knowledge, and confidence. I really believed at the beginning of my project that I would make little impact on any of the teachers. I think I felt this way because I was asking them to look at and implement something that was important to me, not something they had come to me with. The idea behind a coaching cycle is that a teacher wants to work on or implement something they feel strongly about. But in this case, it was me asking them to learn, implement, and reflect on the S&E practices for my own research. However, after doing these three coaching cycles, I realized that my knowledge and the cognitive coaching I used did have a positive impact on their teaching. I also saw how much value there was for me and the things I learned from the three teachers I worked with. I was able to see science taught in three different ways and those experiences will help me to be a better teacher when I enter into the classroom again. Knowing how important science is and will continue to be for our future, teaching students a different way to look at science is very important. I realized that while working

with the NGSS and specifically the S&E practices, we need our teachers to be better equipped with the knowledge and the know-how to teach an ever-changing generation of students in the classroom.

We have to start with one teacher at a time. Being allowed the time to work with these teachers will help them to look closely at their current teaching and how to help adjust so that our students are receiving the best learning possible in science. Knowing that I helped and made an impact on how they are teaching was very impactful to me as a professional. The additional piece I would have liked to include would have been video recording myself during my coaching conversations. I could have also used other professionals in coaching, having them review the footage of the conversations and provide me with feedback. This would have helped me to be aware of things that I could have improved on or what things I was doing well. I think looking forward that I need to start recording myself so that I can go back and analyze my own coaching practices.

Looking back at my research project, I know that focusing on all eight S&E practices in a four-week coaching cycle was too much. I believe the teachers were overwhelmed with the amount of information to absorb and try to fit into their lessons. If done again, I would look at fewer of the practices but with more depth. Many times while planning with the teachers, they would want to dive into one specific practice and focus on that for a length of time. I think this impacted my results about the gains seen from the student's perspective in regards to the S&E practices. If teachers could have focused on a few practices rather than all eight, students might have gained more knowledge and understanding. I also feel that using the specific terminology of the NGSS wasn't very

student friendly. At times when talking with students using the precise vocabulary of the NGSS, it seemed to confuse them. For example, when I interviewed students and asked them to tell me what they thought the practice using Mathematics and Computational Thinking meant, many would tell me that although they knew what math was, they didn't know the computational part. If I told them it was another word for using math, they then seemed more able to give me a definition or an example. It makes me wonder if I had used student friendly language, would there be more significant gains in understanding of the S&E practices from the students' perspective? Looking back, I also wondered if I was too focused on the terminology of the practices instead of the actual demonstrating of the practices. If I would have allowed myself to observe more closely whether teachers and students were doing the practice rather than expressing it, I wonder how my research would have turned out. However, if that was the case, my data collection instruments would have to look slightly different.

I realized that instructional coaching can be a powerful tool for teachers. One of the issues, however, is teacher buy-in. Coaching is not mandatory in our school district so many teachers do not use me in this capacity. I feel that if teachers would embrace instructional coaching, we could improve the processes of science education. Continued relationship building will be a key for this to be successful.

Finally, as a teacher and an instructional coach, this project has verified for me the importance of collaborating with colleagues. It also verified for me that I can make an impact on teacher pedagogy and confidence, but I also have much more learning to do

myself. This project has helped me to become even more self-reflective as a coach and a person.

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APPENDICES

APPENDIX A  
IRB EXEMPTION



**INSTITUTIONAL REVIEW BOARD**  
**For the Protection of Human Subjects**  
**FWA 00000165**

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**MEMORANDUM**

**TO:** Jessica Kremer and Eric Brunsell

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

**DATE:** November 9, 2017

**RE:** "Shifting to Science and Engineering Practices through Instructional Coaching" [JK110917-EX]

The above research, described in your submission of November 9, 2017, 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  
PRE AND POST TEACHER SURVEY

Next Generation Science Standards Teacher Survey

Please note: this survey is completely voluntary, it will in no way effect your job status or evaluation.

What grade(s) do you currently teach? \_\_\_\_\_

What discipline(s) of Science do you currently teach? \_\_\_\_\_

If you currently teach more than one discipline, pick one discipline that you teach and answer the following questions about that discipline only.

Discipline: \_\_\_\_\_

**Please circle the number that most represents your level of familiarity.**

| 1                      | 2                 | 3                          | 4                        | 5               | 6                    |
|------------------------|-------------------|----------------------------|--------------------------|-----------------|----------------------|
| <b>Very Unfamiliar</b> | <b>Unfamiliar</b> | <b>Slightly Unfamiliar</b> | <b>Slightly Familiar</b> | <b>Familiar</b> | <b>Very Familiar</b> |

|                                                                            |   |   |   |   |   |   |
|----------------------------------------------------------------------------|---|---|---|---|---|---|
| How familiar are you with the Next Generation Science Standards            | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the eight NGSS Science and Engineering Practices | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the seven NGSS Crosscutting Concepts             | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the four NGSS disciplinary Core Ideas            | 1 | 2 | 3 | 4 | 5 | 6 |

**Please circle the number that most represents your comfort level.**

| 1                         | 2                    | 3                             | 4                           | 5                  | 6                       |
|---------------------------|----------------------|-------------------------------|-----------------------------|--------------------|-------------------------|
| <b>Very Uncomfortable</b> | <b>Uncomfortable</b> | <b>Slightly Uncomfortable</b> | <b>Slightly Comfortable</b> | <b>Comfortable</b> | <b>Very Comfortable</b> |

|                                                                                   |   |   |   |   |   |   |
|-----------------------------------------------------------------------------------|---|---|---|---|---|---|
| How comfortable are you teaching the Next Generation Science standards            | 1 | 2 | 3 | 4 | 5 | 6 |
| How comfortable are you teaching the NGSS eight Science and Engineering practices | 1 | 2 | 3 | 4 | 5 | 6 |
| How comfortable are you teaching the seven NGSS crosscutting concepts             | 1 | 2 | 3 | 4 | 5 | 6 |





APPENDIX C

TEACHER PRE AND POST INTERVIEW

## Teacher Interview Pre and Post Coaching cycle

Please note this interview is completely voluntary and will in no way affect your job or evaluation.

Date: \_\_\_\_\_

1. How do you feel about using the Next Generation Science standards? Why?
2. Have you had any kind of professional development that involved NGSS? What were they?
3. Have you ever worked with an Instructional Coach before? How many times?
4. What are your current teaching practices of giving instruction? Labs, Lecture, flipped classroom?
5. How often do you think you use the terminology of the science and engineering practices in your classroom on a given day?
6. How do you provide opportunities for students to engage in Science and engineering practices in your classroom?
7. What are the shifts (if any) you are making to provide science instruction that makes the science and engineering practices accessible for all student?
8. What support or professional development do you think you need to help shift to NGSS?
9. How familiar do think your students are with the science and engineering practices? What makes you think that?

## Additional Questions asked on Post-Coaching interview only

1. After looking at your goal when we started this coaching cycle, how do you feel about obtaining your goal and why?
2. How has this coaching cycle impacted your teachers?
3. What will you do differently moving forward?
4. What parts did not work for you?
5. What was your biggest take away?

APPENDIX D  
PRE AND POST STUDENT SURVEY

## Next Generation Science Standards Student Survey

Please note: this survey is completely voluntary and will in no way affect your grade or class standing

What grade are you currently in? \_\_\_\_\_

What science class(es) are you currently taking? \_\_\_\_\_

If you are currently taking more than one science class, pick one class that you are in and answer the following questions about that class only.

Name of class: \_\_\_\_\_

*Please circle the number that most represents your level of familiarity.*

| 1                      | 2                 | 3                          | 4                        | 5               | 6                    |
|------------------------|-------------------|----------------------------|--------------------------|-----------------|----------------------|
| <b>Very Unfamiliar</b> | <b>Unfamiliar</b> | <b>Slightly Unfamiliar</b> | <b>Slightly Familiar</b> | <b>Familiar</b> | <b>Very Familiar</b> |

|                                                                                                                                    |   |   |   |   |   |   |
|------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|
| How familiar are you with the Next Generation Science Standards (NGSS)?                                                            | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the eight NGSS Science and Engineering Practices (S & E)?                                                | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the S & E practice of asking questions (for science) and defining problems (for engineering)?            | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the S & E practice of developing and using models?                                                       | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the S & E practice of planning and carrying out investigations?                                          | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the S & E practice of analyzing and interpreting data?                                                   | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the S & E practice of using mathematics and computational thinking?                                      | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the S & E practice of constructing explanations (for science) and designing solutions (for engineering)? | 1 | 2 | 3 | 4 | 5 | 6 |
| How familiar are you with the S & E practice of engaging in argument from evidence?                                                | 1 | 2 | 3 | 4 | 5 | 6 |



APPENDIX E  
STUDENT INTERVIEW

Student Interview questions

Pre and post intervention

Date: \_\_\_\_\_

Please note: this interview is completely voluntary and will in no way affect your grade or class standing.

1. Can you identify any of the eight Science and Engineering practices? If so, which ones?

\_\_\_\_\_

I am going to ask you to describe in your own words what the following eight Science and Engineering practices means to you. Give me an example, if you can of a time you have done/used the practice in science class. Also indicate yes, no or unsure if you would feel comfortable taking a science course using the following practice.

1. Asking questions (for science) and defining problems (for engineering)

- a. Definition:

\_\_\_\_\_

- b. Example:

\_\_\_\_\_

- c. Would you feel comfortable taking a science course using this practice?

Yes \_\_\_\_ No \_\_\_\_ Unsure \_\_\_\_

2. Developing and using models

- a. Definition:

\_\_\_\_\_

- b. Example:

\_\_\_\_\_

- c. Would you feel comfortable taking a science course using this practice?

Yes \_\_\_\_ No \_\_\_\_ Unsure \_\_\_\_

3. Planning and carrying out investigations

- a. Definition:

\_\_\_\_\_

b. Example:

---

---

c. Would you feel comfortable taking a science course using this practice?

Yes \_\_\_\_ No \_\_\_\_ Unsure \_\_\_\_

4. Analyzing and interpreting data

a. Definition:

---

---

b. Example:

---

---

c. Would you feel comfortable taking a science course using this practice?

Yes \_\_\_\_ No \_\_\_\_ Unsure \_\_\_\_

5. Using mathematics and computational thinking

a. Definition:

---

---

b. Example:

---

---

c. Would you feel comfortable taking a science course using this practice?

Yes \_\_\_\_ No \_\_\_\_ Unsure \_\_\_\_

6. Construction explanations (for science) and designing solutions (for engineering)

a. Definition:

---

---

b. Example:

---

---

c. Would you feel comfortable taking a science course using this practice?

Yes \_\_\_\_ No \_\_\_\_ Unsure \_\_\_\_

7. Engaging in arguments from evidence

a. Definition:

---

---

b. Example:

---

---

c. Would you feel comfortable taking a science course using this practice?  
Yes \_\_\_\_ No \_\_\_\_ Unsure \_\_\_\_

8. Obtaining, evaluating, and communicating information

a. Definition:

---

b. Example:

---

c. Would you feel comfortable taking a science course using this practice?

Yes \_\_\_\_ No \_\_\_\_ Unsure \_\_\_\_

APPENDIX F  
CLASSROOM OBSERVATION NOTES

Classroom Observation Form

Class: \_\_\_\_\_ Content: \_\_\_\_\_ Date: \_\_\_\_\_

Scale to be used for observation

- 0- No mention of S&E practice
- 1- Brief mention of title of S&E practice
- 2- Application of S&E practice into part of instruction
- 3- Full integration of S&E practice into instruction with student utilizing S&E language

| Science and Engineering Practice                                     | # of times observed | Observations | Scale 0-3 |
|----------------------------------------------------------------------|---------------------|--------------|-----------|
| Asking questions (for science) and defining problems for engineering |                     |              |           |
| Developing and using models                                          |                     |              |           |
| Planning and carrying out investigations                             |                     |              |           |

|                                              |  |  |  |
|----------------------------------------------|--|--|--|
|                                              |  |  |  |
| Analyzing and interpreting data              |  |  |  |
| Using mathematics and computational thinking |  |  |  |

|                                                                                   |  |  |  |
|-----------------------------------------------------------------------------------|--|--|--|
|                                                                                   |  |  |  |
| Constructing explanations (for science) and designing solutions (for engineering) |  |  |  |
| Engaging in argument from evidence                                                |  |  |  |