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What Is The Impact Of Effective Questioning And Critical, Relevant Conversations On Sixth Grade Science Students' Agentic Engagement?

Corrie L. Christensen
Hamline University

WHAT IS THE IMPACT OF EFFECTIVE QUESTIONING AND CRITICAL, RELEVANT CONVERSATIONS ON SIXTH GRADE SCIENCE STUDENTS' AGENTIC ENGAGEMENT?

by
Corrie L. Christensen

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Primary Advisor: Jason Miller
Secondary Advisor: Cora Packard
Peer Reviewer: Jennifer Marty

To my family and friends for your patience and faith in my completing this stage of my education and for your support.

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"A good question is never answered. It is not a bolt to be tightened into place but a seed to be planted and to bear more seed toward the hope of greening the landscape of idea."
~John Anthony Ciardi

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Special thanks to my school district for supporting me throughout this process and for allowing me to conduct this research in my classroom.

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The research question in this project was, "What is the impact of effective questioning and critical, relevant conversations on sixth grade science students' agentic engagement?" It documents a teacher's investigation into the impact of two isolated components, effective questioning and relevant conversations, on the agentic engagement of a group of sixth grade students. The author describes the outcomes of data collection using randomized student agentic engagement surveys. She outlines the successes and struggles that were realized during the process as well as the realization that an isolated component or two does not make a significant change in agentic engagement.

CHAPTER ONE

INTRODUCTION

"Scientists, it is time to share the results of what you noticed in the lab on bubble gum brand and bubble size. In the next five minutes, share your results with one another and your thoughts about what happened." This is my most recent set of instructions following our sixth grade science lab. I hear the buzzing of the lights, some deep sighs of anticipation mixed with anxiety and then conversations ensue. Eagerly, I walk around and listen to what students are talking about and I quickly begin to hear things about their abilities to blow a bubble, gum sticking to their face, and what they are going to do for recess. It is at this moment that I realize most of my students have not made a strong connection to this lab and the science concepts. I recognize that they are disengaged from the goal of this lesson and I get a rush of anxiety by the outcome of this lab.

Ramirez (2012), said the following in her TED book, *Save our Science*:

"The 21st century requires a new kind of learner--not someone who can simply churn out answers by rote, as has been done in past, but a student who can think expansively and solve problems resourcefully. The traditional academic skills must be replaced with creativity, curiosity, critical thinking and problem solving, and collaborative and communication skills in order to solve the complex problems of tomorrow." (p. 23) I read this quote over a year ago and it has lingered in my mind, creating a sense of wonder about what I am doing in my classroom and what I could change in my classroom to prepare my students for what is ahead. This year, I was given the opportunity to teach sixth grade science all day and everything seemed to fit together. This was the door opening for me to explore some teaching options! I had the opportunity to see if student engagement could be affected by providing students with a framework for asking more effective questions and critically communicating what they see happening in the science classroom. Now I could focus on making the topics more relevant to the learners. My research question is as follows: "*What is the impact of effective questioning and critical, relevant conversations on 6th grade science students' agentic engagement?"*

In this chapter, I will take you on the journey that has led to my interest in researching agentic engagement through effective questioning and critical, relevant conversations. My interest in this topic has three key lenses: as a student, as a teacher, and as a global citizen.

Personal Interest as a Student

My journey as a student has not always been the smoothest one. Lacking confidence and having undiagnosed ADD, my brain wandered which led to a challenge in synthesizing information.I did not feel comfortable discussing ideas or asking topic specific questions. I would hear someone inquire and wonder, "How do they come up with these questions?" or if an adult asked what other questions we might have regarding a topic, I was left with a blank. I never felt smart enough and made the decision to wait around for others to respond which happened because in every class or group there is usually a dominant talker. More often than not this series of events led to a disengagement on my part.

As a student, both in adolescence and in adulthood, I have had experiences that had major impacts on my engagement levels. In junior high and high school classes, particularly science classes, I reflect back and feel like we were not given the opportunity to really dig deep into things and make connections to topics that were relevant to us. Teachers had a lesson plan and timeframe to accomplish that lesson and anything “extra” was just a waste of academic time. Most of the science (and other courses) primarily involved regurgitation of facts and these classes left me bored and therefore uninvested cognitively. The only question that evolved much of the time was, “What is this teacher talking about?”

Things began to change a little in high school. During my junior year, I had Mr. Marcella for Environmental Science. He loved expanding on topics and engaging the class in conversations. We had to ask questions and dive into topics that weren’t always easy to talk about, especially in the 1990s when environmental science was even more dismissed than it is now. It was because of this class and his style that I became invested in science.

During my adult education experiences, I had the chance to pursue programs and courses that pushed and encouraged us to talk and ask questions. These were not your large stadium seating types of courses. These were courses more geared towards discussion and inquiry. It was in this environment that I gained the most out of the experience. When I was given a safe place to ask questions and engage in conversations about a topic, I noticed an increasing interest and capability to make deeper connections with the topic. In reflecting back to all of these experiences, I recognize that I didn’t intuitively know how to ask questions or pull questions out of content we were studying. We weren't encouraged or taught during my formative years how to ask questions, what types of questions to ask, and how to have critical conversations regarding a topic. I just assumed communication was an either/or type of skill: Either you can or you can't. Many years into my education, I have realized that I am much more engaged as a learner when I can make connections, ask questions and get into critical conversations about a topic.

Personal Interest as a Teacher

I have been a teacher for twelve years. My experiences have included first through eighth grade. This perspective comes from many subject areas and many developmental levels of the students. In my observations and from conversations I have had with colleagues, students in the upper elementary and middle school grades tend to wait for others, put down as little as possible when reflecting or journaling about a concept, sit around saying very little during discussion time, don't ask questions and indicate that science is more boring than when they were younger.

For me, there is not a more exciting teaching time than when a student asks a deeper level question or makes a connection to a discussion that involves something from outside of the classroom. Their enthusiasm and excitement is infectious, but the challenge is getting all students to that point at this age. I find myself posing questions as "Thinker Questions" and I wonder if this puts on the brakes for students who don't consider themselves to be "challenge thinkers".

In my classroom, I often get the response, “When do we get to start building or playing with the materials?” After an activity or lab, students tend to just want to move on to the next topic. Up until this point, much of their science education has been “play-based”. In my opinion, there are many institutional reasons why teachers in the K-5 environment don’t dig deeper into a topic. These reasons include, but are not limited to, teacher confidence in content and time allotted for specific academic areas. Science includes questioning and conversations not just hands-on exploration and finding an answer.

From talking to teachers and looking at state testing scores, it appears that students are challenged in application of concepts to the type of questions being asked on the state test. This appears true especially when those questions are not in the context in which the students learned the skill. For example, if I teach “There is no perfect design” through the use of bridges and an assessment comes up with this topic nonspecific to bridges, students are less successful. In the TIMSS (Trends in International Mathematics and Science Study) 2011, our students in grade 4 were in the top ten worldwide and by grade 8 our students had dropped to twenty-three. What is it about the time between grade 4 and grade 8 that has changed to cause this drop? (TIMSS, 2011).

Guiding students into deeper level questioning and critical conversations is a necessary set of skills for our 21st century learners. According to NSTA, NEA and a multitude of other organizations the following “4 Cs” are important to the education of today’s youth: Critical thinking, collaboration, communication and creativity. The use of questioning and conversations in the classroom attend to all four.

Personal Interest as a Global Citizen

Many of the careers for the future are beyond our current level of knowledge. Some of the occupations that my students will have are not even created yet. I have heard this so many times and it has been restated so often it is hard to know and find out who originally made the statement, but Thomas Frey speaks to this in great detail in his Futurist article online (Frey, 2014). This statement is important because if students cannot think outside of the box and build off of what is already out there, ask questions about how to improve upon what is already in place or whether old ways of doing things are even necessary, our students will not be on the forefront of the global job train. We are exploring places in our universe that at one point were just part of science fiction plots, our technology is replacing what once were human tasks, the climate change occurring across our planet is leading to events that will need deep thinkers and our global world is resulting in people needing strengths in communication and being immersed in conversations among many cultures and belief systems. A large percentage of today's teachers are still part of the rote learning mentality of the 1900s and assessing knowledge of facts (Davidson, 2011). Today, the students are being tested on higher levels of thinking such as analyzing, synthesizing, interacting and problem solving. (Davidson, 2011) If we can get students to ask and answer those types of questions/problems and have deep level conversations about concepts in all of our curricular areas, then we are giving them vital tools necessary to be successful in our quickly changing world.

Finally, from my perspective as a global citizen, our students have historically been disengaged in the science fields. Student pursuit of science courses outside of the required ones, dwindles as they get into higher education. Much of this is the result of decreased cognitive engagement and a lack of self-confidence in their ability to pursue a science education. In *STEM the Tide*, Drew (2011) has a discussion about the American education system and limitations on acquired knowledge. We tend to think from the mindset that "Some students can only go so far" and others are capable of going much further. This is different from other countries and their education systems where everyone is EXPECTED to achieve the levels.

Evolution of Personal Interest Into a Research Topic

As a student, educator and global citizen, I believe it is important to evaluate current instruction and whether we are using best practice in this era. What we have done is not always what should continue to be done. I want to find ways to implement effective questioning and critical conversations as strategies. With the increasing loads for teachers, my hope is to find things that are not going to take total reform and would rather tweak what is already happening on a building, district and state level. I also want to know if questioning and conversations actually have an impact on student engagement either positively or negatively. My school district and my school in particular has developed a growth goal in the area of student engagement. Having established this as a topic idea for my capstone and now having this as a school goal, I feel it is a perfect fit to align with my professional goals.

In Chapter 2, I will be presenting research showing that students' engagement levels will increase based upon types of questions they are asked and begin to ask one another regarding a specific science concept presented in class. Sobel (2008) referred to an unpredictability in the classroom (p. 96) that cannot be accounted for with a pre-packaged set of resources. Each class is made up of a multitude of personalities and experiences and through the process of “student led questioning” and “critical conversations”, unplanned and deep learning opportunities can unfold. I notice this on a daily basis from hour to hour. More often than not, students will inquire or connect to something that relates to our topic and if nurtured this can be built into a deeper level learning platform than a prescribed lesson. When given a pacing calendar or a purchased curriculum to follow rigidly, learning opportunities stay quite shallow. In *Ecological Literacy*, Holt referred to this as a curriculum straitjacket (Holt, p. 56). She goes on to say that students need to have time to understand concepts and not just memorize them.

From my experiences in the classroom, I believe, students are not just bystanders answering predetermined questions being led by the teacher. Instead, they are self-directed learners who create questions that: 1) interest them, 2) build off of learning they are doing in class, and 3) pose further inquiry to their peers. Students are used to being spoon-fed the step by step “how to” of a lesson whether it is in mathematics, science, reading, etc. If students are presented with the questions then pursue the answer, the success rate drops. When students are given the activities and then proceed to ask questions and communicate about these questions they scored 25% higher. (Kuchment, 2013)

I also will look at research regarding students being engaged and passionate about a topic if they are having critical conversations that relate to a concept or topic. This includes questioning that refers to scientific concepts and discussions that further define the concept. Application to current and relevant topics, activities in their daily lives, and so on will lead to stronger thinking and engagement inside and outside the classroom walls. In the younger grades, interest and engagement continues because of the nature of learning being more playful, in my opinion. As they get older without the crutch of those playful day by day lessons, students seem stuck, disengaged and make a decision that they are not “good” at a certain subject and engagement begins to dwindle. Given the tools and opportunities, students will seek further understanding and connection to ideas they are being presented. Since my area of teaching is focused primarily on science concepts, I hope students will begin to see that learning is interconnected and concepts they learn are not isolated to just my class.

I am aware that oceans of literature and research have been done on each specific learning area and philosophy I will be presenting. In this project, I hope to find questioning and communication components in each that keep me engaged as a teacher, keep students engaged as continuous learners, and prepares students for the higher level questioning that takes place in the high stakes assessments as well as for the 21st Century skills they will need in our world.

CHAPTER TWO

LITERATURE REVIEW

"For the purpose of teaching and instruction is to bring ever more out of man rather than to put more and more into him" (Froebel, p. 79).

Sit in a classroom on any given day and make some observations. Often times this is what the observer will see: A teacher is asking a question, several hands go into the air. The same students answer most of the questions. The teacher appears to be satisfied that the answer was given and moves on due to time constraints and/or a need to move on to the next concept/part of the lesson plan in order to make sure each standard has been hit before testing. The rest of the students are sitting there nodding their heads or nodding off. Transition over to a classroom discussion or group discussion and much of the same will be observed. Once it comes to assessment time, formative or summative, few students can interact with higher level questions let alone recall the basic information that had been presented in class. The expectation of daily science is much different as students get older and progress through the education system. Jorgenson, Vanosdall, Massey and Cleveland (2014), said that middle school science should be fun, fundamental, and connected to the lives of adolescents. They found that when educators fail to meet their needs in this way, far too many youngsters in the middle grades are turned off to science. I hope to discover the best practices to increase agentic engagement through the use of effective questioning strategies and implementing real life connections through use of discourse among students. *What is the impact of effective questioning and critical, relevant conversations on 6th grade science students' agentic engagement?*

The first part of this research is to define student engagement and determine a tool for gauging a specific component that is newer in educational research called agentic engagement. Engagement can be viewed through many lenses and the motivation behind increasing the engagement levels has varied intentions. Defining the term(s) and the parameters is necessary.

The second part of this research is to find out what already has been studied regarding components of the question in terms of agentic engagement, effective questioning and student discourse. If agentic engagement increases, what effect does it have on student achievement? When looking at research there are many approaches to this and some of these are packaged within a context of a curriculum or curricular components. I feel like this can be accomplished using what we already have and by implementing key elements. I will be looking at a variety of terms, programs and research in order to dissect their parts and find out how each one includes questioning and scientific discourse. Why do we ask questions? What are the purposes of questions? How do students connect to the information being introduced aside from being expected by classroom teachers and mandated state testing? More importantly, how do we create opportunities and lead students towards a more proactive approach in their own learning through asking questions and conversations?

The third part of this research is to gauge pre/post student engagement via observations of agentic behaviors and using surveys presented to the students.

"Student engagement is the product of motivation and active learning. It is a product rather than a sum because it will not occur if either element is missing."
~Elizabeth F. Barkley

Student Engagement

The word "engagement" is a buzzword, or popular word, that has taken over many educational reform movements and/or conversations. The simple addition of an adjective such as student, behavioral or cognitive in front of the word engagement brings on a slew of definitions or examples. When the words "cognitive engagement" are entered into a Google search, over seventy-five million, seven hundred thousand results come up. This research begins by defining the original three types of engagement and then a definition of agentic engagement which will be presented in this study and in particular how it connects to middle school science education. Why does it matter? How does a teacher increase levels of agentic engagement with the hope to increase student achievement or is there even a relationship between the two?

What is engagement? According to the Glossary of Education Reform (edglossary.org), student engagement refers to the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education.

Reeve (2013) explained engagement as the range of action students take to get from not knowing, not understanding, not having a skill or not achieving to knowing, understanding, having a skill and achieving. As reported by Conner (2013), at a secondary level, forty to sixty percent of students are disengaged. Varying reasons for a proclaimed “boredom” are uninteresting material, lack of interaction with teacher and lack of challenge in their assignments. Research points to the fact that curricular relevance to their life increases engagement as well as more interactive teaching that involves hands on learning and a project-based learning style. Conner also indicated there are three types of engagement: affective, behavioral, and cognitive. She defined cognitive engagement as valuing and caring about the work, a psychological investment which is shown through learning goals, mastery goals and an intrinsic motivation to learn.

Engagement has many definitions and forms. Parsons (2014) stated that engagement is not just defined by on-task engagement (behavioral and emotional engagement), rather it is engagement that demonstrates perseverance and the use of metacognitive and self-regulated strategies (cognitive and agentic engagement). Metacognitive strategies include thinking about thinking and learning from mistakes in the form of self-questioning, reflection and discussion. Piaget (1972) and Vygotsky (1962) described engagement as an active learning process. If engagement is an active learning process, then it is something that can be taught through varying strategies.

In much of the research up to now, a range of two to three tiers of engagement are most commonly used. The initial engagement theory chosen to be used in this research starts with three levels of engagement: behavioral, emotional and cognitive. As with most social sciences, the definitions of each of these levels depends upon the researcher, but there are some common threads that can summarize some general definitions for each of the above engagement types.

Behavioral engagement. Behavioral engagement is defined in Sinatra's article (2015) as involvement in one's own learning and academic tasks. It is observed through displays of effort, persistence, eye contact, leaning forward during conversations and seeking out information without prompting or assistance by an outside source. Reeve (2013) defined behavioral engagement as how involved the student is in the learning activity with regards to attention, effort and persistence.

Emotional Engagement. Sinatra (2015) defined emotional engagement as a student's reaction to academic subjects, tasks or school in general. The emotion can be a positive or negative emotion which triggers the engagement, but positive emotions have an advantage in achievement. For example, knowing that completing an assignment for homework can equate to a benefit towards a preferred career can put a high value on that assignment. Another example would be investment in a book character that a reader feels invested in that character's success and therefore engages fully with the book. Reeve (2013) defined emotional engagement as the presence of positive emotions during a task such as interest and absence of negative emotions such as anxiety.

Cognitive Engagement. Cognitive engagement is the most challenging form to define. Meece (1988) states that cognitive engagement can change from task to task in a given subject. Students can be engaged in scientific learning during their early elementary years, but become disengaged during the middle school years as is often the case in U.S. schools. (Drew, 2011) Cognitive engagement is described as a student's willingness to engage in effortful tasks, purposiveness, strategy use, and self-regulation. It is also defined by Sinatra (2015) as a psychological investment. Cognitive engagement includes self-regulating, setting learning goals or persisting on challenging tasks versus giving up. Reeve (2013) defines cognitive engagement as how strategically the student attempts to learn using sophisticated strategies such as elaboration versus superficial strategies such as memorization. A final definition of the complex, cognitive engagement comes from Newmann (1992): cognitive engagement is the student's psychological investment in and effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote.

All of the engagement types defined so far are reactionary and based on the structure of the learning environments which revolve around the teacher's strategies and plans.

Motivation versus Engagement

Researchers consistently attempt to clarify the differences of motivation and engagement. Often times confused, the terms motivation and engagement are not the same thing. Motivation is considered by many researchers to be a general trait. A person can be motivated but not engaged. Christenson (2012) makes the distinction between motivation and engagement as motivation being an intent and engagement being the action that arises out of that intent. Engagement can be more outwardly perceived by another person while motivation is internal. According to Sinatra, motivation and self-regulation runs through each of the "engagement" categories (behavioral, emotional, cognitive, and agentic). Motivation is woven through all of the engagement dimensions. Reeve (2013) indicates from his research that agentic engagement can lead to academic progress and is a self-initiated pathway to a more motivationally supportive learning environment. Unlike behavioral engagement's effect on motivation, agentic engagement is an intentional, purposeful, student-initiated action that leads to a more motivationally supportive learning environment.

Deep and shallow engagement

Research by Newmann (1992) goes further into the definitions of engagement and discusses shallow and deep engagement. Shallow engagement encompasses the use of basic processing skills and rote memory. Deep engagement involves thinking, asking questions, and integration of prior knowledge with current concepts. Students who display shallow engagement tend to develop vague, unrelated or not very thought out answers to a question. On the other hand, students who implement deep engagement show behaviors that allow students to master academic work. These students read carefully and develop well thought out answers. To state that engaged students will achieve academic success is not completely correct according to Newmann. Students can perform well on assessments while still being disengaged cognitively, emotionally, behaviorally or agentically. Newmann (1992) stated that significant amounts of research indicate that "students invest much of their energy in performing rituals, procedures, and routines without developing substantive understanding.

Active Learning. Active learning is referred to or coined as the term constructivism in many education journals and papers. Edwards (2015), citing research from Collins and O'Brien (2003), says active learning is the process of having students engaged in an activity that forces them to reflect upon ideas and how they are going to use those ideas. The definition goes on to say that it is the attainment of knowledge by participating or contributing. There are three categories of environments to focus on within the active learning framework: intellectual, social and physical.

Intellectual environment. Students should be intellectually active versus sitting back and getting the information passively and just accepting the authority's delivery, often referred to as "sit and get". The goal within this framework at this level is to step away from memorization and basic comprehension and move towards more mentally active types of strategies that involve synthesis, analysis, evaluation and creativity. Curiosity is still high at the middle school level and instruction is most effective when teachers use that curiosity within their teaching time. Examples given are problem solving and higher-level questioning to name a few (Edwards, 2015).

Social Environment. The next, social environment, addresses the natural tendency of middle school kids to be peer-oriented. The suggestion is to allow students to work collaboratively. This can be as basic as having partners answer and ask questions together and can be more elaborate such as having small groups work on a project together. An emphasis on small group and whole group discussions are included as a way to get students more actively learning (Edwards, 2015).

Physical Environment. The final environment in active learning framework is the physical environment. This involves getting kids up and moving and or involving kinesthetics of some type to engage them in the learning. This can be using manipulatives and can also be taking a lesson outside and having students gather data in various places. (Edwards, 2015).

All three of the above categories can be included in a single lesson and/or lessons can revolve around just one of the categories. The best practice according to Edwards (2015) is to not just have active learning for activity's sake or to just have fun. The lessons should have an educationally purposeful objective and should be planned out. Active learning encourages students to create new information with what they have learned, empowers them to uncover information on their own, and to work with information until it makes sense to the learner. (Edwards, 2015).

"To be an agent is to influence intentionally one's functioning and life circumstances"
~Bandura, 2006, p. 164

What is agentic engagement?

The concept of agency has been in the research troves for many decades. In the past few years, researcher Johnmarshall Reeve, coined the term "agentic engagement" as a new tier of student engagement and pursued a number of studies in an attempt to seek out validity in the addition of this engagement form. Reeve (2011) defines agentic engagement as students' constructive contribution into the flow of the education they receive. The interactions between student input and engagement and teacher instruction make this a unique form of engagement that can lead to proactive changes in the learning environment. (see figure on four aspects of student engagement, Reeve (2011 p. 580).

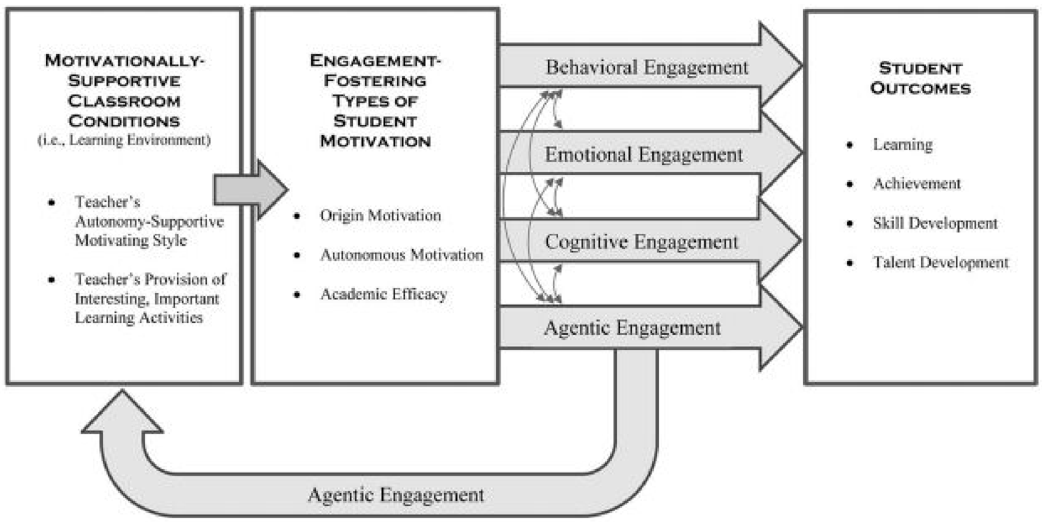


Figure 1. Four interrelated aspects of student engagement that explain students' positive outcomes (four horizontal lines) plus agentic engagement's unique contribution to constructive changes in the learning environment (curved line at the base of the figure). The six curved lines with double-sided arrows communicate the positive intercorrelations among the four aspects of engagement.

Figure 1. Engagement types and classroom connection

According to Reeve, the following five items, define the operation of agentic engagement and are the five items on the Agentic Engagement Scale:

• During class, I ask questions to help me learn.

• I tell my teacher what I like and what I don't like.

• I let my teacher know what I'm interested in.

• During class, I express my preferences and opinions.

• I offer suggestions about how to make the class better.

Student and teacher interactions are what drives the instruction. This is referred to as dialectical activity. Reeve says, student-initiated questions and communications affect change in and transform the teacher's instructional behavior, just as the teacher's instructional behavior in turn affects change in and transforms the quality and quantity of the student's engagement. Effective teachers are constantly changing their instruction as they perceive the needs of students in the classroom. The Agentic Engagement Scale items above are broken into unilateral and transactional contributions to the learning environment. Unilateral contributions occur when the actions involve the student without input from the teacher. Transactional contributions are defined by what a student does (proactively) affects and changes what a teacher does.

Engagement is what students do to make academic progress. Agentic engagement is a student's proactive approach to making the learning more meaningful to them. Agentic engagement gives some of the "power" back to the students in regards to steering a teacher in a direction of questions and connections that increase student engagement.

Behavioral, cognitive and emotional engagement are pathways to learning that are important but more teacher-dependent. Students take the teacher provided instruction as it is delivered and translate it into their learning network. The teacher is the all-knowing and powerful 'oz'. In agentic engagement, the students contribute to the learning in a proactive way and give the teacher insight into ideas and thoughts that motivate them and help to make the learning more real-world connected. This is a key to all learning and especially a strong force in making the material and information tangible and useful.

"Men often oppose a thing merely because they have no agency in planning it, or because it may have been planned by those whom they dislike." – Alexander Hamilton

According to the Handbook of Research on Student Engagement, there are five constructs of agentic engagement:

1. It is proactive, occurs before or during learning.
2. It is intentional, deliberate and purposive.
3. It makes the learning experience more personal, challenging, interesting or valued.
4. It contributes constructive input into the teacher's' planning or ongoing flow of instruction.
5. It does not connote teacher ineffectiveness or incompetence.

Agentic engagement encompasses making the learning tangible. In classrooms where students are beginning to lose interest and the science course drop-rates are high and science course success rates are at an international low (Drew, 2011), how can a teacher make the learning of science tangible and relatable to students?

Christenson (2012), using the research from Reeve, defines agentic engagement as the following: a student's intentional, proactive and constructive contribution to the flow of instruction that they receive. This can be assessed with behavioral observation and self-report. For example, a student might note that during class, they express their preferences and opinions about a topic. An agentically engaged student might offer input, make a suggestion, express a preference, contribute something helpful, seek clarification, provide or request an example, and/or ask for a say in how problems will be solved.

These are all constructive and personalizing acts that functionally enhance the conditions in which a student learns.

Agentic engagement is a proactive, student-centered style of engagement whereas emotional, behavioral and cognitive engagement are reactionary to a teacher led activity. Key things need to be in place in order for the students to feel a sense of "agency" in their own learning. First the basic needs of students have to be met on a physical and emotional level. Agentic engagement gives some of the "power" back to the students in regards to steering a teacher in a direction of questions and connections that increase student engagement. The overall goal of agentic engagement, according to Reeve's research, is to recruit the interpersonal support necessary to create a motivationally supportive learning environment.

Why does continued research into agentic engagement matter? In the rush to get through required skills and standards, the "talk" time is often the first thing to go in a classroom. Students go through the play and interaction mode but rarely get the opportunity to discuss, question and interact through words.
Students need to be able to make the language of science "their own" and talk science in a way that makes them comfortable and confident without the constrictions of teacher expectation of what should be said and what should be questioned.

In the world of science education there is a flood of new information being presented weekly just as there is a flood of new innovations and change in the world of science. The National Science Teacher's Association (NSTA) has endorsed and promoted many writings and pieces of work that revolve around a few key educational terms or instructional models. The following three will be a focus of the next section of this research: Twenty-first century learning skills, STEM education and the 5E Instructional Model for science lessons. Agentic engagement, as well as the other levels of engagement, can be found in the skills, strategies and theories that are in each of these key areas of modern day and tweaked/reformed science education.

Twenty-first century learning skills and STEM careers rely on agency within students and professionals. Much of what is to come in our world will require people to be able to ask questions and be proactive in the ideas they develop according to the P21 website. (http://www.p21.org/) Technological devices and the use of learning strategies such as Project Based Learning (PBL) guide students in taking the steering wheel of their learning. Technology use in the classroom, PBL, active learning, and STEM learning all require the characteristic of agency for students to fully acquire the positive potential of these teaching methods and tools. For instance, in a robotics class, students with agency appear to go on, ask questions, make connections and get the most out of the unit and students without the sense of agency appear to a sit back and watch style. An organization financed and led by Steve Jobs' widow, Laurene Powell Jobs, called XQ: the Super School Project, (http://xqsuperschool.org/static/XQ06_Student_Agency.pdf) addresses the need for acknowledging student agency in the schools of this century. The first few statements in one of their modules regarding design of Super Schools, clearly addresses the importance of agency, engagement and education: "Young people have valuable insights about their own learning journeys. They have the most to gain from their own learning experiences. Young people must be legitimate contributors to their own development.

Much of the learning that takes place in the traditional classroom is teacher led. Our ever-changing world requires changes in the educational approaches that are taken. In a century where significant change has happened in technology and science such as the use of cellphones, the internet and exploring the universe in ways we never expected using robotics, the traditional "sit and get" needs some updates. In a book called *Doing Good Science in Middle School*, the authors state, "good science constitutes a shift away from the textbook-centered direct instruction that emphasizes discrete factual knowledge claims and passive observation of science phenomena toward active, learner-centered, hands-on and minds-on investigations conducted to some degree by students themselves" (Jorgenson, 2014). Students are encouraged to be agents of their learning in the science classroom.

Research about online learning and technology from Irvine, Code and Richards (2013) addresses the recent surge of technology based instruction and the importance of student input to personalize their learning experience. They indicate that this has encouraged students to become more active agents in their learning and that embedding this sense of agency into learning communities is important for twenty-first century thinkers.

If students are lacking engagement, Christenson, Reschly and Wylie's (2012) report indicates they are missing the direct and only pathway to cumulative learning, long-term achievement and academic success.

Education Reform History

Science education reform has been on a journey that has resulted in many roadblocks and detours. Starting with the National Science Foundation's science curriculum reforms of the 1960s which resulted in significant change and funding at a federal level. This led most schools to return to the original text-book science at the end of the reform time. The 1980s brought Standards-Based reform which began with the government initiated report, *A Nation at Risk*. This report declared our nation was falling behind other countries and something needed to be done about it. The result was standards for content, instruction, assessment and professional development across all academic subjects to provide all students with knowledge and skills that were competitive. This era brought on many reform initiatives at the federal, state and local levels to increase science and math education. There were positive outcomes and many negative outcomes of the 1980s/1990s reform era. The current direction in science reform is a stronger focus on what science is and how students learn science. As a nation we are still falling behind other countries and there is growing concern about the future of our students in a "Science Technology Engineering and Mathematics" (STEM) competitive world. How can the United States increase the success of the underrepresented populations and the number of students entering college-level STEM programs? (National Research Council, 2007) Drew (2015) says, too often, attempts to reform STEM education seek a simple, concrete solution. Change the curriculum, hire teachers who excelled in college, select a charismatic school principal, and recruit the most talented students. Taken together, these reforms fall short of implementing deep, permanent improvement in STEM education. True reform requires transforming the way we teach, learn and lead. Drew (p.204) asks, "What does it mean to focus on teaching?" It means recognizing that the details of what teachers do, the particular questions teachers ask, the kind of task they assign students, the explanations they provide--are the things that matter for students' learning. The United States Department of Labor says that the the STEM workforce accounts for more than fifty percent of the United States economic growth, but few workers in the United States are employed in STEM-related jobs. This job force is expected to increase by almost three million new jobs by 2018. The Department of Labor says that the United States education system is not preparing students for these fields. (Walker, 2012).

If the words "best practice science curriculum" are typed into a Google search, more than one hundred, ninety-two million results are displayed. What is the best science curriculum resource? Does a school have to invest the huge amount of money necessary to get packaged resources in order to produce the most productive, successful and cognitively engaged students? Researchers are continuously writing journals and articles about how to create a set of parameters for educating students in science. Much of the success of a program comes down to a teacher's ability to deliver the materials in a way that will engage students and keep them talking, questioning, exploring scientific concepts and making the learning their own. Wieman (2012) says, learners must be convinced of the value of the goal and believe that hard work, not innate talent, is critical. If students are not engaged, the necessary hard work is difficult to extract. Drew's research has found many countries that are scientific leaders in education also believe success comes from hard work and not innate talent. These countries make the decision to teach all students with an expectation that success is possible.

Next Generation Science Standards. The framework for K-12 science education has identified eight essential practices for students with an emphasis on engagement. It is stated in the Next Generation For Science Standards, August 2015 newsletter, when students are able to construct their understanding by asking questions and arguing from evidence, teachers are able to use this classroom dialogue to guide and restructure their instruction. All aspects of that statement support the research on agentic engagement and the proposed ideas in this study. The NGSS has moved away from the previous push of inquiry as a marketing method and have a stronger focus on science and engineering practices. Even though inquiry has taken a buzzword backseat with the new set of standards, the concept of questioning remains foundational to guide good science education (Jorgenson, et. al, 2014).

STEM. Science, Technology, Engineering and Mathematics (STEM) has become a vital part of the education reform policies of this century. President Obama's recent law, Every Students Succeeds Act (ESSA) signed on December 10, 2015, further supports his original 2011 goal of preparing one hundred thousand STEM teachers in the United States within the next decade. Wingert and Bell (2015) refer to the National Research Council's Framework for K-12 Science Education's eight essential practices. Within this, Wingert and Bell express consideration to the idea that students should be learning *when* to be engaging in the science and engineering practices. They go on to say this is best done while they're pursuing a question that matters to them or when they are working through uncertainties that come up during investigations.

Twenty-first Century Skills. According to the NEA in *Preparing 21st century students for a global society ,* the term “twenty-first century skills” has been touted in the education world for about twenty years. The key parts that make up twenty-first century skills has been refined in many educational organizations to the following four Cs: critical thinking, collaboration, communication and creativity. The American education system was built on a structure for an economy and society that has changed significantly in the past one hundred years. The focus on the three Rs of the past, reading, writing and arithmetic is no longer enough in a globally competitive workforce. Within this framework, agentic engagement can be connected to each of the four Cs, yet the education system continues to work with an outdated concept of learning which is teacher-led/teacher-driven.

5E Instructional model for science. In most resources and supplemental guides provided by STEM funded projects and NSTA, the 5E instructional model for science is being used. The 5E instructional model lays out a framework for teachers to plan their lessons and units of study focusing on the 5Es; engagement, exploration, explanation, elaboration and evaluation. Effective questioning and relevant student discourse are components of each of these.

1. Engagement - students’ prior knowledge accessed and interest engaged in the phenomenon

2. Exploration - students participate in an activity that facilitates conceptual change
3. Explanation - students generate an explanation of the phenomenon
4. Elaboration - students' understanding of the phenomenon challenged and deepened through new experiences
5. Evaluation - students assess their understanding of the phenomenon

Within the 5Es of lesson building, agentic engagement can be a focal point in making sure that the 5Es especially in the areas of Engagement and Elaboration. Asking students questions and promoting discussions can open up ideas that would pull out agency in their learning.

Up to this point much research has been done in the areas of cognitive, behavioral and emotional engagement. The area of agentic engagement is new and much remains to be learned about this specific engagement type especially around actions that could affect the levels of agentic engagement in a student in the science classroom. Reeve concluded his 2013 report with the following:

> The general conclusion is that agentic engagement is a new and constructive aspect of student engagement that allows educators to more fully appreciate how students actually engage themselves in learning activities, as they not only try to learn and develop skill, but they also try to create a more motivationally supportive learning environment for themselves.

The remaining focus of this literature review will be a focus on two components of learning, effective questioning and discourse (or talk) in the science classroom. These are two areas in which a student’s input can be highly considered in structuring the learning environment. These are two dimensions in the area of science education that are dominantly emphasized and pushed for improvement and change according to STEM, 5E instructional framework components, the NGSS, and the definition of twenty-first century skills. The National Academy of Sciences lays out four strands of scientific proficiency in their report, “Taking Science to School”. Strand four states students should participate productively in scientific practices and discourse determines that to engage productively in science, students need to understand how to participate in scientific debates, adopt a critical stance and be willing to ask questions.

“The scientist is not a person who gives the right answers, he's one who asks the right questions.” ~ Claude Lévi-Strauss

What is effective questioning?

One of the items on Reeve’s Agentic Engagement Scale is “During class, I ask questions to help me learn.” In the book, *Effective Questioning Strategies in the Classroom*, Fusco (2012) has done much to clarify the components of effective questioning. On page one of the book, he begins by stating that questions encourage critical thinking skills, effectively assess the nature of the learning and build the confidence of students, build memory, focus attention, create emotions, hook the learning and build imagination.

Effective questioning promotes more than just recitation or memorization of an expected answer. Effective questioning does not exist in all classrooms due to the pressures of testing time limits and to cover the content expected on state tests. The call by many organizations associated with 21st Century learning, STEM education and science education is to create curiosity in our learners. Effective questioning can provoke that curiosity in all learners. Fusco (2012) said, “As we prepare our students for success in the future, we are aware of the complexity and uncertainty they face in the ever-changing, fast-paced world they will enter. Providing them with a solid cognitive foundation that supports critical thinking and problem-solving is our major responsibility as teachers” (p. 2). During Fusco’s research, a student responded to a teacher asking about the purpose of questions: He said, “ I thought you were checking up on whether we were listening to you. I didn’t think you were interested in my thinking” (Fusco, p. 11).

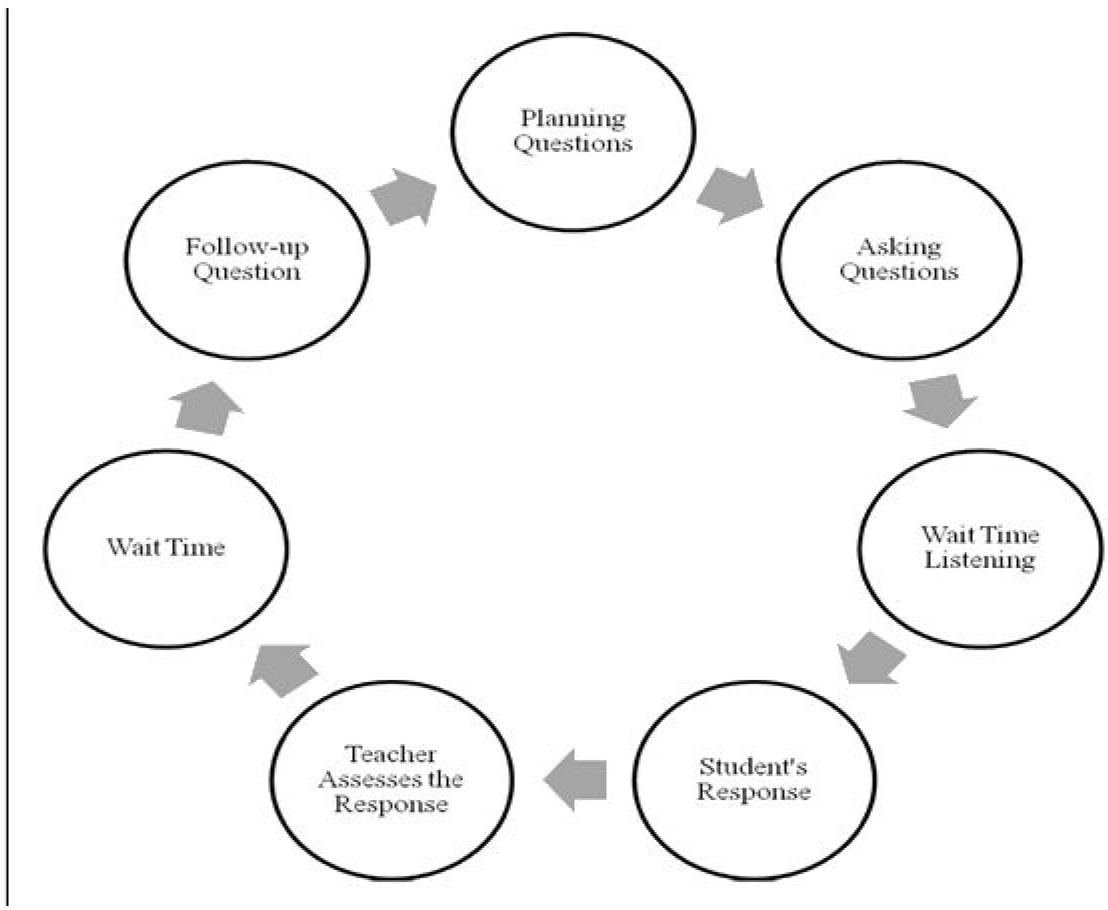


Figure 2 Steps in the Questioning Cycle (Fusco, p. 12)

"Good questions outrank easy answers." ~Paul Samuleson

Questioning Cycle. Good questioning, according to Fusco, goes through a questioning cycle. (see Figure 2). The stages of this cycle go through the process of establishing lesson goals with guiding questions, planning and asking the questions, allowing wait time, listening to the students' responses, assessing the students' responses, following up the student responses with another question, and re-planning based on students' responses.

Often times, teachers ask questions intended to evaluate student knowledge with a predominance of closed, "right there" type of questions. These lead to a reactionary answer from the students. Various writings on questioning (Fusco, 2012 & Smart, 2013), refer to a type of scaffolding of questions making sure to include lower order to higher order level questioning, also known as literal, inferential and metacognitive.

In Fusco's research and reflection upon other researchers, he found that a teacher will ask a question and in an evaluative mode, declare the answer right or wrong and the science talk stops there. Effective questioning by the teacher goes deeper into the questioning mode and has been shown to "stimulate the use of various cognitive processes and support students' development of conceptual understandings of concepts in science" (Smart, 2013, p. 252).

Purpose of questions. When students trust that teachers are actually listening and responding to their thinking and they (students) are developing a clearer understanding of a concept and growing in knowledge they become more actively engaged. They feel excited and empowered (Fusco, p. 14).

Ramsey Musallam, a chemistry teacher, gave a TED talk called 3 Rules to Spark Learning. He said we should confuse our students, perplex our students and evoke real questions in them because student questions are the seeds of real learning. In his TED talk he discussed a life-threatening condition he had and the change in his ways of teaching based upon the conversations he had with a surgeon. The surgeon told Ramsey the following three statements are what he attributes to his success;

1. Curiosity drove him to ask hard questions.
2. He embraced the trial and error without fear.
3. He gathered information to design and revise.

Ramsey took these statements and adapted them to the following 3 rules that he successfully used to change his teaching:

1. Curiosity comes first. Questions are windows to great instruction. Ask WHY?? The challenge is to keep getting kids to ask the questions!
2. Embrace the MESS.
3. Practice reflection.

Over two million views of his talk have taken place. Musallam's, Three Rules, not only are his thoughts as an experienced chemistry teacher, but can be found in the foundations regarding communication found in NSTA publications, NGSS publications, and many STEM related resources. Strong student reflection and asking purposeful questions are agency factors.

Three Types of Questions. Fusco categorizes questions into three types of questions, literal, inferential and metacognitive. The first being the most commonly used in classrooms around the country, literal. Literal questions are answered with specific answers, recall, or facts. These are the closed questions or questions with “right there” answers. For example, how many minutes are in an hour? Who is the author of? Who was the president in? Literal questions are reactionary questions and are spoon feeding types of questions. Teachers control what goes in, how much and what type.

Inferential questions are not directly stated in the text. These are open-ended questions that don’t necessarily have a single correct response. With inferential questions students develop their own line of reasoning. For example, what would happen to plants in our area if we didn’t have a summer? To differentiate between the two types of question with a topic specific set of questions:

- What is a hurricane? (LITERAL)
- What is the impact of a hurricane? (INFERENTIAL)

The last type of question is metacognitive. This type of questions encourages students to reflect on their own thinking and learning. Metacognitive questions are proactive questions. Students become aware of their needs and processes and therefore build cognitive skills. It is an expansion into their learning. For example, “What else could you do?” or “How do these ideas influence your thinking?”

Strategies to improve effective questioning. Arnold Arons, as cited in Robertson (2009), said the two most important questions to ask in a science classroom are “How do you know?” and “Why do we (you) believe?” in regards to any science concept addressed. Gallas (1995), and Rogers and Abell (2008) suggest that by asking open-ended types of questions and allowing for wait-time, a teacher creates opportunities for students to come up with their own questions and sparks discussion.

Danielson (2007) emphasizes the need for teachers in planning their questions especially the inferential and metacognitive types of questions. As students begin to respond more often to questions that require them to create, invent and design answers, teachers start to notice that students transfer these skills into all areas of instruction. Students are used to right and wrong answers and shy away when asked a follow up question. If they get used to follow up questions, they begin to trust this process and a dialogue happens that may deepen their connection to ideas of other students (Fusco, p. 20).

The Framework for K-12 Science Education says that students at any grade level should be able to ask questions of each other about the texts they read, the features of the phenomena they observe, and the conclusions they draw from their models or scientific investigations. For engineering, they should ask questions to define the problem to be solved and to elicit ideas that lead to the constraints and specifications for its solution. As they progress across the grades, their questions should become more relevant, focused, and sophisticated. Facilitating such evolution will require a classroom culture that respects and values good questions, that offers students opportunities to refine their questions and questioning strategies, and that incorporates the teaching of effective questioning strategies across all grade levels. As a result, students will become increasingly proficient at posing questions that request relevant empirical evidence; that seek to refine a model, an explanation, or an engineering problem; or that challenge the premise of an argument or the suitability of a design." Within this statement, the word "question" was stated eight times. This emphasis on a specific word in a short passage can lead one to think that questioning is a huge component of science education.

The HandsOn Science Partnership (2011) elicits the following key questions for science educators to consider:

1. What would happen to our solutions if the only way to solve a problem was through reading a textbook, or to have someone else tell us how to solve or address a problem?
2. What would happen if we could not discuss, see or explore the problems we face: individually and collectively?
3. How effective would our solutions be if we only solved problems with these one dimensional tools and did this by ourselves?

Curiosity Questioning. Galit Hagay and Ayelet Baram-Tsarabi (2015) conducted research on how to bring student interest into the high school science classroom. They found that students felt the curriculum was disconnected from their lives and interests. Their study involved bringing, what they called, curiosity questions. Within this research, they found studies that concluded a consensus among elementary, middle and high school students in regards to the disconnect between what they wanted to know and what the curriculum addressed (Hagay, 2015). Their research and the strategy introduced in their research will be one of the key effective questioning strategies included in the data collection period during the research in this capstone. During their research, only half of the student generated curiosity questions came up in the biology curriculum that was being used. This is in large part because the writers of curriculum seldom include student input, rather it is based on adult-perceived ideas of what students are wondering about a topic (Hagay, 2015). By using the student questions and ideas generated through the use of this anonymous strategy, the researchers found that the swath of students' voices stretched beyond the typical "question asking" students. Many other voices were heard and incorporated in the planning. This was given the name "shadow curriculum" because it was an annotated or edited curriculum that reflected the interests and informational needs of the users not the developers. Shadow curriculum, as a term, originated from the term "shadow government" which is alternative policies developed by political figures not in office (Hagay, 2015). Creating a shadow curriculum feels like a fitting strategy to increase students' agentic engagement as it is a proactive and student-centered approach. (Since 2014, the term shadow curriculum has been associated with educational scandal at universities so it is not a searchable term that would be relevant to this topic). Many of the questions being asked during Hagay's research led to relevant discussions in the classroom.

Questioning Sequences. Encouraging, emphasizing and guiding students into the hows of effective questioning and expanding upon the questioning already in place within the frameworks of packaged curriculum addresses the agentic engagement criteria for asking questions in the classroom within a supportive framework of learning that is being drawn out and encouraged by researchers in the field of science education reform.

What is student discourse?

Classroom talk, also referred to as discourse, guides students in making meaning of science concepts. According to Smart (2013), teacher questioning has been identified as a critical factor in facilitating effective discourse in the classroom, especially in the area of supporting students' engagement.

Dawes (2004) encourages a shift from communication between student and teacher, which has been the traditional approach, to a student to student conversation. She refers to this as dialogue between the students. A study called the Thinking Together Project (2016), was done to see if an increase in student dialogue could raise achievement in science and mathematics. This project is based out of the University of Cambridge and has many resources to encourage discourse in the classroom.

Communication is a learned process and if done incorrectly can lead to misbehavior and learners who are not engaged. The author goes on to say that talk and discussion about a concept among students is necessary to bring out the significance of the activity including use of the vocabulary of the concept. This study focused on teaching the students how to work and talk in groups, with a focus on Exploratory Talk. Neil Mercer (2008) defines three types of talk in the classroom as disputational, cumulative and exploratory talk. Disputational takes on a competitive style. There are a lot of "No, it's not" and "Yes, it is" argumentative conversations. Cumulative talk is a type of talk where everyone agrees, no one is critical and there is very little evaluation going on in the conversation. Cumulative and disputational talk are the typical types of discussion going on in middle school science classroom. The third type of talk, exploratory talk, is a constructive type of discussion where people challenge each other's thinking, students are actively listening, there is a sense of trust and shared purpose, students ask questions and everyone contributes in some way.

Cervetti (2014) discussed how talk supports science learning in three ways. First, student-to-student discussions lead to deeper understanding and problem solving than one would be capable of doing alone. Discussion supported crucial science skills necessary to be successful such as developing and articulating arguments which led to an increase in engagement. Second, students were able to learn from other students' ways of creating meaning about a topic. Third, students were able to see science as a process of continuous challenge and change. In order for discussion in the classroom to be productive, deliberate instruction in science talk is necessary. Students need to be provided strategies for talking effectively and thinking collaboratively. Cervetti (2014), references a study done by Neil Mercer with a focus on the term exploratory talk. According to Cervetti's article, (2014) Mercer defines exploratory talk as talk in which participants engage critically and constructively with one another's ideas. A study done in 1999 by Mercer found that middle school age students who were taught how to engage in exploratory talk were better able to establish science arguments, consider other perspectives and support their own perspectives. Another study found that in some cases, less than two percent of classroom time was spent in discussion because of the challenges that teachers face in establishing a productive science talk environment. It all comes down to proper training for the teachers and thoughtful, intentional implementation into the classroom. As the study unfolded in regards to exploratory talk the following question developed: whether it is always worth the time to allow students to construct their own understanding.

Michaels and O'Connor (2013) determine four goals for productive talk in the classroom. They refer to these as necessary and foundational to achieve "substantive and rigorous" discussion. Goal one is helping individual students share their own thoughts. If a student is going to participate in a discussion, he or she has to be able to share out loud in a way that is understandable and heard by others. Goal two is helping students orient to and listen carefully to each other. If students are only waiting to speak, but not listening to the other responses or making an attempt to understand their responses, they cannot participate in a true discussion. Goal three is helping students deepen their reasoning. If a student thought or discussion does not include "solid and sustained" reasoning, a discussion can fall short or fail to be academically productive. Goal four is helping students engage with other students' reasoning. This goal includes taking in the other student responses and responding to them. Michaels and O'Connor (2013) refer to this as the fun part of discussions.

Discussion Diamond. This is a strategy that encourages students to respond to a statement or question and commit to reasoning behind their viewpoint. It is also called "place mat" by Lin (2005). This strategy encourage individual and group thinking and reflection. Group members independently respond to the question or statement, jot their thoughts in their section of the team output sheet, then share their responses with the team. Upon hearing all team members input, a summary is decided upon and shared out to the class, other groups, or written for assessment. This strategy emphasizes respect, active listening, and critical thinking. These are skills included as critical to teach in the various frameworks referenced earlier in this chapter.

Four Corners Discussion. This strategy is found on many teaching sites. In the article, *Strategies to increase active discussion and thinking for all students*, Lin (2005) addresses the difficulty of getting middle school age students to engage in ongoing relevant discussions. One of the strategies she suggests to use is Four Corners. The purpose is to get kids to choose a view or perspective on a statement or question and share their reason for responding. It is considered to be a cooperative learning strategy. This strategy is kinesthetic, in that it gets kids up and moving. It also encourages listening, verbal communication, critical thinking and decision-making. These skills are all touted as important skills to reinforce in the science classroom as indicated above. They are explicit or implied within the Four Cs of Twenty-First Century learning and the 5E framework.

Talk Moves. In the book, Ready, Set, Science, (2008) the authors describe the use of "Talk Moves" to get students moving out of the recitation style of discussion and into a more student centered discussion format. Talk is an important and integral part of science education which should be employed daily to give students an opportunity talk through their ideas. Scientists share their ideas through communication and they collaborate through argumentation about evidence and disagreement in order to move a scientific idea forward (Michaels et al., 2008). Talk Moves starts with some basic prompts to be used in the classroom as follow ups to lessons and questions. For example, asking students to clarify the explanation or thinking of another student by putting it into their own words. Another example, would be to ask a student if they agree or disagree with a student's position. Often times, simply asking a student "Why they think that?" or using the phrase "Tell me more" encourages deeper levels of discussion.

Michaels and O'Connor (2013), separate talk moves into two categories: "say more" and "press for reasoning". Say more includes questions such as "can you say more?" and "Can you give us an example?" Press for reasoning includes statements such as "Why do you think that?", "What's your evidence?", or "What led you to that conclusion?"

Classroom talk or discourse is a pathway to giving students the opportunity to show how they see things in regards to learning, to making the ideas relevant to their lives, to providing their preferences and opinions and a way for the teacher to listen to how a student sees things and would like to make connections. Michaels (2008), says talk moves can create deeper engagement, allow students to talk about their own thinking, and provide motivation by enabling students to become connected with their peers' ideas.

Why a focus on effective questioning and classroom discourse?

Smart's research (2013) says teacher questioning can be an integral part of incorporating effective classroom talk or discourse. Interactions between teacher and student can shape the course of student learning. In an inquiry-based classroom, the teacher's questions adjust based on student responses and lead to higher-level thinking questions. Science learning and engagement involves more than just conducting interesting investigations and hoping that students grasp the intended outcomes. Effective science instruction and learning include communication and collaboration. Communication and collaboration create a pathway for students to become agents of their own learning. (Michael, Shouse, & Schweingruber, 2008). Michaels and O'Connor (2013) stress the importance of linking discussion and the learning defined in the Next Generation Science Standards.

Agentic engagement is a newer term but the premise behind it includes many important and already in place ingredients to potentially improving educational frameworks. Through evaluation of current resources being used in the sixth grade classroom at my school/district and surveys that will gauge student agentic engagement, my intentions are to find out if effective questioning and increased student discourse increase or have no impact on agentic engagement levels of students at varying academic levels. The ever-changing world requires a change in the way students are approaching their own learning so students may become agents in their own learning.

CHAPTER THREE

METHODOLOGY

Introduction

The purpose of this chapter is to explain the methods that will be used in answering the research question, "*What is the impact of effective questioning and critical, relevant conversations on 6th grade science students' agentic engagement?*" In this chapter, I will describe the participants, the setting in which the research will take place, and the research tools/methods that will be used in answering the research question as well as the rationale for choosing those research methods. There will be two units taught to all of the sixth grade science students. One unit will be taught as it has been set up through the use of district purchased resources and district created unit plans to align with standards. The other unit will be taught with a focus on creating relevant topics with the expected units objectives as well as teaching specific strategies for effective questioning and increasing the use of discourse or classroom discussion among students in the classroom.

Participants

The participants in this study will be one hundred twenty-four sixth grade students at a Title 1 suburban school outside of the Twin Cities. The students were chosen because they are my current students in science. The demographic of this school is as follows: 30.3% free/reduced, 13.6% Special Education, and 13% English Language learners. This particular school has the greatest demographic disparity compared to other elementary schools within this district. The cultural demographic in this school is 63% white, 16% black, 10% Hispanic, 10% Asian, Pacific-Islander and less than 1% American Indian/Alaskan native. I received approval from the Hamline HSC (Human Subjects Committee) committee as well as permissions via a parent permission/opt-out form from the parents of the students who were going to be a part of the data collection process. Students who were not granted permission or who opted-out did not participate in the data collection.

Setting

As mentioned above, the location is a suburb school on the eastern side of the Minneapolis/St. Paul area. The school is one with comparably large demographic differences compared to the other schools within this specific school district. It is a limited school setting in regards to teaching science because the classrooms are not set up to fit a full time rotational schedule science classroom. There is limited space to partake in the labs and a lack of resources in terms of the physical science standards that are to be taught in this classroom.

METHODS

Student Interest Survey

(taken from http://www.niu.edu/ETEAMs/pdf_s/VALUE_StudentInterestInventory.pdf)

Student interest surveys (Appendix) have become an integral part of the classroom. I usually give one, but after reading them, an ignorance ensues in order to meet the demands in the classroom. Relevance of learning based on student interest will be taken into consideration during the planning of the second unit during this research.

The following six questions will be given to each of my classes as a student interest survey at the very beginning of the research timeframe. This interest survey is given to understand the underlying motivations, extrinsic or intrinsic, behind a student's engagement in their school life and their extracurricular life. I will send these surveys home for students to fill out with the guidance of their parents so the surveys are thoughtful and as detailed as possible.

1. What can teachers do to capture your interest?
2. Give an example of a classroom activity where you really learned a lot. What was it about that activity that made you learn?
3. Tell me about a time that you felt really proud of yourself (in or out of school). What is it about this moment that made you feel proud?
4. Do you belong to any clubs, organizations, or teams? (in or out of school).
5. Do you prefer to work alone, in partners, small groups or large groups? Why?
6. What do you see yourself doing after you graduate from high school?

When it comes to agentic engagement and incorporating relevant topics to allow for student to student discussions, student interest will be a tool to guide me in the second part of the data collection period.

Learning Climate Questionnaire

It is important to understand the student's perspective of their learning environment and their ideas around agency within the learning environment. Reeve (2013) developed a survey called the Learning Climate Questionnaire and included the following six items to gauge agentic engagement of students:

- I feel that my teacher provides me with choices and options.
- I feel understood by my teacher.
- My teacher encourages me to ask questions.
- My teacher listens to how I would like to do things.
- My teacher conveys confidence in my ability to do well in the course.
- My teacher tries to understand how I see things before suggesting a new way to do things.

Within the goals set by my school district in terms of self-reflection in the classroom, we provide a survey to our students to gain understanding of how the students feel in the classroom. As part of this, I wanted to delve further into how the students feel in the classroom about specific items. This learning climate questionnaire will accomplish that goal as well as getting the above information which is important in establishing some parameters within agentic engagement factors that are impacted by the learning climate.

Video Tape Observations

On two occasions during each unit, I will be video taping my classes throughout the day to later view and gauge student on-task behaviors and interactions connected to engagement. As I will be teaching these classes at the same time I am gathering data and will not have access to an observing second set of eyes. Viewing the videotaped sessions will help me see things I may miss during the lessons. These video tapes will only be used by me to gather data and I will erase the videos once the research has been completed. Students will be identified by numbers and not by name to assure confidentiality.

Experience Sampling Methods

The Northern Illinois University College of Education (2016) developed a team of researchers called SciMo. SciMo is “Science in the Moment” and the focus of the research group was to collect data on student cognitive and affective engagement. Their data collection included the use of Experience Sampling Method, ESM, which is a method of data collection connected to the use of a randomized signal. ESM is used with adolescent and adult populations to study their affective states during activities. Affective states can be positive which lead to an increase in motivation or negative which can lead to a decrease in motivation (Harmon-Jones, 2014).

Following the outlined science classroom research of the SciMO project, over a five day period in each of the two units, I will conduct Experience Sampling Method (ESM) surveys to measure students’ experience. A timer will be set to go off at random times which will signal students in groups of six to ten to go to a designated area in the classroom to fill out an Experience Sampling Form. This form will record their current activity and their thoughts/opinions of the learning content at that specific time. The survey will include some agentic questions for students to gauge their experience. The individual surveys should take no longer than two to three minutes for the students to complete each day (Shumow, 2014). The questionnaires are in paper format that students will fill out over a five-day learning period.

Why ESM? The following research on experience sampling method was used to decide on the use of this method. Students reported on the cognitive dimensions of their subjective experience by rating on a 5-point scale items about the challenge of the activity, their skill in meeting these challenges, the degree of control they felt during the learning, the degree of choice they felt in how the activities were completed, the degree to which they felt they were living up to their teachers' expectations, and their levels of concentration at the moment they were signaled to fill out the survey. Similarly, students also rated these affective dimensions of their experience in terms of their enjoyment of the activity, their interest in the activity, their anxiety and levels of anger or frustration during the activity.

The original form, the Experience Sampling Form, ESF, was a thirty-four item survey that assessed a variety of dimensions of students' experience. Students indicated, on the ESF, both the main thing and what else they were doing at each time they were signaled. Using zero to three on Likert scales, students also reported on multiple dimensions of their subjective experience, reporting up to twenty times by the completion of the study. These dimensions included both students' emotions (e.g., happy, bored, anxious) and their cognitive (e.g., concentration, interest, effort) responses to reported classroom activities. Each subjective report was then linked to a: (a) specific course, e.g., biology; (b) content unit, e.g., forces and motion in two dimensions; and (c) classroom activity, e.g., laboratory work, such as enzymatic browning of fruit. In the SciMo project, a total of 4,136 ESF reports were collected: 2,139 during the Fall and 1,997 during the Spring semesters (Smith, 2012).

Experience Sampling is not currently widely used in educational research. There is much to learn about this form of data collection. This form of data collection allows the researcher to examine experience in context of the daily lessons. (Zirkel, Garcia and Murphy, 2015). These types of survey are "in the moment" and allow reflection on the lesson/strategy and student experience as it is occurring. Using ESM gives the researcher a chance to acquire data in the moment as individuals typically mis-remember how they spent their time or how they felt about a situation if not taken at the immediate moment. Experiential memories are often shaped differently than they happen due to cognitive and behavioral processes that take place after an occurrence (Zirkel et al., 2015).

In this study, students will be reporting a total of ten times by the completion of the data collection period.

Likert Scale. It is important to explain the Likert scale rating as it will be used in this research. The Likert scale originated in 1932 by Rensis Likert. It is generally a five to seven point scale that rates the degree to which a respondent agrees or disagrees with a statement. Likert scales are best used when collecting data about people's attitudes, feelings or opinions. The Agentic Engagement Survey will include a five point scale in this study. ("What is a Likert Scale?", n.d.)

Agentic Engagement Survey/Learning Climate Questionnaire

The whole purpose of this research is to see if there is an increase, decrease or neutrality in student agentic engagement levels. The agentic engagement survey and learning climate questionnaire will be given at the start of the research timeframe when the student interest surveys are sent home. In addition, an AES will be given at the end of the first unit and at the end of the second unit. Some of the AES questions will be included in the ten ESF surveys given. I will modify the second unit to increase the opportunities for student questioning, student input on the concepts and student conversations/discourse. Throughout the second unit, I will intentionally provide students with strategies in the area of questioning and discourse. The students will complete an AES at the end of the unit.

Process

The first unit will be taught as it is laid out by the district framework and the district resources without much modification. For the second unit, there will be changes to the use of effective questioning strategies and student conversation structures in the classroom through direct instruction of strategies in these two areas. In addition there will be intentional placement of relative topics to students in the unit of study. At the closure of each unit, I will administer the agentic engagement survey to all students. The initial plan is to give the agentic engagement survey to students in all of the four science classrooms to get a ballpark of student self-reflections. Both the AES and LCQ will be based on a four point Likert scale using zero to three as the ratings.

Why? The timeframe and use of multiple surveys stem from research by Reeve and colleagues (Reeve, 2013). In this study, participants completed a brief questionnaire three times during the semester, two weeks into the semester (T1), a week after the midterm exam (T2), and the next-to-last week of the semester (T3). The T1 questionnaire assessed students' demographic information, class-specific agentic engagement, and perceptions of teacher-provided autonomy support. The T2 questionnaire assessed students' agentic engagement and perceived autonomy support and the T3 questionnaire assessed only perceived autonomy support. The research assistant who administered the questionnaire told participants that their responses would be confidential, anonymous, and used only for purposes of the research study. Aside from the use of an assistant to collect the data, I will follow a similar plan. Throughout the first unit and in planning the second unit, I will be looking for opportunities to increase agentic engagement with students in the FOSS curriculum and school district purchased items so as not to negate the resources provided by the district.

I will pick students and count or track the number of agentic engagement moments through observation and use of survey methods during an original unit of study.

For the second unit of study, the method will be to teach strategies specific to effective questioning and student discourse to the students. In conjunction with these taught strategies, data will be collected using agentic engagement moments. The driving questions going forward throughout the second unit of study will be, "Where are the opportunities to increase agentic engagement with students to supplement the FOSS curriculum and school district purchased items?" and "What additional strategies and resources are helpful in making the learning more connected to students so they increase their agentic engagement levels?"

Timeline

The timeline for the study is to begin with the student interest survey, the first Agentic Engagement Survey and the Learning Climate Questionnaire in April 2016. The unit will be taught as is using the district unit outlines/framework and district purchased resources throughout the unit. I will use the Experience Sampling Method to gather information as well as recording various classroom sessions to have a second opportunity to view engagement around the classroom. In May, I will teach a new unit implementing strategies to increase effective questioning by the students. I will also teach strategies which increase student discourse specifically using issues relevant to the students which were identified through the student interest surveys. Throughout this second unit, I will again use the Experience Sampling method to gather student information as well as videotape classroom sessions for a second opportunity to view engagement around the classroom. At the end or towards the end of the second unit, late May, students will fill out the final Agentic Engagement Survey and the Learning Climate Questionnaire. Even though I am gathering data on all of the students, there are particular students in each hour who will be a focal point based on their historic disengagement and lack of motivation in the classroom. This will be determined through the use of identifying the highest achieving students and lowest achieving students in each hour. These students will only be identified with a number that I have assigned to them to assure privacy and confidentiality.

Limitations

Limitations for this study include student attendance, district and state testing schedules for the spring, and interest level in the two different units that are being focused on during the research collection time. Students will also have some engagement interference during the units when they are being asked to stop the current learning activity to fill out the experience sampling surveys. My initial role will be to continue teaching the science classes without much change to my current way of teaching using the resources provided within the framework laid out by district for units of study in sixth grade science. Then I will modify the next unit based on student input in regards to student interest, best practice strategies for increasing effective questioning and relevant science discourse. I will also be doing video observations of various students that will include an attempt to count/track the number of "agentic" engagement observable moments. I want to focus specifically on students that have been historically known as disengaged and unmotivated students. I am aware that many factors could influence the data that I am gathering, but the reality of isolation of certain factors given the classroom numbers I have along with minimal classroom support makes this difficult.

Strategies

I chose a focus on questioning and classroom discussions because these are areas in education that tend to be lacking in effective implementation in the average science classroom. As a teacher, I struggle with finding time to really use these strategies and as a learner, I know that my best learning takes place in the times I am developing and asking questions as well as having discussions with my peers.

Effective Questioning Strategies.

"The art and science of asking questions is the source of all knowledge."

~Thomas Berger

A plethora of research has been done since 1912, which signaled the beginning of the questioning debate. At this time, a researcher, Romiett Stevens, investigated teachers' questioning practices. The basis of her research was regarding the amount of questions a teacher asks in a day. From this point forward, there has been an ongoing conflict of interest in higher order versus lower level questioning. Some argue that lower level thinking questions are more important while some argue that higher order thinking questions are more important in student achievement and engagement (Marzano, 2014). Bloom's taxonomy has become a buzzword in the field of education, especially in regards to effective questioning strategies. Within Bloom's framework, there are six domains: knowledge, comprehension, application, analysis, synthesis and evaluation. Within the arguments indicated above, Bloom's taxonomy has been at the core of the types of questions being asked and the importance of hierarchical levels of question. (Marzano, 2014). The following strategies: questioning sequences with the use of sentence stems, questioning as thinking and curiosity questions were research based, best practice strategies (Marzano, 2014; Tofade, Elsner, & Haines, 2013; Hagay & Baram-Tsabari, 2015) that include the use of Bloom's taxonomy levels along with utilizing student interest. I have decided to use these strategies during the second phase of my data collection to implement effective questioning in the science classroom.

Questioning Sequences. There are four phases of questions within the framework laid out for questioning sequences. (Marzano, 2014). These questioning phases are titled detail, category, elaboration and evidence. The phases include questions that are lower order, such as knowledge or recall inquiries, and higher order questions that ask students to think more deeply. Keep in mind that not all higher order questions are answered using higher order thinking. Some students have heard the answers to these higher level questions and even though the answers sound “cognitively more challenging”, the students are simply recalling information they have already heard or learned.

Questioning as Thinking. (QAT). In this strategy, the focus is on student-generated questions to help them explore and investigate their understanding of a topic. The goal is for students to self-monitor and bring themselves back to the topic with questions such as, “What are my goals for learning?” or “Does this make sense to me right now?” (Tofade et al., 2013).

Curiosity Questions. This strategy uses student interest and curiosity about a topic to develop lessons within a specific standard framework to teach a unit. The strategy involves introducing a topic to the classroom then prompting students to write anonymous questions they have about the topic or things they want to know more about. These questions or curiosities will then be incorporated into the resources available while still being tied to the Minnesota standards required. During the first part of the data collection period, I will teach units without modifying based on student questions and curiosities. In the second part, I will introduce the topic to be studied and collect the student questions and “I wonders” about the topic to guide my planning of the upcoming lessons. During the teaching, when an item brought up by a student's anonymous question is addressed, I will begin with phrasing similar to the following, “I was asked by one of the students”. Any topics not brought up during the actual unit will be addressed in a summary component of the unit so students will not feel as if their questions went unanswered or unaddressed.

Discourse Strategies.

"Great minds discuss ideas. Average minds discuss events. Small minds discuss people." ~Eleanor Roosevelt

Discourse in the classroom is the second most common method of teaching, besides lecture. Discussion is becoming increasingly more important based on the Next Generation Science Standards and Twenty-first century learning. More often than not, what some consider to be discussion is simply recitation. Initiation (or inquiry)-response-evaluation (IRE) is used which does not lead to increased perspective-taking, understanding, empathy, and higher order thinking (Finley, 2013). IRE is the typical classroom discussion that is initiated by the teacher, students respond and the teacher evaluates the student responses (Bacolor et al). This form of discussion limits student interaction. IRE is a form of convergent (closed) framework for classroom talk versus the divergent (open) framework which emphasizes more student talk and student-to-student interaction. Convergent frameworks are teacher led with a teacher-to-student interaction (Henning, 2007). The following strategies will be used during the second phase of data collection to make the classroom discussion more divergent: four corners discussion, discussion diamond, and talk moves. These three simple strategies have been designed to increase talk in the classroom as well as having students establish reasoning. From my professional opinion, these are activities that will flow and be easy to implement into the classroom environment to enhance the discussion framework. These methods give accountability to each student and leave little room for reluctant students to be non-participators. An added bonus is these strategies get kids moving around which is an important factor in my classroom structure and within my school's goals of getting kids up and moving.

Four Corners Discussion. This is a strategy that can be fun and purposeful. Students are given a statement or claim then must take a stand on their position in regards to the statement or position. They begin by thinking about their position. Students choose a corner of the room and listen to one another's reasoning for making the decision and discussing as a larger group. The discussion is opened up to the whole group including all of the perspectives of each corner. Students can ask clarifying questions of one another for a deeper discussion as well as to understand other perspectives. Norms of how this activity works will be set up ahead of time. The voice of each student in the classroom will not be heard but the hope is to get students more engaged and listening to each other. Often I will be known to state to the class, "Commit to an answer" after which they either tell their team members or they give me an indicator to show what they chose. The purpose is to get the students to make a decision instead of being passive. I believe, The Four Corners Discussion will take this strategy to a more interactive level.

Discussion Diamond. This strategy, also known as place mat, is a small group discussion activity. A question or statement is given to the groups. Students ponder individually on their position regarding this topic and write their response in a section of the group discussion diamond sheet. After a given time limit, groups share with one another as each group member asks clarifying questions or gives comments. A recorder will summarize the group's comments/thoughts prior to the end of the activity and another student will report out the group's thoughts, disagreements or agreements.

Students will alternate roles of recorder and reporter so members have accountability in all aspects of this activity over the duration of a unit or lesson. I plan to use this resource to encourage discussion in the classroom. This is a soft implementation mechanism for getting discussions going.

Talk Moves. In the book, Ready, Set, Science, (2008) the authors describe the use of "Talk Moves" to get students moving out of the recitation style of discussion and into a more student centered discussion format. Talk Moves starts with some basic prompts to be used in the classroom as follow ups to lessons and questions. For example, asking students to clarify the explanation or thinking of another student by putting it into their own words. Another example, would be to ask a student if they agree or disagree with a student's position. Often times, simply asking a student "Why do they think that?" or using the phrase "Tell me more" encourages deeper levels of discussion. The key, I believe, is to get students using this kind of speak in their group discussions. As in the other strategies for group discussions, group norms will need to be established for each hour so students feel safe and trusting in the process. The use of "Talk Moves" will be an easier transition because some of the ideas are already being used in the classroom. It will not feel unnatural as the responsibility shifts away from the teacher and more onto the students. Through the use of assessment probes found in Page Keeley's many NSTA books, I will implement a more intentional use of talk moves in my classroom.

NGSS and the Institute for Math and Science, say that scientists, mathematicians, engineers and writers need to effectively communicate and make sense of their ideas which involves reasoning and seeking understanding. This classroom talk is referred to as productive talk and includes four goals for classroom discussion: sharing and clarifying individual thinking, listening to each other, deepening individual reasoning, and thinking together. (Bacolor et al).

By implementing effective questioning strategies and classroom discussion strategies, I hope to find out whether individual agentic engagement increases for students or whether there is minimal to no impact on the engagement levels. Through an intentional use of effective questioning and discussion strategies, I believe I will see more investment or agentic engagement on the part of the student. The classroom will take on a more collaborative feel and by providing opportunities for agency within the lesson planning I will be looking to see if there is an impact on student engagement as defined in chapter two.

In chapter four, I will explain the results of the data collected with the use of the methods and instruments outlined in this chapter. I will also discuss in more detail limitations of the process that took place in my classroom.

CHAPTER FOUR

RESULTS

The purpose of this chapter is to compile and share my results from the classroom study done as laid out in chapter three. This study included over 120, sixth grade students in a science classroom. A variety of surveys and implementation instructional strategies was included as part of the research. The study was focused on the following research question: "*What is the impact of effective questioning and critical, relevant conversations on 6th grade science students' agentic engagement?"*

Analyzing my data was difficult. Many changes had to be made and the original expectations of what I planned on doing got dropped or modified. Getting to this chapter took me a few months to get to because upon my original overview of the data collection, I was feeling frustrated and did not see much validity in my results. The following information discusses the limitations of my research, the anecdotal information about this process and the various surveys and strategies used.

Initial Agentic Engagement Survey

Students began the research period by taking an agentic engagement survey. The initial AES results for the entire sixth grade population are as follows:

Figure 3: Statement 1: I let my science teacher know what I need and want.

3.8% Never; 13.3% Rarely; 31.4% Sometimes; 41% Most of the time; 10.5% Always

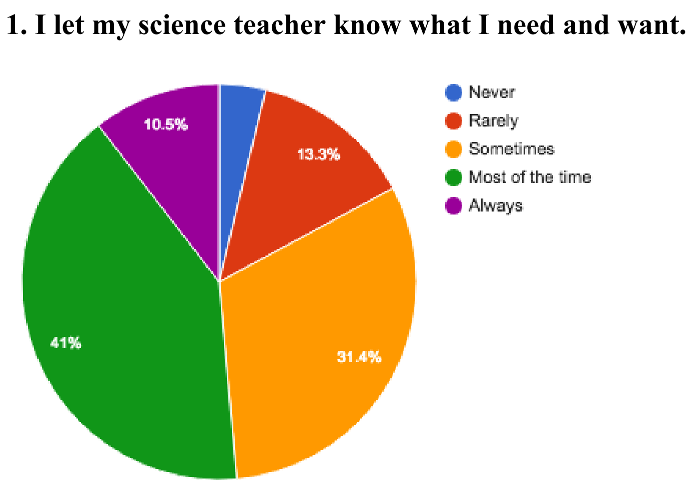


Figure 4: Statement 2: During this class, I express my preferences and opinions.

2.8% Never; 22.6% Rarely; 28.3% Sometimes; 32.1% Most of the time; 14.2% Always

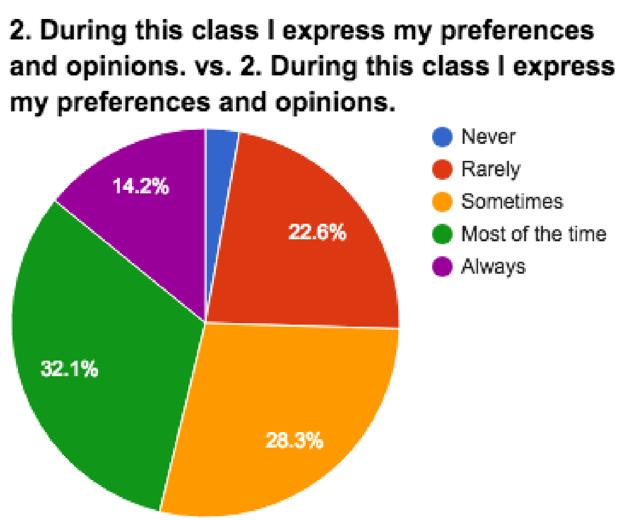


Figure 5: Statement 3: When I need something in this class, I'll ask the teacher for it.

0.9% Never; 6.6% Rarely; 15.1% Sometimes; 38.7% Most of the time; 38.7 % Always

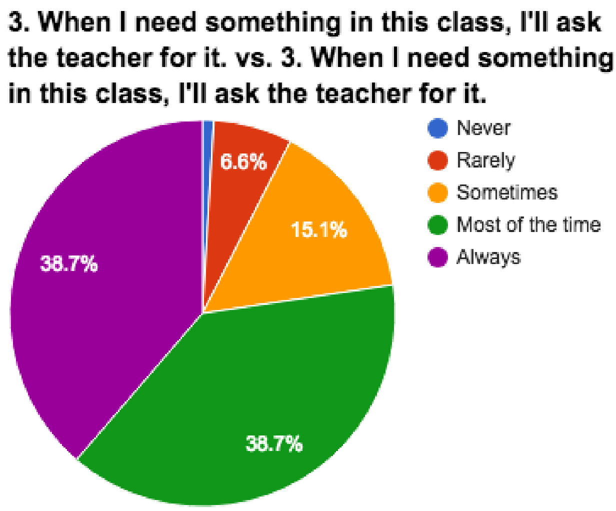


Figure 6: Statement 4: During science class, I ask questions to help me learn.

0% Never; 10.5% Rarely; 34.3% Sometimes; 30.5% Most of the time; 21.9% Always

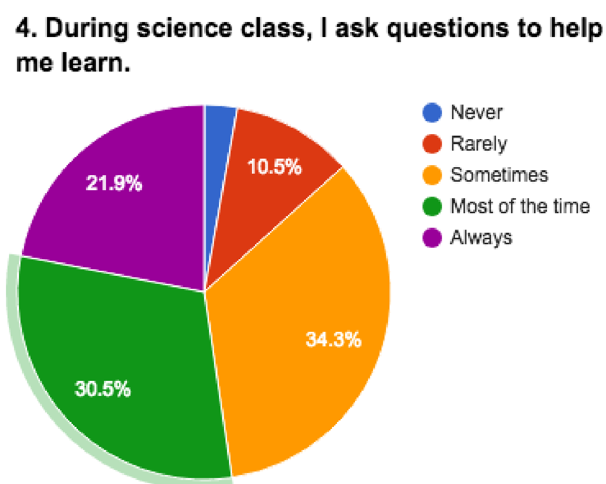
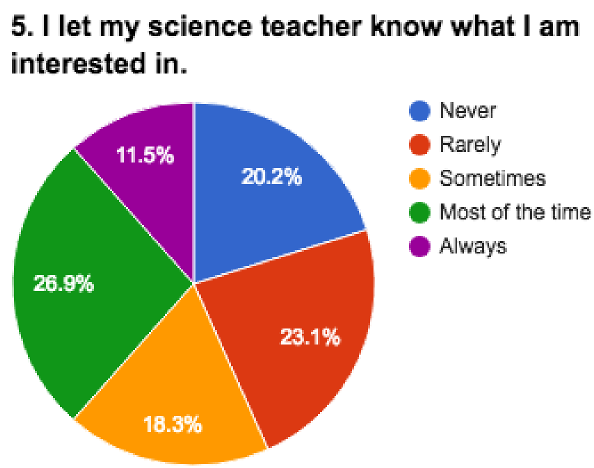


Figure 7: Statement 5: I let my science teacher know what I am interested in.

20.2% Never; 23.1% Rarely; 18.3% Sometimes; 26.9% Most of the time; 11.5% Always



Looking at these results was surprising and at the same time, not surprising. The last statement's results, "I let my science teacher know what I am interested in," prior to implementing the various strategies, showed that students did not feel as if they gave much input on their interests. Over 60% of the students never, rarely or sometimes shared their interests. The take-away for me in this situation is to ask students for their interests. Historically, science has been fairly prescribed and teacher-led especially in terms of what is being taught. The NGSS and STEM approaches to science education are encouraging and supporting relevance which is intended to increase inclusion of student interest. There is room for improvement and plenty of information out there to support or encourage all of the above in the science classroom. I will share more about moving forward in chapter five.

Week one (May 16-20)

The first week of data collection, I just taught the lesson as it was laid out by the purchased curriculum. I have to be honest, that I was extremely uninterested in the role of the teacher with this process. The lessons were prescribed and did not leave a lot of room for students to think out of the box. The boxed resources are necessary in the elementary level because of the lack of science content background for many of the teachers or the difficulty in going deep because of the large swatch of preparations for all of the subject areas being taught by one teacher. Use of the boxed resources makes the delivery of the content consistent and as accurate as can be for those younger learners. The number of questions that are in the lessons and the room for discussion is limited. The question types are fairly low in the number of higher thinking and engaging thinking types of questions. I tried to keep away from adding my own twist or bringing in my own flavor to the lessons to get as valid data as possible.

The sense and feedback was driven to a lot of "bored" students.

I started the ESM with students. After the second day, I decided to reduce the survey days to 3 instead of 5 because it seemed like the students were getting less intentional as they days went on. At first, there was a lot of excitement around something new and different, but that wore off quickly. The original use by SciMo of the ESM was done with older students. I realized I did not spend enough time going over the surveys and some of the groups were very rushed to fill them out.

This week we were using a very prescribed resource called "Newton's Toy Box". The questions are pretty straight forward and are provided. We did the surveys in intervals of 10 minutes and I randomly drew sticks of team numbers. The teams went at that time to fill out survey and return to the seats. The goal was to have students fill out the surveys without disrupting the flow of the learning, but it definitely created a transitional delay in learning and was quite a disruption to class time. Students were focused on watching the timer and every time I randomly grabbed a number stick to decide which group was going to fill out the survey, they would get so distracted. I tried doing this subtly and without a lot of pomp and circumstance but still the students got distracted. Transition with middle school age students can create a large amount of purposeful time loss.

The surveys had to be changed after the first day to give more specific prompting to the students. Responses to question number one was very generic which asked them to give a short description of what was happening in class at the time they were asked to fill out the survey. It made it difficult for me to organize the results into types of work, independent, lab, whole group, partner, etc. The change made has been included in the Appendix ESM 1 (original) and ESM 2 (modified). The change was simply giving specific prompts. The next day, it was difficult because many of the students were dependent on those prompts and ONLY wrote one of them without any extra details. I had to redirect and set up my expectations each day for the surveys which is not unusual but time consuming. One day, students did not fill out number one at all and this happened on occasion throughout the surveys. I was disappointed because even though I can look at the data overall, I cannot categorize those specific surveys into a category.

Week two (May 23-27)

I should have been surprised by the students' general inability to solve issues and questions about the process when they were left to their own problem-solving and when they were not given a prescribed set of directions to complete a lesson, but given my experience as a teacher, I know that this has been the education system approach and therefore students seem to expect the prescribed format. The number of times students would come to me and say "How do I?" or "What does this mean?" has been an eye opener as far as changing my approach to teaching and anticipating the amount of preparation that will need to be included. The redirect I gave students during this data collection time was to go back to their group and ask each other, analyze the goal of their lesson and decide on the best fit answer to the problem. The time frame issue is a big factor for leaning towards being more prescribed in a lesson. The extra time it takes to have a full discussion and to let students develop a plan of action per group in executing a design or process can be a deterrent. I had posters around the classroom with "question prompts" for students to look to for guidance but they were reluctant or became ignorant of those being available for them. During the current school year, I am going to give each student a list of question prompts to keep in the front of their science notebooks, so they have them readily available and I will guide them as well as encourage them to refer to that especially at the beginning of the year. I will continue to post the question stems in the classroom as well.

Wait Time. I began to allow more wait time for students to respond. The students would get shifty in their seats (and I felt a little uncomfortable at first), but as I let students sit over time more and more students were losing reluctance and hands began to go up with responses. Then I started to use a version of second wait time which is waiting to say or do anything after a response. This definitely caused discomfort and students did not appear to know what to do. I plan to continue doing this during the current school year and implementing this method earlier in the year will allow for me to analyze its effectiveness over a long term period versus the quick time frame I used at the end of the previous school year.

Monday, May 23. This week I continued to use the district resources but utilized some specific strategies to encourage discussion and questioning in the classroom. I continued to use Newton's Toy Box as the main source of lessons and planning, but included the use of additional, researched strategies to see if inclusion of these would affect student agentic engagement. I also began using the surveys again for the beginning of this week.

One activity that was used was a way to gain some student interest input in regards to the learning targets for the upcoming week of lessons. Students were asked to write down questions they have or their "I wonders" about the specific learning goals. These were shared out as a whole group and documented by the teacher.

Another activity that was used this week involved giving the teams a basket of supplies that pertained to the upcoming lesson. They were asked to write down any thoughts, "I wonders", and/or questions about the supplies and how these items relate to our current learning goals. The students were given time to explore their "I wonders" with their team using the materials. This was a time that students seemed to be having a lot of fun indicated by laughs and lots of talking. I heard many students asking or commenting on doing something like this again in class. From my observations and from the conversations that ensued, this was a successful engagement activity.

The students were introduced and guided through a strategy called *Discussion Diamond*. The teacher used ActivInspire flipcharts to introduce this strategy. The initial prompt was about a topic that related to their lives versus a science specific topic. The purpose for this was to give students a "safe" place to start and practice the use of Discussion Diamonds.

1) *What are you most looking forward to next year in junior high?*

The discussions that resulted were interesting and fun to hear. Using this topic appeared to help students see that they had some of the same questions even though at first they thought their idea was not suitable or was "dumb".

We moved on to having a science relevant discussion diamond on the concepts we had been discussing in class. In keeping with limited time and feeling a little rushed, the students discussed two different topics and shared out to the class.

2) *Teams 1-4 did a Discussion Diamond on Newton's First Law and teams 5-9 completed a Discussion Diamond Newton's Second Law.*

Hour 1 was interrupted by a fire drill and the discussions did not end up resulting in much depth as it took them a while to settle back in. The rest of the hours were mildly engaged but students tended to get off topic and were beginning to get fidgety and unwilling to really listen to one another.

Tuesday, May 24. I continued the conversations about the discussion diamond and we finished up talking about the commonalities and differences. In trying to give each group an opportunity to share out, the conversations got a bit long and student interest waned by the end.

Wednesday, May 25. Talk Moves. I tried to video record again today but moving the camera around and the added inconvenience of limited volume input really proved to be useless. I could not gather any data from the recordings and decided to take that out of my useful data collection techniques. At this point, I decided to drop the recording as a data collection tool. Talk Moves was something that I needed to teach and guide the students through starting at the beginning of the school year. Trying to throw this in during the last few weeks of school felt artificial and created more stress than anything else. If the teacher is stressed, the students can feel it and they tend to be less engaged.

Students had to develop a lesson about their “I wonder” or question that was generated on Monday. The teacher purposefully left the lesson development open-ended. Students had many questions about “how” or “what” and students were challenged to make sense of the goals of the lesson. A general sense of frustration was looming around the classroom because the teacher left the students to figuring out the answers and building off of their own questions.

Thursday, May 26. Gallery Walk**.** I used a spontaneous activity to try to promote some student talk and to get students asking one another questions. Students walked around the classroom looking at comic-like drawings and ideas that one another had about one of Newton's Laws of motion in physical science. They were to create questions and find similarities between their drawings and things that were different. The overall activity appeared to be one that students enjoyed but discussions were shallow and the students appeared to be afraid to offend one another by asking questions.

Many of the responses to a question on the ESM was bored. What does BORED mean to a sixth grade student in science? This is a very important word and question that has evolved during this part of the study for me as a teacher. I want to know more about how students define boredom in the classroom. From definition, agency includes giving students a say in what they are learning and how/why they are learning instead of being talked at and/or taught in a one size fits all approach. If topics are relevant to students and they are talking about the topics, asking questions about the topic on their own then it seems intuitively like this would result in less boredom.

ESM Data Collection Results

The ESM data collection was an interesting attempt at gathering data and input from students. However, organizing this data and finding any connective pieces was a struggle. Using random times to have students fill out the survey resulted in inconsistent responses. Many of the surveys were not filled in properly so I did not have an idea if the activity they were referring to was a hands-on activity, discussion activity, or questioning activity. Over sixty percent of the hundreds of sheets were not filled out properly. I attempted to classify relevance and feelings at the time of activity by female versus male to see if there was a significance based on gender and once again found it inconsistent.

For the statement on the ESM survey (see appendix), that I found most relevant to the research question for this project were the following: 3. During this time, I was interested in what we learning. 4. During this time, I could think of ways that this connected to other areas in my life. 5. During this time, I asked a question. 6. During this time, I added to the discussion. 8. During this time I felt (circle all that apply) *interested, excited, bored, anxious, frustrated.*

As I evaluated the data collected, I thought there would be a connection between students interest in what we were learning and how they felt at the moment of the survey. There was such a discrepancy which led me to believe students were just circling these responses without putting much thought into the responses. I would have some say “very true” for interest but then respond with “bored” for feeling. Over eighty percent of the responses indicated “Somewhat true” or “very true” for the response to finding a connection to other areas in their life. Over eighty-five percent of the responses indicated students felt it was “somewhat true” or “very true” that they added to a discussion, but more than ninety percent said no to whether they asked a question.

When do you just “tell” the students the correct knowledge? This is a debate by educators and researchers of educators. A big realization is the student's’ inability to address each other and instead look to me as the authority and audience.

Correlation of effective questioning, critical conversations, and agentic engagement

The data collection ended up being much more difficult than I had planned and through implementing this at the end of the year, I found many interruptions and situations that made consistency very difficult. I gathered as much data as I could during that time but the consistency and novelty wore off quickly with the numerous surveys which led to students answering the surveys in what appeared to be superficial responses. Often times the first question was not answered which made it difficult to separate the lessons into types of lessons to really analyze the effectiveness of specific strategies that were used. One key thing I recognized from the survey was a general feeling of "boredom" in the classroom especially when it came to note-taking and documenting the ideas that were being investigated or discussed.

Moving forward into a new school year and new group of students, I plan to continue to utilize the knowledge and research I received last year to get the questioning and discussion components embedded as an integral part of my daily lessons. NGSS emphasizes the use of communication and collaboration as vital pieces of the science classroom and I have found these to be two of the most difficult pieces to "teach" students. When they are talking about a topic it is a quick run-down and then the conversation moves off-topic versus digging deeper into the topic. Questions that students asked tended to be minimal and a struggle because the students would tell me they did not want to ask one another questions as it felt corny to ask probing questions. I have done a lot of reading on the use of questions and using phenomena in the classroom since the end of the previous school year and feel that making the connective piece to some phenomena will make the "ownership" of the learning or the agency of the learning a more natural fit to students. This year I will start each topic off with the "curiosity questions" to investigate and develop learning around things students are "wondering" about. Curiosity is the key and peeking into those curiosities appears to be the trick to less boredom and more investment within the students.

I have changed my results chapter focus to be an exploratory sequential mixed methods design whereas I am using the results of my data collection from last year to guide my forward moves and use a qualitative approach in analyzing the results then redesigning my survey into a quantitative format for gathering information with the current students with a focus on questions, discussions and boredom. Discourse is going to become an integral part of my classroom next year. Students will be taught the norms of a discourse session and use this process to support and/or defend their understandings of a concept.

In chapter five, I will share my forward thinking and how the research and data has influenced my frame of thinking around agentic engagement in the classroom as well as the use of questioning and classroom discourse. Learning is a wheel with many spokes to pull it all together and there is not one or two isolated factors that will be the pivotal piece to making it work. Just as each student is an individual in how they learn, each pathway to engaging students or promoting engagement is unique based upon the topic, students, teacher, atmosphere and strategies.

CHAPTER 5

CONCLUSIONS

"A good question is never answered. It is not a bolt to be tightened into place but a seed to be planted and to bear more seed toward the hope of greening the landscape of idea."

~John Anthony Ciardi

I asked the question about questions in the science classroom and agentic engagement. The conclusion I have ascertained is that the myriad of pieces that come together to contribute to increased agentic engagement for students cannot be isolated to just one component. As I attempted to increase the use of questioning and discourse, I found myself trying out a variety of strategies and ultimately changing my approach to teaching. I have found myself on a continued journey to try new approaches in my classroom and to let my fear of failing be what it is and still try new things. Questioning is a HUGE piece of curiosity. The student curiosity seems to decrease as students get older. I taught almost every grade, first through eighth, and I can attest to this. Students ask MANY questions in the primary grades, but once they reach the pre-adolescent age they tend to wait for the questions from the teacher and generally I have seen the questions they do ask to be literal questions or clarifying questions versus curiosity or idea developing questions. Changing this with my students is my continued goal as an educator. Everything I've realized and want to change aligns perfectly with implementing Next Generation Science Standards as well as Project-Based Learning in my classroom over the next few years of teaching.

Limitations

Limitations are part of every classroom. A few key limitations that were experienced in getting data collected and implementation of strategies in the classroom were as follows. I was very rushed due to some complications with getting things approved and in order. I decided to gather my data at the end of the school year during a time when students were beginning to check out and time was feeling tight. I also did not anticipate the MANY interruptions that were going to come up during those two weeks.

A limitation that affected my survey and data collection was students did not always fill out number one on the ESM Survey which left me with having to put those data sheets to the side and not categorize the results around the type of activity that was happening at that time.

My fourth hour academic class was my most difficult class to connect with this year and to teach content. There were many interruptions, behaviors and the motivation was very low. Being the last hour of my day, I came into it with low energy and less patience as well. The surveys were a huge disruption to this group and due to the large number of special education students in this class I had difficulty keeping up the collection process.

Experience Sampling was not ideal for this middle school age group. If it was to be used again it would need to be a smaller survey and only include a few students a day.

Having students complete the surveys was very disruptive to the learning as hard as I tried to make it a smooth process. The students were diligent at first, but I think that it is difficult for students at this age if they feel like they are "missing out" on what is going on in the classroom. Even though the surveys only took about two to three minutes for each student to fill out, they appeared to rush through after a few days of doing the surveys. The method I used to collect the data had been used in college/university level courses and upper high school where there is a bit more independence.

A final limitation for me in this capstone process was on a personal level. I found myself spread thin with a series of personal issues that came to the surface as well as some complications with my original committee members. This last limitation has probably been the biggest factor in completion of this capstone.

Further Research

I'd like to use the AES with my students this school year (2016-2017) just to gauge my work towards this as a teacher. I would also like to do the random sampling again over a longer period of time and I'd like to spend more time setting the students up with questioning strategies and skills. In addition, I feel it is necessary to practice the use and skills of classroom discussion around relevant science concepts/topics. Questioning continues to be emphasized in most literature/research regarding science education. Over the past year, I have been a proponent of adopting the Next Generation Science Standards in my district. I attended a National Science Teacher's Association (NSTA) conference in Los Angeles and was part of a group of teachers from our district who received training in how to train others in NGSS implementation. The concept of relevance and effective questioning were two key factors in all of the literature and all of the discussions.

Revisiting Literature Review

In the literature review, I spent time writing and reading about a lot of factors, research, theories and institutions that contribute to effective science education practice. I have tried to narrow things down to just two factors in understanding agentic engagement.

Coming back to the scientific ideas that are being presented as key in the education of our students, ownership of their own learning, knowing how to learn and what to do with the information not necessarily what to learn, autonomy and agency are vital components, in my opinion. The continued struggle for me as I have completed this research is HOW to increase that agency. Simply encouraging talk in the classroom and asking questions is not enough to make a noticeable difference with agentic engagement in the form self-reporting from students and teacher observation.

Since starting to read and research information regarding agentic engagement over the past few years, there has been an increase in the number of papers and studies done as well as a continued discussion about agency. Even though many of the organizations do not necessarily use the word "agentic engagement", my interpretation would be synonymous.

Going back to the statements and ideas in the Next Generation Science Standards, agency is embedded throughout the 3-Dimensional framework including the Science and

Engineering Practices, the Disciplinary Core Ideas and the Cross-Cutting Concepts. These three pieces are the bones of the NGSS. Student agency is built into this framework, but teaching around these dimensions with intention is going to be of utmost important from what I have concluded.

Questioning and discourse can pull ideas from students, but students appear to show a need to feel connected to the ideas that are being questioned and discussed. Relevancy and buy-in to how a concept or idea of investigation is going to be important to each individual has continued to be of utmost importance to the students in my classroom.

Reflection on Growth and Further Research

Phenomena in the science classroom through the supports and research in the NGSS world is going to be a target as I continue teaching science and encourage the increase in agentic engagement with my students. I also plan to go deeper with implementation of effective questioning in the classroom. Bored was the key word that came up on the surveys. Despite my thinking that this word can be a default for many students when they are not quite sure what they are feeling, if they do not understand what is happening in class or they do not feel connected to the learning and their own lives, students default to the word “bored”. Phenomena and effective questions by both students and teacher will bring that relevance to their learning. I feel this to be a/the missing link to the agentic engagement piece.

Top on my agenda as a classroom teacher is to be much more intentional about how I use questioning strategies and discussions. I would love to use philosophical chairs and other strategies that I learned during a summer AVID training. I also plan on spending some time researching how to redirect the “bored” conversations among students.

Had the school year not come to a close, I would have done some one-on-one interviewing to dig deeper with students about questioning, discussion and the sense of boredom or ownership in their learning. I think an effective strategy would be to do random sampling in regards to “when” students fill out the surveys but know who the surveys belong to so there could be follow-up interviews to get more information about their responses.

Hamline’s School of Education Conceptual Framework

One piece of the conceptual framework is “Practice Thoughtful Inquiry and Reflection.” Throughout the time spent researching and writing this capstone thesis I have found myself in continual inquiry and reflection. As one question is investigated about twenty more pop up. This reflection and inquiry has continued and will continue after I complete my capstone and graduate from Hamline. Throughout my life, I find myself intrigued by new ideas and seeking direction with my curiosities. Upon taking courses at Hamline, I find myself on a path of continual improvement in my teaching and interactions with my students.

My work as I help to develop NGSS and further pursue Project-Based Learning with my district will have agentic engagement on the radar as well as intentional and purposeful implementation of questioning and discourse. However, I feel that phenomena and relevance are going to be a bigger piece of the agentic picture and I will further research and utilize those pieces in my classroom. Engagement involves a myriad of factors and my biggest take-away is a blending of these factors not isolation will nurture engagement of all forms in Twenty-first century learners.

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APPENDIX A

Agentic Engagement Survey

1. I let my science teacher know what I need and want.

Never Rarely Sometimes Most of the time
Always

2. During this class, I express my preferences and opinions.

Never Rarely Sometimes Most of the time
Always

3. When I need something in this class, I'll ask the teacher for it.

Never Rarely Sometimes Most of the time
Always

4. During science class, I ask questions to help me learn.

Never Rarely Sometimes Most of the time
Always

5. I let my science teacher know what I am interested in.

Never Rarely Sometimes Most of the time
Always

APPENDIX B

Experience Sampling Method (Survey)

Date:

1. Please give a short description of what was happening in class at the time you were asked to do this survey:

2. During this time, I felt worried that I would say the wrong thing or sound like I don't know anything.

Not true Somewhat true Very True

3. During this time, I was interested in what we learning.

Not true Somewhat true Very true

4. During this time, I could think of ways that this connected to other areas in my life.

Not true Somewhat true Very true

5. During this time, I asked a question.

Yes No

6. During this time, I added to the discussion.

Not true Somewhat true Very true

7. During this time, I expressed my opinion or thoughts.

Not true Somewhat true Very true

8. During this time I felt (circle all that apply)

Interested Excited Bored Anxious Frustrated

Other: (describe)

9. My gender is

Female Male

10. My class hour:

1st 2nd 3rd 4th

APPENDIX C

Learning Climate Questionnaire

Circle the best fit for each of the following questions.

0= Not at all
1=Sometimes
2=Most of the time
3=Always

1. I feel that my teacher provides me with choices and options.

   0 1 2 3

2. I feel understood by my teacher.

   0 1 2 3

3. My teacher encourages me to ask questions

   0 1 2 3

4. My teacher listens to how I would like to do things.

   0 1 2 3

5. My teacher conveys confidence in my ability to do well in the course.

   0 1 2 3

6. My teacher tries to understand how I see things before suggesting a new way to do things.

   0 1 2 3

APPENDIX D

Requesting Permission for Minors to Take Part in Graduate Research

April 11, 2016

Dear Parent or Guardian,

I am your child's science teacher and a graduate student working on an advanced degree in education at Hamline University, St. Paul, Minnesota. As part of my graduate work, I plan to conduct research in my classroom from April 2016 to May 2016. The purpose of this letter is to ask your permission for your child to take part in my research. This research is public scholarship, the abstract and final product will be catalogued in Hamline's Bush Library Digital Commons, a searchable electronic repository. It may be published or used in other ways.

My plan is to study the impacts of increased implementation of effective questioning strategies and student discourse (discussions) on agentic engagement. Middle school is a time for many students to begin to lose interest and become disengaged from the study of science and other STEM specific areas of study. I plan to teach and collect research using two units of study. One unit will be taught strictly using district resources and the science unit framework while the other unit will be supplemented by teaching strategies to increase effective questioning and increase student discussions or discourse with topics relevant to the students. I will be conducting a variety of surveys as well as videotaping classes for further observation by me.

There is little to no risk for your child to participate. All results will be confidential and anonymous. I will not record information about individual students, such as their names, nor report identifying information in the capstone. Participation is voluntary and you may decide at any time and without negative consequences that information about your child will not be included in the capstone.

I have received approval for my study from the School of Education at Hamline University and from the principal of Lake Elmo Elementary, Stephen Gorde, as well as permission from Executive Director of Learning and Innovation, Dr. Robert McDowell, . The capstone will be catalogued in Hamline's Bush Library Digital Commons, a searchable electronic repository. My results might also be included in an article for publication in a professional journal or in a report at a professional conference. In all cases, your child's identity and participation in this study will be confidential.

If you agree that your child may participate, keep this page. Fill out the duplicate agreement to participate on page two and return to me by sending it back with your child or copy the form in an email me no later than __Friday, April 15th_____. If you have any questions, please email or call me at school.

Sincerely,
Corrie Christensen
11030 Stillwater Blvd
Lake Elmo, MN 55042
651-351-6766
christensenc@stillwaterschools.org

Informed Consent to Participate in Classroom Surveys and Videotaping for Observation

Keep this page for your records.

I have received your letter about the study you plan to conduct in which you will be observing students' agentic engagement in the classroom. I understand that my child will be asked to fill out surveys throughout the research period and that there will occasions when the students will be videotaped solely for the purpose of teacher observation. I understand there is little to no risk involved for my child, that his/her confidentiality will be protected, and that I may withdraw or my child may withdraw from the project at any time.

__________________________________ _________________

Parent/Guardian Signature Date

Participant copy

Informed Consent to Participate in Classroom Surveys and Videotaping for Observation
Return this portion to Ms. Christensen

I have received your letter about the study you plan to conduct in which you will be observing students' agentic engagement in the classroom. I understand that my child will be asked to fill out surveys throughout the research period and that there will occasions when the students will be videotaped solely for the purpose of teacher observation. I understand there is little to no risk involved for my child, that his/her confidentiality will be protected, and that I may withdraw or my child may withdraw from the project at any time.

_________________________________ _________________
Student Name Science Hour

_________________________________ _________________
Parent/Guardian Signature Date

Researcher Copy