NAVIGATING THE WHIRLWIND: ONE SCIENCE TEACHER’S EXPERIENCE UTILIZING A SCIENCE FICTION NOVEL IN THE SECONDARY CLASSROOM

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ABSTRACT

This study was a narrative inquiry that explored the experience of one science teacher as he utilized a science fiction novel in his secondary physical science classroom. With the recent implementation of the Common Core literacy standards in Alabama, science teachers are now required to address literacy and reading along with teaching science content and pursuing scientific literacy. Since these standards originate from a language arts perspective, science teachers may not be aware of how to best undertake this initiative without the necessary in-depth training in literacy strategies. This story of one Alabama science teacher integrating a science fiction novel in his physical science classroom provided an understanding and affinity of the ideas, practices, decisions, and Discourses (Gee, 2005, 2012) that influenced the situated cognition of this novice “literacy teacher” as he tried out a new tool. This narrative inquiry was guided by the following research questions: 1) what is the experience of a science teacher as he utilizes a science fiction novel in the secondary science classroom, and 2) how does a secondary science teacher meaningfully address scientific literacy through the use of a science fiction novel in a physical science classroom?

Participant selection was through purposeful sampling, and data collection consisted of open-ended and story-telling interviews, participant observation, and document review. Data analysis resulted in the re-storying of the participant’s experience as well as insights gained from the story. Major conclusions drawn from this science teacher’s experience were the representation of three differing identities-science teacher, literacy teacher, and coach- through
the entirety of the project; the use of a science fiction novel is a viable curricular option for addressing both content literacy and scientific literacy; knowing student learners is essential for strategically teaching a science fiction novel; and support and professional development are required for content teachers as they address content literacy standards. The story of this teacher’s experience and the conclusions gathered will be beneficial to science teachers and all other educators incorporating new approaches or tools while navigating various directives and mandates affecting the classroom in addition to their other professional duties.
DEDICATION

This dissertation is dedicated to my parents, Radford and Connie Hester, for their continuous support of my education and career. They both devoted their lives to the teaching profession, which inspired my career choice as well. Coming from a family of educators, the stories of their struggles and successes encouraged this investigation into a significant and meaningful profession.
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CHAPTER I:
INTRODUCTION

Background

Since *A Nation at Risk* (National Commission of Excellence in Education, 1983) was released in 1983 and then again with the signing of the No Child Left Behind Act (NCLB) in 2001, schools have been constantly in search of programs, resources, and standards to help their students academically achieve at the highest level (Bybee, 1997; Gee, 2012; Laguardia & Pearl, 2009; Lee & Ready, 2009). Furthermore, the American Association for the Advancement of Science’s (AAAS) (1993) *Benchmarks for Science Literacy* and the National Research Council’s (NRC) (1996) *National Science Education Standards* (NSES) have been a major influence on science education across the country providing guidelines and indicators that science students must meet to be considered “scientifically literate” citizens (Bybee, 1997; DeBoer, 2000; Eisenhart, Finkel, & Marion, 1996; Llewellyn, 2005; Saul, Kohnen, Newman, & Pearce, 2012).

Currently, the *Common Core State Standards* (CCSS) (National Governors Association Center for Best Practices [NGA Center] and the Council of Chief State School Officers [CCSSO], 2010a) as well as the *Next Generation Science Standards* (NGSS) (Lead States, 2013) are being implemented in numerous states. These “new and improved” standards address the 21st century skills required of current students by supporting scientifically literate students who will enter society able to critically contemplate scientific realities and ethical issues to make informed decisions. These new standards as well as the other educational reform documents and schooling practices that affect certain classroom processes, diverse student populations, and the
unique nature of teaching science create a whirlwind of decisions, procedures, and activities that a classroom science teacher encounters on a daily basis. This situated reality of the teacher makes it difficult to revise procedures and teaching styles or incorporate new and inventive techniques and tools into the classroom, even when it is a standard and/or curriculum requirement. To address intersecting issues of literacies and science education, this narrative inquiry examined the experiences of a high school science teacher using a science fiction novel to teach physical science. Information from this narrative study offered insights applicable to science and other content area teachers in respect to teacher learning and research.

**Statement of the Problem**

This study focused on the issues facing practicing science teachers of how to best address literacy standards along with science content when they have limited or no training in literacy pedagogy. Typically the reforms affecting science teachers have been science education reforms; however, currently, science teachers are found in an unprecedented situation as they are being mandated to enact reforms from language arts and mathematics perspectives. As in many other states, the continuous educational reforms as well as the implementation of new standards and programs have drastically affected public education within the State of Alabama. One significant reform is the implementation of the *College and Career Ready Standards* (CCRS) (Alabama State Department of Education [ALSDE], 2010a) for all public schools in the state of Alabama. The Alabama CCRS include not only the *Common Core Standards* (NGA Center & CCSSO, 2010), but also specific Alabama Standards. The CCRS for math were implemented during the 2012-2013 school year with the English Language Arts and Content Literacy Standards for all subjects, including science, being implemented during the 2013-2014 school year (CCRS Implementation Team, 2012). According to the CCRS implementation team (2012),
content area teachers should be prepared to embed reading and writing tasks within student work and provide opportunities for wide and deep reading of complex texts to meet the new CCRS Standards. Even the teacher evaluation system in Alabama, EDUCATEAlabama (ALSDE, 2009), denotes the need for teaching reading and literacy across all content areas.

The aforementioned educational commissions have created an atmosphere of change and urgency for classroom science teachers. No longer will they be responsible for only imparting science content knowledge to students, but now must also become aware of their reading and literacy issues (ALSDE, 2010b). With all of the standards and criteria that must be met for standardized testing as well as the voluminous science curriculum found in most secondary science courses, how do science teachers contend with it all? In an unpublished survey (Bunn, 2012) conducted with several North Alabama science teachers about reading in the secondary science classroom, an already packed curriculum (75.9%) was the main reason given for not incorporating reading and literacy activities into science. This was followed by lack of funds to purchase alternative reading resources (55.2%) and must emphasize standardized test preparation (48.3%). All three of these reasons relate to the problems that teachers encounter while attempting to find ways to implement reading in the science classroom.

According to the survey (Bunn, 2012), these reasons may also suggest why state adopted text books are the primary reading source with 51.6% of teacher respondents stating that they use the textbook on a daily basis and 38.7% using it at least weekly. Survey results illustrated that internet resources were used by most respondents weekly, and other textbooks, magazine and newspaper articles were reported as being used occasionally. Both narrative and non-fiction trade books as well as science fiction novels were reported by the majority of respondents as either rarely or never being used in the science classroom. However, over dependence on
textbooks within the science classroom can hinder the development of scientific literacy of students (Gee, 2012; Olson & Mokhtari, 2010; Rutherford, 2005; Wellington & Osborne, 2001; Yager, 2004b). In addition, most textbooks will not be updated timely enough to keep up with the new science technologies that constantly emerge; and even if they were, most school budgets could not support textbook replacement as often as needed (Saul et al., 2012). Consequently, reading resources must be found that are cost-effective, can be used multiple times, and can support discussion of current science technologies as well as those in the future. Furthermore, to fulfill the CCRS literacy standards requirement, teachers are in search of innovative and engaging reading resources that can be implemented into their already packed curriculum that compliment the science content and promote scientific literacy.

**Purpose of the Study**

The primary purpose of this study was to relay the experience of an Alabama secondary science teacher as he employs a science fiction novel in his classroom. This complex story occurs in the midst of a multitude of educational and science discourses mandating classroom practices as the teacher continually strives for resources and approaches to help his students enhance their scientific literacy. This story will also represent the teacher’s situated learning experience as he is a learner trying out a new approach and a teacher facilitating learning with his students. The re-storying of this experience as well as the insights gained from the story will be beneficial to science teachers and all other educators incorporating new approaches or tools while navigating various directives and mandates affecting education in general, the school, or the classroom.
Significance of the Study

With the implementation of the Alabama CCRS (ALSDE, 2010a) and the EDUCATEAlabama (ALSDE, 2009) teacher evaluation system, all Alabama classroom teachers are required to incorporate reading and literacy into their content areas. Content literacy must be addressed and weaved among the specific content, all while preparing students to do well on standardized tests. Specifically for science teachers, they must also guide their students in developing scientific literacy. The responsibility of strategically teaching literacy and reading by a science content specialist with no or limited training in literacy can be overwhelming and confusing. Not only is the science teacher responsible for integrating literacy strategies into the content, but he or she must also decide and acquire reading resources that are engaging, useful, and economical. This story of one Alabama science teacher integrating a science fiction novel in his physical science classroom can provide an understanding and affinity of the ideas, practices, and decisions that are required as this novice “literacy teacher” tries out a new tool. This story is significant for all classroom teachers, as every teacher must navigate similar issues when trying out new approaches, tools, or standards.

The Science Fiction Novel

During this narrative study, the science fiction novel acts as the mediational tool that creates the pedagogical context of how this teacher’s ideas and practices can be explored through his story. The novel can be utilized within the science classroom to promote scientific literacy and address CCSS content literacy standards. Furthermore, the novel offers a tangible object that can assist in actualizing the job of the science teacher in a creative and engaging way by illuminating science in the context of a story. The literature on incorporating science fiction in the classroom offers several purposes for its use which includes student engagement and
motivation (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010; Smolkin & Donovan, 2004); connection to the real world issues of science and technology (Clemmons & Sheehy, 2011; Czerneda, 1999; Gallo, 2007; Groenke & Scherff, 2010; Kilby-Goodwin, 2010; Raham, 2004; Zigo & Moore, 2004); enhancement of critical thinking and 21st century skills (Bixler, 2007; Clemmons & Sheehy, 2011; Zigo & Moore, 2004); interdisciplinary discussions (Bixler, 2007; Kilby-Goodwin, 2010); and prompts for inquiry and ethical discussions (Gallo, 2007; Groenke & Scherff, 2010). However, the most significant purpose for incorporating the science fiction novel in the classroom for the intention of this study is because it is a tool that can be used to promote scientific literacy (Czerneda, 1999), and it satisfies the content literacy standards of the CCSS, and more specifically the Alabama version of the CCSS which are the College and Career Ready Standards (CCRS) (ALSDE, 2010a).

The CCRS content literacy standards for science were first implemented in Alabama classrooms during the 2013-2014 school year (CCRS Implementation Team, 2012). The incorporation of literacy and reading across the curriculum is also assessed through the Alabama teacher evaluation system, EDUCATE.Alabama, (ALSDE, 2009). Consequently, Alabama science teachers are in search of tools, activities, and strategies to fulfill these Alabama State Department requirements. Science fiction novels and the benefits they can offer are a viable option for science teachers to employ in the classroom. The science fiction novel can be a tool that addresses many of the educational and science discourses that relate to the best practices of teaching science.
Research Questions

The following research questions guided this study:

1. What is the experience of a science teacher as he utilizes a science fiction novel in the secondary science classroom?; and

2. How does a secondary science teacher meaningfully address scientific literacy through the use of a science fiction novel in a physical science classroom?

Study Methods Overview

This study explored the ideas and practices of an Alabama secondary science teacher trying out a creative approach of using a science fiction novel in the physical science classroom. In order to portray the complex story of the teacher using this novel while navigating curriculum reform discourses, promoting scientific literacy, and situationally learning an unfamiliar pedagogical approach, narrative inquiry was utilized. Narrative inquiry seeks to re-story the lived experience of an individual, giving voice to the participant through the collaborative and trusting relationship between participant and the researcher (Clandinin, 2013; Connelly & Clandinin, 1990; Creswell, 2007; Marshall & Rossman, 2011). The story of this single teacher’s experience will be transferable to science teachers specifically and any other educators attempting a new approach or employing a new tool in their classroom.

Several methodological and methods conditions were addressed to ensure a quality trustworthy study. Data collection methods facilitated the re-storying of this teacher’s experience. In this re-presented story, the participant as well as the school was assigned pseudonyms. Multiple data sources were used to establish triangulation and enable prolonged engagement, member checking, peer review, and thick descriptions. With approval of the university’s institutional review board (IRB), data were collected through open-ended and story-
telling interviews, participant observation, and document review. The interviews took place before the teacher’s class began reading the novel, during the reading of the novel, and immediately after the class finished reading the novel. Participant observations took place in the teacher’s classroom while the novel was being discussed and document review occurred during the entirety of the study. Documents included emails, anecdotal records, classroom work products, and lesson plans.

Data analysis in the tradition of narrative inquiry is unique in that it is a retelling of the participant’s story through the researcher (Clandinin, 2013; Connelly & Clandinin, 1990; Creswell, 2007) as opposed to the positivistic tradition of reporting results or findings. Therefore, the results are the distinctive story of this individual teacher as re-presented by the researcher at this particular time and place. Insights were also gathered that framed this teacher’s story within the theoretical framework applied by the researcher.

**Researcher Perspective**

Given that narrative inquiry is generated through the subjective perspectives of the researcher, it is essential that the researcher’s own story is acknowledged within the study. In my own science classroom, I was faced with the dilemma of how to incorporate reading external to the textbook into my packed curriculum while preparing students for the Alabama High School Graduation (AHSGE), which they were required to pass in order to graduate high school. I was also responsible for guiding students in becoming scientifically literate, which required more of my students than memorizing facts for a standardized test (Bybee, 1997; Lemke, 2004; Norris & Phillips, 2003; Yager, 2004b). Through my teaching reflections, I realized that for students to truly pursue scientific literacy, it would require more than a transmissionist classroom where I provided the “knowledge” to my students who in turn “received” this knowledge
(Llewellyn, 2005, 2013). I wanted to bring science alive to the students in a “real-life” situation that was difficult to achieve utilizing only the textbook and lecture method.

Seeking guidance, I consulted a colleague who taught language arts and shared with her my idea of incorporating some type of reading resource into my classroom that could initiate more critical and ethical discussions related to authentic science practices while still allowing time to cover the science curriculum. I also shared with her my love for the science fiction genre and how I felt that a “good” science fiction novel would fulfill my predilection. She suggested I use an already available young adult science fiction novel, *Ender’s Game* (1991) by Orson Scott Card, which was purchased previously by another language arts teacher. After reading the book, I found that the characters faced many ethical dilemmas that would serve as great prompts for class discussions. It also contained many science concepts that were applicable to my physical science class such as Newton’s laws and gravity.

Once I decided to incorporate the novel into my physical science class, I was again at a loss of what to actually do in way of literacy strategies. I was then introduced to literature circles (Daniels, 1994) in a graduate class. Literature circles can be summarized as temporary discussion arrangements where each member of the group chooses a particular role to take on as they read the material, taking role specific notes and sharing these findings as appropriate (Daniels, 1994). In this approach, the teacher acts mainly as a facilitator while the students lead the discussions based on their particular “role” (Daniels, 1994; McCall, 2010; Straits & Nichols, 2007). These literature circle roles guided the ethical and critical discussions based on the book and allowed the students to interact with each other both in small and large group discussions, which led to even deeper understanding of the issues surrounding science and technology, thus increasing their scientific literacy.
In addition to using science fiction novels in my classroom, I have also been involved in the implementation of the CCRS in Alabama classrooms. The Alabama State Department of Education formed implementation teams to assist in the smooth execution of the new CCRS into Alabama schools. These teams consisted of representatives from various educational areas such as higher education, Alabama Math, Science, and Technology Initiative (AMSTI), and state department personnel. Because of serving on this team, I was able to follow the progress of the implementation, the development of tools to assist in the implementation, and the discussions related to problems and successes of the implementation. Serving on this team provided me with insight and experience of what was expected with the release of the content literacy standards before they were actually required in science classrooms. Accordingly, I am more familiar with the CCRS content literacy standards than some other higher education faculty.

**Researcher Assumptions**

The following researcher assumptions were noted through the entirety of this study:

1. It is assumed that the participant will answer interview questions and share his story openly and honestly without fear of having his decisions and practices critiqued for “right” or “wrong” ways of doing things;

2. It is assumed that the participant will use the science fiction novel to complement science content and fulfill the CCRS literacy standards by ensuring that his students participate in any activities and assessments associated with the novel;

3. It is assumed that the participant will read the novel beforehand and act as the primary instructor in the classroom; and
4. It is assumed that the participant will openly share any documents related to the study. These include, but are not limited to, lesson plans, work products, anecdotal records, and emails.

**Overview of Key Theoretical Frameworks**

In the previous section, I described my own researcher subjectivities, largely in the sense of my historical background that I am bringing to this study. My own narratives are framed within several key theoretical frameworks which include: scientific literacy, educational and science discourses, and the teacher’s situated learning.

**Scientific Literacy**

One of the major goals of science teachers is to guide students in pursuit of scientific literacy (AAAS, 1993; Bybee, 1997; Laugksch, 2000; Llewellyn, 2013; NRC, 1996; Pratt & Pratt, 2004; Saul et al., 2012; van Eijck & Roth, 2010). There are varying definitions, however, and explanations of what it means to “be” scientifically literate (Brown, Reveles, & Kelly, 2005; Bybee, 1997; DeBoer, 2000; Holbrook & Rannikmae, 2009; Laugksch, 2000; Liu, 2009; Norman, 1998; van Eijck & Roth, 2010; Roberts, 2007; Yager, 2004b) and debatable of whether scientific literacy can ever even be attained (Shamos, 1995). In *The National Science Education Standards* (NSES), the NRC (1996) attempted to craft a unitary interpretation of scientific literacy to guide science educators. Accordingly, these National Standards included not only learning science content, but also addressed social and societal issues related to science as requisites of scientific literacy (Bybee, 1997; Hand, Lawrence, & Yore, 1999; Kouba et al., 1998; NRC, 1996). Although the NSES provided science educators with their definition of scientific literacy, the conversations over the definition and what characteristics a scientifically literate person would exhibit were still transpiring.
Various other researchers offered suggestions for definitions and characteristics of scientific literacy as well. For instance, several authors suggested that technological literacy should be included in the definition (DeBoer, 2000). Others described how scientific literacy was directed by the needs of society and was continuously changing (Bybee, 1997; DeBoer, 2000; Holbrook, 2010; Holbrook & Rannikmae, 2009; Liu, 2009). In addition, characteristics of scientific literacy included being able to make informed decisions about science and technology in society (Holbrook & Rannikmae, 2009); use the language of science (Norris & Phillips, 2003; Yore et al., 2004; Wellington & Osborne, 2001); and work collectively together to solve real scientific problems (Roth & Lee, 2002).

With all of the literature discussing and debating definitions of scientific literacy, the classroom science teacher must wade through it all to decide what he or she will use as the scientific literacy “standard” in the classroom. Although the pursuit of scientific literacy is a mandated goal from national educational reforms, the activities and approaches that the science teacher employs to address this goal intersect with his or her ideas of how students will demonstrate and characterize scientific literacy. For instance, rote replication of science content on a test as the measure of scientific literacy, differs greatly from performative knowledge and skills involved in discussing a science concept and its impact on society. Furthermore, the view of “society” the teacher brings to the classroom will shape his or her pedagogical intents and practices. Consequently, this study exploring a science teacher’s choice to use a science fiction novel to “teach” high school physical science provides an opportunity to learn about his notions of scientific literacy within his perceived context of practice.
Educational and Science Discourses

According to Gee (2005), discourse (note lowercase d) is regarded as “language in use or stretches of language” (p. 26). In the cases of educational and science discourses, it refers to the multitude of voices and research that speak to the complexity of teaching science. However, the language that is enacted surrounding these issues is not free from other influential factors; in other words, language is never just about language and words alone (Gee, 2005, 2012). These other factors include “gestures, actions, interactions, symbols, tools, technologies…, values, attitudes, beliefs, and emotions” (Gee, 2005, p. 7) that join the language to create a certain identity. Gee (2005, 2012) referred to language combined with these other influential factors as Discourses (note capital D). In the classroom, the science teacher’s individual identity is affected by his Discourse as it relates to what a science teacher “looks like” and what activities a science teacher will carry out. In addition, the various science and educational discourses that guide the science teacher in the best practices of teaching science are also shaped by Discourses. Consequently, the science teacher must negotiate all of these various D/discourses as he goes about using the science fiction novel to teach science to students and promote scientific literacy.

Some of the current educational and science discourses that affect the science teacher are science teaching practices which encourage 21st century skills; content literacy and reading in science; the unique nature of science language; marginalized students underrepresented in science; and the preponderance of standards. In regard to promoting 21st century skills, students in today’s classrooms require a more critical and authentic experience with science that is not as focused on memorization and regurgitation of science facts, but instead allows them to encounter science as it occurs in life outside of school (Hurd, 1998, 2000; Yager, 2004a; Yore, Bisanz, & Hand, 2003). Furthermore, the science pedagogical literature supports the incorporation of
argumentation and discussion of science concepts (Hand et al., 1999; Llewellyn, 2013; Yore et al., 2004; Wellington & Osborne, 2001) as well as inquiry learning in the science classroom (Llewellyn, 2005, 2013).

Content literacy and reading in science has always been a best practice of teaching science (Fang & Wei, 2010; Norris & Phillips, 2003; O’Brien, Stewart, & Moje, 1995; Shanahan, 2004; Wellington & Osborne, 2001); however, with the authorization of the Alabama CCRS, it is now essential that science teachers address literacy and reading in the classroom (ALSDE, 2010b; CCRS Implementation Team, 2012; NGA Center & CCSSO, 2010b). Even though now a requirement, many science teachers may be unaware of how to exactly go about successfully implementing literacy in science (Greenleaf et al., 2011). Furthermore, the technical and difficult nature of science language makes reading and literacy integration even more demanding for both students and the teacher (Fang, 2004; Fang & Wei, 2010; Wellington & Osborne, 2001). Although math is many times considered as the predominant language of science, in actuality, written and spoken language are fundamental to the practice of science (Fang & Wei, 2010; Hand et al., 2003; Lemke, 2004; Yore, 2004; Yore et al., 2003). Accordingly, science teachers should integrate opportunities for students to use science language in the classroom (Baker et al., 2009; Fang, 2004; Gee, 2004; Hand et al., 2003). When coupled with real life experiences, practice with using science language can increase the overall knowledge of science and promote life-long understanding (Baker et al., 2009; Wellington & Osborne, 2001).

Throughout the years of educational reform and the development of various standards (i.e. Benchmarks for Science Literacy, National Science Education Standards, Next Generation Science Standards), the successful science education of ALL students has been an area of focus
(Bybee, 1997; Eisenhart et al., 1996, NGSS Lead States, 2013). Even with all of this effort, students of color and low socio-economic status still struggle in science (Eisenhart et al., 1996; Rodriguez, 1997). According to Gee (2012), this struggle could be related to the conflicting Discourses that occur between the science classroom and the student’s home. In the same fashion, Brown et al. (2005) discussed how a student’s discursive identity could affect their learning and understanding of science. Regardless of the reasons why marginalized students struggle in science, the research does support addressing students’ prior knowledge and experiences related to science content, as well as considering the literacy and language issues of science (Gee, 2012; Lee & Fradd, 1998).

The Teacher’s Situated Learning

In this study, the science teacher exists in a dual role of both teacher and learner. In his situated reality of the classroom, he must persist in the day to day pedagogical practices which will include the facilitator of science leaning and scientific literacy as well as navigating the various other decisions, influences, and practices required of “being” a teacher. The identity of a teacher is construed as the expert in the classroom, yet many times teachers have a dual identity of expert and learner. This is the case with the participant in this study because he must simultaneously teach science with a new approach and tool (science fiction novel), yet still learn and participate in the new activities associated with this approach.

In situated cognition and learning beliefs, learning does not occur independently from context, culture, or social influences (Kim & Hannafin, 2008; Lave & Wenger, 1991; Núñez, Edwards, & Matos, 1999). Furthermore, when new knowledge is learned, the individual develops a new identity and takes part in the activities associated with this new identity (Brickhouse, 2001; Gee, 2005, 2012; Lave & Wenger, 1991; Núñez et al., 1999). Thus, the
science teacher in this study takes on the identity and activities of what are more commonly demonstrated by English or literacy teachers as opposed to science teachers. In addition, the science teacher learns how to best implement a science fiction novel in his classroom while immersed in the professional culture of his job as a teacher. According to Brown, Collins, and Duguid (1989), this is the most effective way to situationally learn new knowledge and participate in new activities.

Summary

The newly implemented Alabama *College and Career Ready Standards* (ALSDE, 2010a) have added yet another facet to the existing whirlwind of issues affecting science teachers. Along with the teaching of content, science teachers must also assume the identity of a literacy/reading teacher in order to address content literacy standards in the science classroom. Over the past half century, various education curriculum reform documents have been disseminated, many times never being realized at the level of the classroom where change is expected to occur (Bybee, 1997). This is not the case for the Alabama CCRS (ALSDE, 2010a) as there is a unified and concentrated implementation plan through the Alabama State Department of Education (CCRS Implementation Team, 2012), which places responsibility for student’s futures on the teacher’s shoulders. In addition, the teacher evaluation system for Alabama educators also requires teaching content literacy (ALSDE, 2009) thus tying in job security to the science teacher’s fidelity carrying out this curricular reform. Consequently, Alabama science teachers must simultaneously transform these education reform documents into classroom practices. The science fiction novel is just one tool that can be creatively incorporated into the science classroom to fulfill not only the literacy standards, but also be used to promote scientific literacy and 21st century skills (Bixler, 2007; Clemmons & Sheehy, 2011; Czerneda,
1999; Zigo & Moore, 2004), engage students (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010; Smolkin & Donovan, 2004), and teach science content in a storied format (Raham, 2004; Smolkin & Donovan, 2004). The story of this science teacher as he navigates the whirlwind of curricular issues and mandates and is a learner trying out a new pedagogical tool will offer important understanding and insights into the decisions, ideas, and processes that result in classroom practices.
CHAPTER II:
REVIEW OF LITERATURE

Overview

Over the past 50 years, the word reform has been used to denote major shifts in education. Use of this term has enabled taking an object-like view of change where one can manipulate and re-shape the system of education. It has been convenient to speak of education as reform within the larger discourses of the past century, which have centered around industrialism and bureaucratic management. Documentation of major changes in science education is rife with descriptions and analyses of reform. Ultimately, this study moves past thinking of reform in a positivist manner to view education change as discourses. Accordingly, this study intends to bring awareness to the narratives of a high school science teacher responding to the new Alabama College and Career Ready Standards (CCRS) (Alabama State Department of Education [ALSDE], 2010b) literacy guidelines. Undertaken as narrative inquiry, this study re-storied a teacher’s use of a science fiction novel to provide a focal point to learn from his experience. Significance occurs through the awareness of the situation of the teacher as he navigated this educational reform along with the various other discourses that direct classroom practices, reflecting the teacher’s sense of emotions, rationales, and physical constraints that he brings to actions of change in his classroom. In addition, the use of the science fiction novel created a context where the participant is both teacher and learner in the classroom as he utilizes a tool somewhat uncommon in the teaching of science.
Chapter II begins with a literature review of science education reform to bring into view how historical discourses point to power struggles enacting meaningful science in classrooms. Within this review, I will note how notions of literacy have been pivotal throughout science education reform discourses. Chapter II will continue with a discussion of the current science educational reforms as well as various other educational and science discourses that currently affect pedagogical practices in the science classroom and will conclude with a review of the literature related to the situated cognition of individuals as they learn new tasks. The pursuit of scientific literacy, the multitude of educational discourses, and the situated cognition of the teacher as he utilizes a unique tool in the science classroom creates a whirlwind of issues that must be navigated on a daily basis. This literature review will highlight the most significant of these to create the backdrop for this teacher’s story.

Scientific Literacy: A Goal for Science Education

Throughout the years, science education has evolved in many ways, influenced by significant world and life events. Debates among education researchers, scientists, politicians, and other stakeholders have resulted in numerous changes and reforms to science education in the United States. Most every reform effort and debate has the common question of how to best pursue scientific literacy for all students and what criteria would define that concept of scientific literacy. In relation to the theoretical framework of this dissertation, facilitating scientific literacy represents the job that a science teacher is responsible for doing in the classroom. To facilitate scientific literacy in the classroom with students, the science teacher must navigate many standards, reforms, mandates, and best practices that guide and influence what happens in the classroom.
Historical Science Educational Reform

The content and knowledge that science teachers are responsible for teaching their students has been debated for many years (Bybee, 1997; Lee & Ready, 2009). As society and education were influenced by historical events such as World War II and the launching of Sputnik, the question of what students should know about science continuously evolved. The reform that has occurred over the past years has sought to include more diversity into science classes, in order to promote and cultivate an understanding of science for all students. Science education reform has also resulted in science being taught at all levels of schooling from elementary to post-secondary. Unfortunately, this reform has come in the form of policies and programs with less influence on science classroom teaching practices (Bybee, 1997; Rutherford, 2005). Over the past 60 years, multitudes of policies and proposals for science education have been advocated and debated leading to the current concept of scientific literacy and science education in the twenty-first century; consequently, I will contain my discussion to the most influential and prominent of these, beginning at the conclusion of World War II.

In the early days of high school curriculum, a variety of courses were offered that differed based on rigor and career-path, where college-bound students were tracked into more academically-oriented courses and work-bound students were required to take the less academic vocational courses (Lee & Ready, 2009). At the conclusion of World War II, society became more concerned with advancing science and technology and addressing education for all students (Bybee, 1997; DeBoer, 2000; Shamos, 1995; Yager, 2004b). There was much discussion of how to incorporate science and technology into the general curriculum, and education was regarded as a way to address societal injustices and promote social change (Bybee, 1997). Although the need for science and technology education was becoming more apparent, these issues were still
being addressed through the general educational curriculum instead of through specific science curricula.

Educational reforms post World War II were indicative of the progressive educational movement in that students were encouraged to attend school longer; therefore, additional electives were needed (Bybee, 1997). In addition, the progressive education movement sought more curricular choice and authentic experiences for students (Bybee, 1997; Lee & Ready, 2009). This trend continued until the Russian spacecraft Sputnik I was successfully launched on October 4, 1957. After this momentous event, the U.S. educational system began to support more rigorous standards and an updated science curriculum, specifically emphasizing science, math, and authentic science experiences (Bybee, 1997; DeBoer, 2000; Shamos, 1995) along with inquiry-based instruction (Llewellyn, 2013). According to DeBoer (2000), at this time, “the main goals of the science community were the preparation of future scientists and a general public that would be knowledgeable enough to be sympathetic to the work of scientists” (p. 587).

The reform initiative of the 1960s Golden Age was to totally replace the traditional teaching methods of science with more advanced materials and methods such as inquiry and discovery learning. Curriculum developers provided prescribed materials for teachers to use in the science classroom that allowed for very little, if any, academic freedom. The proliferation of kit-based science curricular projects funded through the National Science Foundation (NSF) at this time were collectively referred to as the Alphabet Soup curricula. The kits, which primarily targeted elementary teaching such as Science Curriculum Improvement Study (SCIS), Science-A Process Approach (S-APA), and Elementary Science Study (ESS), were designed by university scientists and intended to be teacher-proof. Secondary curricula were also developed in the same fashion becoming known as Physical Science Study Committee (PSSC) physics or Biological
Sciences Curriculum Study (BSCS) biology. This reform movement focused intensely on the curriculum, ignoring many important aspects of public education (Bybee, 1997) and significant to the present study-exclusive of teacher input. It was also the hope that scientifically and mathematically talented students would be challenged in these newly developed academic disciplines. Unfortunately, statistics did not support the major success of these NSF initiatives as expected, with fewer students taking these science-based classes as desired (Bybee, 1997).

According to Bybee (1997), the explanation for the less than successful reform movements can be found in the domestic and social issues that were prominent in the mid-1960s. These included racial turmoil in the South, the death of President John F. Kennedy, poverty, and the Vietnam War. Once again, society and the government became more concerned with educating all children, especially minorities and the disadvantaged, and less concerned with scientific domination (Bybee, 1997).

As society progressed into the 1970s, American schools and the concept of public education came under great scrutiny, especially secondary education (Bybee, 1997). Many of the reform recommendations of this time sought to provide more academic choices for high school students and more opportunities for career based experiences external to the school setting (Bybee, 1997). In regard to science education reform, there was not much change in science education programs during this era. Science curricula were still emphasizing science and mathematics for the “academically talented” (Bybee, 1997, p. 15), yet because of societal pressure, students became more of the focus of reform efforts than actual school programs. According to DeBoer (2000), science educators during this time began to appreciate the broader scheme of science as a goal for science education, with less focus on strict disciplines and more inclusion of socio-scientific issues and technology into the curriculum.
During the 1980s, another educational reform movement began, initiated by the bleak outlook summarized by the National Commission on Excellence in Education’s (NCEE) (1983) *A Nation at Risk*. In response to substantial success of international business and a fragile U.S. economy, “the nation…needed higher levels of academic achievement, a productive workforce, economic progress, and a strong national defense” (Bybee, 1997, p. 20). *A Nation at Risk* provided suggestions to save the U.S. from certain demise. These included increasing the length of the school day and year, increasing the rigor of subject content, stressing science and mathematics in the school curriculum, and raising expectations and increasing accountability for students, college graduates, and pre-service teachers (Bybee, 1997; DeBoer, 2000; Gee, 2012; Hurd, 2000; Lee & Ready, 2009; Llewellyn, 2005). High school graduation requirements now included “a minimum of four years of English and three years each of mathematics, science, and social studies” (Lee & Ready, 2009, p. 139) with a decreased emphasis on diverse educational opportunities. The report also initiated increased interest in science within the community outside of school by prompting the establishment of community science programs and an increased spotlight of science in the media (Shamos, 1995). *A Nation at Risk* (NCEE, 1983) was just the beginning of the reform reports that proliferated during this decade. Accordingly, all of the reports recommended changes to the educational system as well as specific improvement to science education (Bybee, 1997; Shamos, 1995).

Another of the 80s reform movements was the AAAS’s *Project 2061* which began in 1985 and was named for the year Halley’s Comet would once again pass near Earth. This reform movement involved a team of experts that outlined what science, technology, and mathematics were important for students to know and what would make the next generation scientifically literate (AAAS, 1985; Bybee, 1997; DeBoer, 2000; Eisenhart et al., 1996; Laugksch, 2000;
Llewellyn, 2005; Rutherford & Ahlgren, 1990; Shamos, 1995). The recommendations of the expert panel were finalized and published in Science for All Americans (Rutherford & Ahlgren, 1990). At its publication date, Science for All Americans “presented one of the most comprehensive and innovative statements of scientific literacy in the history of science education” (Bybee, 1997, p. 64). This report characterized what a student should do and learn during their school career in order to be considered scientifically literate. Science for All Americans was somewhat different in its suggestions for science curriculum because it did not focus as much on students knowing decontextualized and disconnected science facts, but instead stressed science, math, and technology connections and concepts along with promoting higher thinking skills (Bybee, 1997; Eisenhart et al., 1996; Rutherford & Ahlgren, 1990). As its name implies, it established a framework for ALL students and adults to pursue scientific literacy.

Continuing with the concept of science for all, the National Science Teachers Association (NSTA) began the Project on Scope, Sequence, and Coordination (1996) to focus more on science teaching practices and curriculum organization in schools (Aldridge, 1992; Eisenhart et al., 1996; NSTA, 1996). Although the report did not specifically define scientific literacy, it advocated the definition provided by Project 2061 and the belief that, with proficient science teaching, all students could learn science and become scientifically literate (Eisenhart et al., 1996). In 1993, Benchmarks for Science Literacy, another extension of Project 2061, were published. They provided recommendations for science teachers in their effort to promote the ideas in Science for All Americans as well (AAAS, 1993; Bybee, 1997; Eisenhart et al., 1996). Together these reports launched a new outlook of scientific literacy. In addition, with encouragement from NSTA, the NRC began the development of science education standards in the early 90s. After much deliberation and input from both scientists and science teachers, the
NRC published the completed *National Science Education Standards* in 1996 (Bybee, 1997, NRC, 1996).

After the *Benchmarks* and *Standards* were published, the attention of reform was focused more closely on the science curriculum and classroom practices of science teachers. Finally the area where true change must take place was being scrutinized. However, this focus revealed that at the school and classroom level, there were issues understanding exactly how these documents could help (Bybee, 1997). For instance, there was some confusion on what the term *curriculum* actually meant. From the perspective of a science teacher, curriculum can be the content that will be covered in a particular class such as biology. From the perspective of an administrator, it may represent a broader concept such as materials, equipment, and textbooks needed for the entire high school science curriculum. Ultimately, science teachers do not have the “…time, budget, expertise, and personnel to develop science curriculum for their unique teaching style, students, and community” (Bybee, 1997, p. 142). Unfortunately, this is where reform efforts may end with no or minimum changes to classroom practices (Bybee, 1997).

In 2001, the No Child Left Behind Act (NCLB) was implemented as a revised version of the 1965 Elementary and Secondary Education Act (Laguardia & Pearl, 2009; Taylor & Nolen 2008). NCLB’s purpose was to elevate ALL students to reach 100% of their achievement goals in their core subjects by 2014 (Taylor & Nolen, 2008). NCLB mandated that all students, including special populations such as students with disabilities and English language learners, be assessed through standardized testing yearly for grades 3 through 8 and at least once more in grades 10 through 12. Along with increased, high-stakes standardized testing for all students, schools were required to assess one additional criterion such as drop-out rate or unexcused absences (Taylor & Nolen, 2008). Once this legislation was passed, it became the main national
educational reform movement drastically affecting public schools across the country. Laguardia and Pearl (2009) asserted that NCLB was a continuance of the previously mentioned *A Nation at Risk* (NCEE, 1983) using “scare tactics” to promote educational reform.

**Current Educational Reform**

In response to the changing world that students will enter upon graduation, there are currently two major educational reform movements that are being realized in public education. The first of these reform efforts is the *Common Core State Standards* (CCSS) which were commissioned by the National Governors Association for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO) and were released in June 2010 (Ivey, 2011; Llewellyn, 2013; NGA Center & CCSSO, 2010a; Porter, McMaken, Hwang, & Yang, 2011; Rothman, 2012). The development of the CCSS (NGA Center & CCSSO, 2010a) involved the input of various stakeholders including teachers and higher education faculty and cover mathematics, English language arts, and content literacy in other subjects including science (Conley, 2011; NGA Center & CCSSO, 2010a, 2010b; Porter et al., 2011). The CCSS have been adopted by 48 states including Alabama where they were combined with Alabama’s current state standards to create the *Alabama College and Career Ready Standards* (CCRS) (ALSDE, 2010a; *Raising Expectations*, 2011).

The goal of the CCSS is to provide a framework of the knowledge and skills that all students will need to enter into college academically ready and, subsequently, to enter the 21st century workforce (Haycock, 2010; Ivey, 2011; Llewellyn, 2013; NGA Center & CCSSO, 2010a; Porter et al., 2011; Rothman, 2012). The premise of the CCSS is that a high school diploma is no longer sufficient to secure a career-oriented job and that too many students complete high school without the academic foundation to be successful in college and/or job
training (Ivey, 2011; NGA Center & CCSSO, 2010a; Rothman, 2012). This is especially significant for disadvantaged and minority students who many times do not have access to more rigorous course offerings (Achieve, 2011). Furthermore, the authors of the CCSS make the argument that when students are more prepared to enter the global workforce, the U.S. will continue to grow and prosper (Achieve, 2012).

Alabama’s version of the CCSS are the *College and Career Ready Standards* (CCRS) (ALSDE, 2010a) and were implemented for the first time during the 2012-2013 school year in the area of math. The English language arts and literacy standards were fully implemented for the first time during the 2013-2014 school year (CCRS Implementation Team, 2012). The CCRS are a framework and guide for Alabama teachers as they develop lessons for their individual students; however, collaboratively developed materials and curriculum guides as well as professional development opportunities will eventually be included in the CCRS “package” (*Raising Expectations*, 2011). These curricular materials will also be available to university teacher education programs.

The *Common Core State Standards* encompass a reform movement aimed at all subjects, including science, whereas the *Next Generation Science Standards* (NGSS) (NGSS Lead States, 2013) are focused only on improving K-12 science teaching across the nation. The development of the NGSS was initiated based on the same premise as the *Common Core State Standards*-to guide students in becoming marketable in a technology saturated, global environment (Achieve, 2010; Krajcik, 2013; NGSS Lead States, 2013). The final version of the NGSS was released in Spring 2013 (Achieve, 2010; NGSS Lead States, 2013) and mirrors many of the reform efforts of the past: *All Standards, All Students*. This section of the NGSS addresses the changing demographics of U.S. students, the challenges and opportunities associated with students
traditionally underrepresented in science, and methods for implementing the standards (NGSS Lead States, 2013). In summary, the NGSS reflect real world interconnections that build from kindergarten through 12th grade, incorporate more engineering concepts than previous science standards, and theoretically guide students to a deeper understanding and application of science content.

Historically, science education has progressed from something only available to the academically talented to a necessity for all students. As discussed previously, reform initiatives in the 1960s supported prescribed “kit” science with little academic freedom for teachers. As years passed, scare tactics and the desire for world domination in science and technology brought about science reforms resulting in documents such as *Benchmarks for Science Literacy* (AAAS, 1993) and the *National Science Education Standards* (NRC, 1996), which emphasized science literacy as a goal for all students. Current educational reforms (NGSS and CCSS) are now concerned with addressing the global, 21st century skills that students will need now and in the future as technology rampantly develops on a daily basis. However, throughout the years of science education reform, the reform efforts did little to influence classroom pedagogy (Bybee, 1997). According to Bybee (1997), “ultimate reform of science education will only occur at the level of science classrooms” (p. 167). Each science teacher and science classroom is unique and diverse, consequently, it is important that science teachers understand the purposes, policies, and programs that develop through reform efforts and utilize this information in their classroom (Bybee, 1997). Yet, how aware are science teachers of the current science education policies and how do they actualize these in their unique classroom? The next couple of sections will focus on the development of scientific literacy as goal for science education and how its concept has been influenced and shaped by the various educational reform movements.
Historical Underpinnings of Scientific Literacy

Historically, defining scientific literacy and how to best pursue it has been a major influence on the science reform movement as well as school science programs; the reverse of this is also true (Bybee, 1997; DeBoer, 2000; Liu, 2009; Roth & Lee, 2002; Shamos, 1995). According to Bybee (1997), the search for scientific literacy began with the first teachers asking what science students should know about science and that search has continued to the present. Bybee (1997) represented these discussions as the “Sisyphean question: What should the scientifically literate person know, value, and do-as a citizen?” (p. 46). According to Shamos (1995), the idea of scientific literacy for all students (even though it was not called scientific literacy at the time) was initiated post World War II in response to both the horror and help that science could generate. Van Eijck and Roth (2010) discussed how the early views of scientific literacy were commensurate with the doing of science by scientists. According to Roberts (2007), originally the expression scientific literacy determined the science knowledge needed for students in non-science related programs of study. The phrase has since evolved to encompass what all students should understand regardless of their career path (Bybee, 1997; Roberts, 2007).

Before a definition of scientific literacy could be developed, it had to be distinguished from literacy in general. Typically, basic literacy represents being able to read, write, speak, listen and understand, with the goal of communication (Gee, 2012; Kouba et al., 1998; Laugksch, 2000; Norris & Phillips, 2003). However, according to Kouba et al. (1998), scientific literacy would require more than basic literacy. This elevated literacy “involves the ability to use language, content and thinking from various perspectives in situationally aware, purposeful ways to make sense of experiences and gain ideas” (Kouba et al., 1998, p. 3). According to Bybee (1997), the phrase scientific literacy is somewhat misleading and is actually a metaphor of the
goals of science education. For instance, customarily for one to be literate means that he can read or write; conversely, for one to be scientifically literate does not necessarily mean one can read and write about science (Bybee, 1997; Yager, 2004).

The term scientific literacy was used in the early 1950s occasionally; but, according to Bybee (1997), it was Paul Dehart Hurd who popularized the term among science educators. He used the term to include both science content and the societal issues that are associated with science (Bybee, 1997; DeBoer, 2000; Hurd, 2000). This initiated scientific literacy as a slogan and as a motivator of science education reform. During the 1960s, the slogan of scientific literacy became more widespread in educational research and as a general purpose for science education; however, a unified, distinct definition of the term had not yet been established (Bybee, 1997; Hurd, 2000; Shamos, 1995). Toward the end of the 1960s, scientific literacy became more clarified in its goals for science education and a working definition was attempted, but critics of the term and definition still prevailed (Bybee, 1997).

Throughout the 1970s and 1980s, the concept of scientific literacy continued to be debated. Bybee (1997) cited various authors’ differing ideas of what is meant by the term scientifically literate. Although, the authors had different concepts of the term, each expressed the need for some understanding of science and society to be included in the definition. As previously mentioned, the National Commission on Excellence in Education (NCEE) published *A Nation at Risk* in 1983. This report was not only significant for educational reform, but it also “highlighted scientific literacy as a national priority and helped define its meaning” (Bybee, 1997, p. 60). The recommendations offered by *A Nation at Risk* sought to promote scientific literacy in all students, not just the college bound or academically talented (Bybee, 1997; DeBoer, 2000). Furthermore, *Project 2061’s* compiled report *Science for All Americans* (AAAS,
1989; Rutherford & Ahlgren, 1990) also supported the inclusion of technological literacy. This publication provided a broad definition of scientific literacy which presented a more holistic approach to the scientific disciplines with less emphasis on specific science content and more emphasis on connections among science, technology, and math in order to make informed societal decisions (AAAS, 1989; Bybee, 1997; DeBoer, 2000; Eisenhart et al., 1996; Laugksch, 2000; Rutherford & Ahlgren, 1990; Shamos, 1995).

Throughout the 1990s, the discussion and debate over the definition of scientific literacy continued. Some responded that scientific literacy was an unreachable goal (Shamos, 1995), however, the term continued to be used as a goal for science education even though it was not always clear which definition was being applied (Holbrook & Rannikmae, 2009). Once the National Science Education Standards (NSES) (NRC, 1996) were released, there was once again support for science students to attain higher scientific literacy (Bybee, 1997; DeBoer, 2000). The content standards of the NSES attempted to provide a contemporary and understandable definition of scientific literacy (Bybee, 1997; DeBoer, 2000; Eisenhart et al., 1996; Hand et al., 1999; Kouba et al., 1998, NRC, 1996). This definition, however, was not based on knowing large amounts of scientific facts without understanding and connections to other science concepts. The NSES promoted scientific literacy through increased critical thinking, scientific reasoning, and inquiry learning (Bybee, 1997; NRC, 1996). A more contemporary aspect of scientific literacy denoted by the NSES was the inclusion of science related social issues that would allow students to explore their understanding of topics they may face as citizens (Bybee, 1997; Hand et al., 1999; Kouba et al., 1998). The NSES also encouraged communication and discussion about science with less emphasis on learning strict science content only to be assessed on a standardized test (Hand et al., 1999; Liu, 2009; NRC, 1996). Additionally, the NSES
suggested that the attainment of scientific literacy will be fostered during an individual’s early years and will continue to develop into adulthood (Yager, 2004b). The *Benchmarks for Science Literacy* (AAAS, 1993) also addressed the concept of scientific literacy, supporting connections across science, mathematics, and technology (AAAS, 1993; Hand et al., 1999; Liu, 2009).

One significant trait of the NSES is that they addressed the importance of the teacher in the realization of the standards in the classroom. The NSES addressed teaching and professional development along with content and assessment so that science teachers could better understand and prepare for facilitating students to the higher levels of scientific literacy (Bybee, 1997; Eisenhart et al., 1996; NRC, 1996). Bybee (1997) stressed that the NSES only created an image of a scientifically literate individual and that it was the responsibility of science teachers as well as educational and community leaders to make this image reality. The NSES provided a flexible and usable way for a reform vision to be realized concretely in the science classroom (Bybee, 1997). Shamos (1995) concurred that the classroom science teacher was essential in providing a “quality and effective science education for the general student” (p. 174), regardless of his belief of scientific literacy as a myth.

Morris Shamos was a major critic of the scientific literacy movement during this time. In his book, *The Myth of Scientific Literacy* (1995), he debunked scientific literacy as a goal for science education referring to the American public as “a nation of scientific illiterates” (p. xi) in spite of all the emphasis placed on reforming science education. Shamos (1995) disparaged the achievement of scientific literacy for various reasons. First, he discredited the crisis in science education formulated by *A Nation at Risk* (1983) blaming political agendas and funding issues related to science programs as the true culprit of the crisis. Shamos (1995) identified achievement of scientific literacy by all students as the “band-wagon” that everyone jumped on
without truly understanding what that meant or how it was to be achieved. Secondly, Shamos (1995) discussed how continuous science education reform has resulted in science alternating between a requirement for college-bound students and a requirement for all students. He lamented that either way it was configured, scientific literacy was still not defined or understood, so how could it be measured in either situation? Thirdly, Shamos (1995) explained that any implication of scientific literacy achievement is really not about understanding science; it is about understanding technology as the products of science and how these products affect society. He asserted that both the adult public and students understand technology because it is a concrete, tangible entity that makes sense in their everyday lives; whereas “true” science is made up of many abstract concepts (e.g. molecular theory of matter) that cannot be physically observed. Shamos (1995) continued in that to truly know and understand science necessitates a “mode of thought that is out of keeping with one’s everyday experiences” (p. 45). Therefore, both the achievement and continuation of scientific literacy, however it is defined, is a difficult task that requires extensive and continuous study of the content, an undertaking that most people external to the profession of science would not take on.

Shamos (1995) continued with his attack on scientific literacy by declaring the only true goal of science education is the production of more scientists, engineers, and science teachers, and the push for science literacy for all is just a politically correct pipe dream. According to Shamos (1995), if the intention of science education was truly to create a scientifically literate population that could understand socio-scientific based issues, the target of this education would be the adult population more than school children. His argument continued in that even if students do well in school science and are for a short time scientifically literate, this literacy is usually lost once the specific class is over. Consequently, any hopes of the scientific knowledge
and understanding gained through school classes carrying over into the adult population after
graduation is quite unrealistic. Furthermore, Shamos (1995) questioned why people should even
strive to maintain a level of scientific literacy when there is an abundance of individual success
stories that required little to no comprehension of science. Shamos (1995) persisted that the
educational reforms devoted to increasing scientific literacy throughout the years have only led
to more sensitivity of the impact of science and technology on society, and the true science
underpinning these issues is no more understood now than it was prior to these reforms.

Current Interpretations of Scientific Literacy

Modern concepts of scientific literacy encompass much more than simply understanding
science vocabulary and specific science content. Scientific literacy means that students
experience the “authentic questions and processes of science” (Bybee, 1997, p. 72). Norris and
Phillips (2003) expanded on this discussion further by distinguishing reading and writing in
science as fundamental scientific literacy and “being knowledgeable, learned, and educated in
science” (p. 224) as derived scientific literacy. They argued that, even though derived scientific
literacy is usually what “counts” as being scientifically literate in schools, the fundamental sense
is essential and should not be ignored. Lemke (2004) further added to this premise in his
discussion of the multiple literacies required for science. Lemke (2004) stated “scientific literacy
is not just the knowledge of scientific concepts and facts; it is the ability to make meaning
conjointly with verbal concepts, mathematical relationships, visual representations, and manual-
technical operations” (p. 38). Yager (2004b) concurred with the idea of scientific literacy
involving more than memorization of facts, but he also cautioned that science education should
not just be a focus on the processes, skills, and duties of real-world scientists. Focusing too
much on the science of practicing scientists will be just as irrelevant to the lives of many students
as concentrating on large amounts of science facts and content (Yager, 2004b). It can then be presumed that an important part of striving for scientific literacy would include incorporating multiple literacy practices and relevant science knowledge in the classroom.

With the release of the *Next Generation Science Standards* (NGSS) (NGSS Lead States, 2013), the idea of scientific literacy is once again being contemplated. In the executive summary published by Achieve (2010), scientific literacy was still a preeminent goal of scientific reform and is to be addressed in the NGSS. The development of the NGSS takes into account the global and technological infused world in which all students live, presenting a need for students to be able to comprehend the issues of science and technology more than ever before, i.e. students need to be scientifically literate (Achieve, 2010; NGSS Lead States, 2013). Again, it is not expected that the NGSS will provide an exact definition of scientific literacy, but instead consider the skills and competencies of science that the U.S., as well as other countries, find as critical to the development of scientific literacy (Achieve, 2010; NGSS Lead States). Furthermore, in the same fashion as previous reform efforts, the NGSS will address the need for all students to become scientifically literate and have the opportunity to enter the STEM workforce if desired.

Even though literature supports the notion of scientific literacy as a goal for science students, there is still no exact, accepted definition of what it actually means to be scientifically literate (Brown et al., 2005; Bybee, 1997; DeBoer, 2000; Holbrook & Rannikmae, 2009; Laugksch, 2000; Liu, 2009; Norman, 1998; van Eijck & Roth, 2010; Roberts, 2007; Yager, 2004b). DeBoer (2000) concluded that scientific literacy, even though continually debated, encompasses a broad definition that includes a public understanding of science, technology, and society. Scientific literacy is determined by society and the information needed to produce
informed citizens within that society (DeBoer, 2000; Holbrook, 2010; Holbrook & Rannikmae, 2009). According to Saul et al. (2012), scientifically literate students will be able to “understand issues that are important to local communities, issues that may vary from school district to school district, and issues that cannot always be identified by textbook makers or curriculum coordinators” (p. 3). Therefore, scientific literacy is continuous and ever changing (Bybee, 1997; DeBoer, 2000; Holbrook, 2010; Liu, 2009), and should not be dictated by science content, but rather by the needs of society (Holbrook, 2010). Furthermore, because of the fluid nature of science literacy, Liu (2009) questioned whether its “achievement” by the end of high school or even into adulthood should even be a goal for science education. Consequently, it is important that teachers are aware of the societal demands and are able to connect the concepts of science to their students’ lives outside of the classroom and inspire life-long learning of science.

Even though one unified definition or interpretation of what it means to be scientifically literate has never been established, many authors describe characteristics of scientific literacy. Holbrook and Rannikmae (2009) stated that a scientifically literate person would be able to make sound decisions related to science and technology when faced with these in their lives. According to Roberts (2007), the consensus is that students must know some subject matter in order to be scientifically literate, yet there is no agreement on what that subject matter should be. Saul et al. (2012) discussed how students must learn skills that “allow them to continue learning about science concepts and enable them to find, make sense of, and assess the information they encounter” (p. 2) if they are going to stay abreast of scientific and technological breakthroughs. According to Czerneda (1999), “scientific literacy is about effective and reliable communication of ideas, including being able to discern the meaningful from the misleading” (p. 20). Eisenhart et al. (1996) continued that “literate persons not only possess knowledge, but they use their
knowledge in varied contexts and for worthwhile purposes” (p. 282). Yore et al. (2004) asserted the importance of written and spoken language to scientific literacy stating that all science is essentially conducted through language. Wellington and Osborne (2001) concurred that “knowing and understanding the language of science is an essential component of scientific literacy” (p. 139). Additionally, Norris and Phillips (2003) cited the decisive nature of reading and writing in regard to learning science and therefore, improving scientific literacy. They stressed that reading and writing were not just the mechanism that delivered science, but that they were as crucial as any other aspect of “doing” science such as observation and experiment. Finally, Hurd (1998) listed several attributes of a scientifically person that “enable students to adapt to the changing world of science and technology and its impact on personal, social, and economic affairs” (p. 413).

The modern concept of scientific literacy considers the technologically infused world and 21st century skills needed for students to be successful in current society (Achieve, 2010). Although much debate has occurred throughout the years on defining and assessing scientific literacy, and even if it is possible for someone to be truly scientifically literate, pursuit of such a goal for science education does not seem to bewaning. Van Eijck and Roth (2010) discussed how attainment of scientific literacy in the “wild” does not depend on decontextualized facts and content that can be memorized by the student, but instead is a “distributed, situated, and dynamic process” (p. 186). Holbrook and Rannikmae (2007) as well as Holbrook (2010) supported a socially influenced science curriculum that not only taught science content but also responsible citizenry, decision-making, and creativity in scientific and technological situations. Holbrook and Rannikmae (2007) proposed that the societal and cultural uniqueness of the science learners should guide how science is taught rather than the science content. If this unconventional
approach to science education is embraced in our globally influenced society, scientific literacy for “responsible citizenship” (p. 1347) should be an obtainable goal. In addition, Holbrook and Rannikmae (2007) emphasized the importance of technology and science together, referring to them jointly as Scientific and Technological Literacy (STL). Although they do acknowledge that science and technology are technically different, within a school setting “conceptual knowledge, personal, and society values inherent in the development of Scientific and Technological Literacy (STL) in this sense are indistinguishable” (Holbrook & Rannikmae, 2007, p. 1356).

Finally, Liu (2009) supported a more modern, reconceptualized view of science literacy that took into account the out-of-school experiences of students, the intrinsic and extrinsic learning motivation, formal and informal learning, and the life-long and evolving nature of science literacy. He referred to this updated vision of science literacy as “science and the public” (Liu, 2009, p. 307).

Although one unified definition of scientific literacy has not yet been actualized, Roberts (2007) identified two differing visions of scientific literacy, Vision I and Vision II. Roberts (2007) described Vision I as being more aligned with the learning of specific science content whereas Vision II supported more situational science concepts that are influenced by more than just the science itself. When comparing the Vision I and Vision II concepts of scientific literacy, Roberts (2007) concluded that students taught from a Vision I curriculum will have much different outcomes than students from a Vision II program. When a Vision I approach is exclusively taken, students’ experiences with the social, ethical, and political aspects of science in society are diminished. Under Vision I, scientific issues are contemplated usually from the single perspective of a scientist, excluding all other perspectives. Any mention of situational science is usually only done so as a means of motivation and engagement. Conversely, Vision II
agendas can neglect the science content. Roberts (2007) also stated that when students are only exposed to a Vision I concept of scientific literacy, they will not necessarily realize the socio-scientific aspects of Vision II scientific literacy. This is because the discourses utilized in Vision I versus Vision II are very different. Thus, science teachers must be aware of the scientific literacy Vision they wish to portray in the classroom and how students can shift from learning content science to learning situational science. In addition, the tools and approaches to science literacy will be very different depending on which vision is being embraced.

Bybee (1997) presented a different framework of scientific literacy from Roberts’ (2007) Vision I and II. Bybee’s (1997) framework situated scientific literacy on a continuum where a person can achieve greater and deeper understanding as he moves up the continuum. At the bottom of the continuum is illiteracy, which comprises a very small percentage of the population, usually confined to those individuals with developmental disabilities. The next level is nominal scientific literacy where individuals will have a minimal familiarity with a science concept, yet possess no real understanding of that concept. According to Bybee (1997), nominal scientific literacy is actually a great starting point for teaching, learning, and the achievement of higher levels of scientific literacy because misconceptions related to science can be replaced with more accurate information. The next stage in the continuum is functional scientific literacy. This level is characterized by the understanding of scientific vocabulary and content within a specific context. Individuals within this level of scientific literacy do have some understanding of science concepts, although very limited. This stage of scientific literacy is many times encouraged by textbooks and science curricula that promote rote memorization of facts and has been the traditional emphasis of science curricula. Conceptual and procedural literacy is the next stage and is typified by an understanding of the distinct concepts of a scientific discipline as
well as the how these concepts fit together in the discipline as a whole. The final and highest level in the continuum is *multidimensional scientific literacy*. Individuals at this level can connect scientific disciplines to the entirety of science including historical and societal issues. Bybee (1997) affirmed that science educators can seek to improve students’ scientific literacy horizontally at each level and also vertically from one level to the next. Furthermore, he explained that it is an impossibility to reach full scientific literacy; therefore, the goal of scientific literacy is a never-ending process.

Shamos (1995) also discussed a continuum of scientific literacy levels or *dimensions*. His first dimension, *cultural scientific literacy*, was based on the idea of E. D Hirsch and represented the simplest level of scientific literacy. Shamos (1995) used this term to describe the population that believes they are scientifically literate because they can reasonably understand science related issues in the popular media. The next dimension is *functional scientific literacy* and is similar to the level of the same name described by Bybee (1997). Shamos (1995) added that this dimension is characterized by individuals being able to “converse, read, and write coherently, using such science terms in perhaps a nontechnical, but nevertheless, meaningful context” (p. 88). Shamos (1995) affirmed that both of these dimensions were possible to achieve by students and could easily be assessed through routine objective testing. However, the next dimension in his continuum was not so easily grasped. “*True*” scientific literacy was illustrated by understanding the underlying theories of science, how these theories were developed, and possessing and utilizing scientific thinking skills such as inquiry, experimentation, and argumentation (Shamos, 1995). According to Shamos (1995), this third dimension of “true” scientific literacy is unlikely to be found in the non-science population, but it is the dimension that should be the goal for declaring someone scientifically literate. It is because this third
dimension is so difficult to attain that Shamos (1995) believed scientific literacy is an unreachable and unrealistic objective for science education.

The lack of a unified definition of scientific literacy also affects the ability to assess scientific literacy (Laugksch, 2000; Roberts, 2007; Shamos, 1995). According to Shamos (1995), without an accepted definition among science educators, the only way to assess the achievement of scientific literacy is through objective testing of hard facts and content or subjectively through “anecdotal impressions” (p. 169). According to DeBoer (2000), a true assessment of scientific literacy can never be realized because scientific literacy will never truly be defined. The failure to define scientific literacy is due to its broad nature, fluidity, and dependence on personal experience within society (Bybee, 1997; DeBoer, 2000; Holbrook, 2010). DeBoer (2000) continued that science teachers should embrace this ever-changing uniqueness of scientific literacy and utilize their expertise to create a science curriculum that will enhance their students understanding of science and society while in the classroom and after graduation. According to DeBoer (2000), “ultimately what we want is a public that finds science interesting and important, who can apply science to their own lives, and who can take part in the conversations regarding science that take place in society” (p. 598). Shamos (1995) exposed the lack of a unified, accepted definition of scientific literacy as well as a lack of guidelines to measure the attainment of scientific literacy as a major flaw of reform movements. However, he did agree that the testing of strict science content was not an acceptable way to assess science literacy in any respect. DeBoer (2000) continued that none of the various routes to scientific literacy included the assessment of meticulous science facts. Furthermore, van Eijck and Roth (2010) lamented over the assumption that scientific literacy could even be assessed through the
typical objective measures. Since scientists do not perform science in this way, they questioned why the measurement of scientific literacy through these means would even be considered.

Conversely, according to the Executive Summary released by the 2011 National Assessment of Educational Progress (NAEP), scientific literacy can not only be attained, but can also be measured through the NAEP Science Assessment (National Assessment Governing Board, 2011). Accordingly, the 2011 NAEP Science Framework Executive Summary provided a revised description of what a scientifically literate person “looks like” based on updated criteria and standards that address the global world. According to NAEP (National Assessment Governing Board, 2011), a scientifically literate individual comprehends the essential science concepts and ideas, can connect these across all science disciplines, and can utilize scientific thinking and processes to solve real-world problems.

Along with the continuous debate over the definition of scientific literacy and whether or not it can ever truly be achieved, there is also debate of the actual terminology to be used (i.e. science literacy versus scientific literacy) (Liu, 2009; Roberts, 2007). Roberts (2007) affirmed that scientific literacy is the most extensive term used in science literature and the most recognized by science educators, but science literacy is also a well-known term. According to Liu (2009) the terms are generally interchangeable, even differing in Science for All Americans (AAAS, 1989; Rutherford & Ahlgren, 1990) (uses science literacy) and the National Science Education Standards (NRC, 1996) (uses scientific literacy). In Liu’s (2009) writings, “science literacy is related to goals of science education, and scientific literacy is related to approaches to achieving science literacy” (p. 302).

Regardless of the exact definition of scientific literacy, research supports its continual pursuit as a reasonable and essential goal for science education (Bybee, 1997; Laugksch, 2000;
Llewellyn, 2013; Pratt & Pratt, 2004; van Eijck & Roth, 2010). Although the goals and direction of science education as well as the concept of scientific literacy have been debated for many years, there seems to be agreement that the 21st century student experiences a much different scientific and technological world than in previous decades. As can be seen from the extensive literature that has been reviewed, most agree that scientific literacy for ALL students should continue to be a goal for science education. However, in the modern classroom, the approach to this may be somewhat different than in years past. Science teachers can no longer passively teach strict content disciplines to students in the old-fashioned, traditional, teacher-centered format. As discussed previously, modern science teachers must consider the literacy skills, background, prior knowledge, and culture of their students in order to strive for the type of scientific literacy that can be carried away from school into real life. This view of scientific literacy is not necessarily something that can be measured since it will be as unique as each student. Accordingly, a scientifically literate student in this respect may not be able to recite hard science facts, but will be able to comprehend scientific and technologically related information, critically analyze this information, and make a responsible, ethical decision.

The above literature review of science literacy and curricular reforms highlight the years of debate and discussion surrounding the best approaches, methods, and practices of teaching science. These debates and discussions attest to the nature of reform as discourses. Unfortunately, many times the science teacher was never considered or provided a voice in the reform discourses of the past. Furthermore, teachers may not have even been aware of how the various reform movements over the decades actually influenced their classroom practices. Currently, there are reform movements directly affecting the classroom practices of Alabama teachers, and whether the teacher is aware of the educational discourses that initiated these
reforms or not, he/she must address them in the classroom. The next section in this literature review will emphasize the current educational and science discourses that affect the science teacher.

**Educational and Science Discourses**

According to Gee (2005, 2012), the use of language always involves not only “language in use” (2005, p. 7), but also a conglomeration of other factors such as beliefs, experiences, attitudes, emotions, style, expressions, etc. that coexist with language in use. He referred to the language in use as *discourse* (note lowercase d) and the other factors as *Discourse* (note capital D). The learning of science is influenced by both the big D and little d discourse. One of the major influences currently affecting classroom pedagogy is the *College and Career Ready Standards* (ALSDE, 2010a, 2010b) and their directive to specifically address content literacy in every subject area. Additionally, the language of science involves its own specialized speech which is extremely challenging for students, especially marginalized students who are rarely successful in science (Gee, 2012; Wellington & Osborne, 2001). Along with the technical language of science, the other Discourses that affect learning science must also be considered. These include the various other Discourses that affect the science teacher’s students as well as other directives, practices, and issues that also influence classroom pedagogy. For purposes of this dissertation, I refer to these d/Discourses as educational and science discourses. As the teacher strives to teach his students and pursue scientific literacy, he must realize how these science and educational d/Discourses affect his teaching practices and the learning of science.
Content Literacy and Reading in Science

Historically, the traditional secondary content teacher found the use of literacy strategies while teaching their subject unfamiliar, time-consuming, and possibly inappropriate unless specifically helping the student carry out traditional activities related to text (O’Brien et al., 1995). However, if content teachers embrace the use of literacy strategies along with other pedagogical practices in the classroom, literacy can help students “socially construct knowledge” (O’Brien et al., 1995, p. 446) which will ultimately facilitate content learning. Yet, the practices of content literacy infusion fail to recognize the unique nature of secondary schools, secondary teachers, and the social construction of knowledge (O’Brien et al., 1995). According to O’Brien et al. (1995), true content literacy teaching cannot be accomplished through the use of literacy strategies alone; content teachers must also “recognize, analyze, and work within the complexities that shape secondary teaching and learning” (p. 447).

One of the intricacies of secondary schools discussed by O’Brien et al. (1995) is that of school curriculum. According to these researchers, school curriculum is a vehicle to exert control and authority over what can be taught and what is deemed important to know in order to maintain the traditional role of secondary schooling, which is to supply an informed workforce. O’Brien et al. (1995) continued that both students and teachers have the traditional, compartmentalized structure of secondary subjects ingrained in their belief systems so deeply, it is very difficult for teachers to break from these traditionalist thoughts and truly incorporate reading and literacy strategies across the curriculum.

A second complexity of secondary schools discussed by O’Brien et al. (1995) is that of pedagogy. The authors explained that the traditional methods for content literacy are based on a structuralist framework and involve the teacher going through specific steps of a particular
strategy with the student with little room for situated and independent learning to take place. Additionally, the school curriculum dictates much of what happens in the secondary classroom with the teacher controlling the pace of the classroom and the specific content to be taught. This results in the secondary teacher reinforcing the “pedagogies of control and telling” (O’Brien et al., 1995, p. 450). That is to say, the teacher controls the classroom environment and tells the students what they need to know through recitation and lecture, choosing these instead of allowing the students to read and interact with texts themselves. However, if content area teachers are willing to abandon their pedagogies of control and telling, it is possible to employ student-centered content literacy strategies in the secondary classroom where the teacher and student interact with each other as well as the text to promote learning (O’Brien et al., 1995). These strategies include cooperative learning, performance assessments, and reader response which allow interaction and discussion.

A third complexity of secondary schools which influences content literacy is that of school culture (O’Brien et al., 1995). According to O’Brien et al. (1995), school culture is unique to each institution and the infusion of content literacy pedagogy into the secondary classroom will be affected greatly by this school culture. Each secondary content teacher is influenced by his personal belief system as well as the mandates required by the school in which he teaches. These factors can create “subcultures,” of which individual members may be opposed to the incorporation of content area literacy in the classroom “because the strategies do not mesh with their ways of believing, thinking, and acting as teachers in the disciplinary subculture” (O’Brien et al., 1995, p. 452). Students as well are influenced by the school culture, finding it strange when content area teachers veer from what students believe are the “normal” instructional practices of the secondary classroom (O’Brien et al., 1995). Therefore, both
teachers and students must face and negotiate the school culture in order to truly infuse content literacy.

Keeping in mind the socioconstructivist nature of content literacy discussed by O’Brien et al. (1995), Adams and Pegg (2012) studied the implementation of content literacy strategies by secondary math and science teachers while they were participating in content literacy focused professional development. Adams and Pegg (2012) found that the teachers differed in the way they enacted the literacy strategies, many times “modifying the strategies in ways that minimized the conflict among their goals, classroom practices, and use of the strategies” (Adams & Pegg, 2012, p. 158). Adams and Pegg (2012) cited various influential reasons for these differing enactments which included “teachers’ learning goals for their students, prior teaching practices, and pressures resulting from limited classroom time” (p. 160).

Fisher, Ross, and Grant (2010) provided reasons why reading across the secondary curriculum is underutilized. One reason was the belief that high school students should not be allowed to read “easy” books. Since many secondary students are below grade on reading level, the students cannot learn the content when they do not understand the book. In response to the problems that occur in middle school literacy (as students shift from narrative to expository texts), Dennis, Parker, Kiefer, and Ellerbrock (2011) conducted a case study of one teacher as he tried to become more developmentally responsive in his teaching practices. One of the strategies that he utilized in this study was to provide his students with multilevel reading materials so that all students could participate in science interactions regardless of their reading level. An additional reason why reading across the curriculum is not very prevalent was cited by Turk, Klein, and Dickstein (2007). They discussed the time constraints that many teachers may feel
when attempting to add reading into an already packed curriculum where testing of the “standards” is expected.

Although the issues with content literacy in secondary schools are well documented, Wendt (2013) stressed its importance in the academic and social development of secondary students. Furthermore, the Common Core State Standards (CCSS) (NGA Center & CCSSO, 2010a) prescribe standards for content literacy in secondary schools emphasizing that “all educators at every level in every subject share in the responsibility for literacy achievement” (Wendt, 2013, p. 40). However, the concentration on academic content in secondary schools does little to support literacy learning. In response, Wendt (2013) discussed several strategies for building fluency such as repeated reading procedures, continuous reading, and peer pairing, even though evidence of successful results with secondary students was limited. Additionally, Wendt (2013) advocated the use of technology and social interaction to promote literacy achievement and motivation.

In their review of research regarding reading strategies, Jetton and Lee (2012b) cautioned teachers to be aware of which strategies were specifically reading strategies and which were instructional in nature. They deemed this important because reading strategies need to be explicitly taught to readers whereas specifically sharing the instructional strategy is not necessary. Conley (2012) also differentiated teaching strategies such as graphic organizers and rubrics from learning strategies such as summarizing, predicting, and questioning. Teaching strategies can be utilized by the teacher to “teach” the specific learning strategy.

Hinchmann, Alvermann, Boyd, Brozo, and Vacca (2003) reviewed ways that adolescents’ literacy practices could be encouraged and connected between school and home life. Hinchmann et al. (2003) explained how students are practicing “literacy” daily through social
media technologies, pop culture, sports, music, and simply existing in the world. Hinchmann et al. (2003) suggested that teachers foster student competence, make personal connections to literacy, create a participatory classroom environment, provide a variety of informational sources for students to utilize, and strategically embed and teach literacy strategies to students in order to bridge the academic and home literacy. This bridge is needed to create successful students and citizens in the 21st century.

There are even more issues involved with teaching content literacy when the content is science. According to Greenleaf et al. (2011), hands-on activities dominate the science classroom and many science teachers, although aware of the need for literacy instruction, are at a loss of how to integrate literacy strategies, reading, and hands-on activities. This led Greenleaf et al. (2011) to establish the Reading Apprenticeship framework and provide professional development to teachers on how to implement this framework into their science classrooms. According to Greenleaf et al. (2011),

The framework thus aims to support teachers in building students’ capacities to carry out close, intellectually engaged reading; gain insight into their own thinking processes; make meaning; acquire academic and disciplinary language; read independently; and set personal goals for literacy development. (p. 658)

The Reading Apprenticeship professional development and intervention took place within biology classrooms that served predominately marginalized students. Results of the intervention were positive indicating that reading integration was increased, assurance in science reading improved, and standardized test scores improved not only in science but in reading comprehension and English language arts as well (Greenleaf et al., 2011). Hence, the results of this study support the incorporation of direct reading and reading strategies into the science classroom as a way to improve science learning and reading skills for ALL students.
Fang and Wei (2010) studied the scientific literacy development of middle school students through the use of “explicit reading strategy instruction and quality science trade books” (p. 265). They asserted that it is important for science teachers to directly provide reading instruction of various scientific texts and build on student prior knowledge in order to promote scientific literacy. When various texts are provided, students are exposed to science vocabulary and discourse in a different way than through the state-adopted textbook. This marriage of science and literacy instruction benefits the student by improving both their science and reading skills (Fang & Wei, 2010). According to Fang and Wei (2010), the results of their study did reveal an improvement in both the fundamental and derived sense (Norris & Phillips, 2003) of scientific literacy when reading and science were joined in the middle school classroom.

Shanahan (2004) also cited several reasons why reading should be incorporated into the science classroom. These included advocating lifelong science learning, mirroring practices of authentic science, participation and understanding of socio-scientific issues, and promoting a deeper and more critical learning and comprehension of science content. Shanahan (2004) also stressed that when students only participated in reading and writing activities in customary classes such as English, they would not practice and enhance their ability of reading and writing in science or benefit from the science knowledge held by science teachers. Furthermore, Shanahan (2012) cautioned science teachers about not having students read science textbooks, even though the many problems with textbooks are well documented. When “good” science teachers explain and teach the textbook information through lecture, notes, and corresponding lab activities, students will not develop their skills at reading science which can then be problematic for them as they continue into college, jobs, or enter society as a citizen. Shanahan (2012) cited several reasons why having science students read texts and other informational
sources were needed. These included being able to re-read for information or an explanation when memories of explained information are inadequate, inaccurate conclusions from experiments which may provide false ideas or reinforce misconceptions of science that students would need to verify through reading about accurate explanations, and that authentic science activities involve much reading and writing.

In regard to science students, Shanahan (2012) reviewed the challenges they face when reading science texts as discussed by a group of chemists reflecting on their own literacy practices. These challenges involved vocabulary, comprehension, fluency, and writing. The science vocabulary was problematic because some words had common meanings external from science, and students had to essentially re-learn the meaning in the scientific context. The other issue with vocabulary was the overwhelming amount of technical terms with complex prefixes, suffixes, and root words that changed the meaning of the word. In regard to comprehension, the challenge was the ability to discern the various textual science concepts in other forms such as graphically or formulaic. The problem with fluency of reading also involved the graphic and formulaic representations of science; students many times skipped over the graphics, and they did not fully understand what the formulaic symbols meant in order to understand their scientific meaning. Furthermore, the same issues with representing graphics and formulas in students writing about science existed as well. According to Shanahan (2012), “scientists have unique ways of representing the world, and these translate to unique discourse practices, which, in turn translate to unique challenges for students wishing to learn science” (p. 162).

Fang and Wei (2010) also discussed several factors that hinder the inclusion of reading into the science classroom. First, many secondary science teachers, as well as students and other stakeholders have preconceived notions of what “science teaching” looks like, which is a highly
specialized, hands-on picture instead of a reading infused class. Second, with an already packed curriculum and limited time and resources, adding reading into the process may be overwhelming for some teachers. Third, the predominant secondary school organization and environment that separates classes into subject areas, diminishes the desire of teachers to incorporate other content into their classes. Fourth, even if teachers aspire to integrate reading and science, they may feel unprepared to do so (Fang & Wei, 2010). Llewellyn (2013) also mentioned the overwhelming curriculum and time constraints to cover all of the material that science classroom teachers experience. Additionally, Wellington and Osborne (2001) discussed how science teachers many times neglect the reading of science for the doing of activities. As previously mentioned, science experiments and activities are considered to be the more authentic science practices; yet, real scientists spend a substantial amount of their job reading about science. Wellington and Osborne (2001) cited other reasons to incorporate reading into science which included student enjoyment and engagement, practice in critically reading different kinds of text, and fostering scientifically literate citizens.

According to Norris and Phillips (2003), reading and science are inherently joined together in the fundamental sense of scientific literacy. Unfortunately, this fundamental scientific literacy is many times disregarded for the derived sense as a measure of “true” scientific literacy. When the fundamental sense is considered, it is only unique to science when science texts are being utilized; consequently, “the educational goal of scientific literacy has a common purpose with literacy goals in other substantive content areas. It means that all teachers can unify their efforts in fostering literacy in its fundamental sense” (Norris & Phillips, 2003, p. 233). This reinforces the notion that strategically teaching content literacy in science as well as other subjects is essential. Norris and Phillips (2003) continued that it is imperative to promote
scientific literacy in the fundamental sense in order for students to fully understand the science concepts and skills promoted in the derived sense of scientific literacy. Furthermore, advocating the fundamental sense of scientific literacy in the science classroom will provide opportunities for cross-curricular connections to other subjects as well as encourage non-scientists to understand science texts after completing high school.

**General literacy strategies versus discipline-specific literacy strategies.** Even with science content, the incorporation of literacy strategies can be accomplished from two different means: utilizing general literacy strategies or more discipline-specific approaches. Brozo, Moorman, Meyer, and Stewart (2013) reviewed these two perspectives and pleaded for proponents from each side to “consider how a blend of practices from both approaches can serve the needs of all students” (p. 354). Brozo et al. (2013) discussed a compromise where content teachers, such as science, can adapt the generic literacy strategies to be more applicable to their specific discipline. Furthermore, instead of the far too common practice of handing over generic literacy strategies to content teachers to figure out on their own, Brozo et al. (2013) advocated literacy specialists working with content area teachers to discuss and develop the most appropriate literacy practices for their specific student population. In a conversation about content area literacies, Bean and O’Brien (2012) also criticized the infusion model of introducing literacy strategies to teachers and then leaving them unsupported to incorporate the strategies into their curriculum. Fang (2012b) supported the collaboration of content teachers and literacy/English teachers, but favored the use of discipline-specific literacy strategies when utilizing academic texts. He supported these strategies because content teachers would have the necessary expertise in the language demands that correspond with the specific discipline.
Shanahan (2012) also discussed the use and effectiveness of literacy strategies in the science classroom. According to Shanahan (2012), science teachers many times receive general literacy strategies at cross-disciplinary workshops or meetings, where the strategies are explained by literacy coaches with little science content knowledge. Science teachers are then expected to incorporate the literacy strategy on their own into their already packed curriculum where “they believe that the strategies aren’t really helping students to understand the science” (Shanahan, 2012, p. 163). Based on the previously discussed challenges of reading science texts by students, Shanahan (2012) offered several strategies to address the problem areas. In regard to vocabulary, Shanahan (2012) suggested using a vocabulary notebook where vocabulary words were explored more deeply through multiple representations in addition to the general definition. Comprehension is addressed through this notebook as well. Shanahan (2012) also suggested providing numerous sources of science information (texts, videos, graphical) to improve comprehension. For writing in science, Shanahan (2012) emphasized forming and supporting arguments.  In summary, Shanahan (2012) noted that reading in science cannot be approached from the same way as reading in other content areas; just because students can pronounce the vocabulary and read the information, does not mean they understand and comprehend the science.

To further complicate the “generic strategies versus discipline-specific strategies” debate, Fang (2012a) reviewed the various pedagogical approaches for advancing content literacy. These approaches included the cognitive approach, sociocultural approach, linguistic approach, and critical approach. The cognitive approach “advocates systematic, explicit teaching of mental routines or procedures for accomplishing cognitive goals, such as understanding a text, writing an essay, or solving a problem” (Fang, 2012a, p. 103). The cognitive approach supports the use
of a variety of generic literacy strategies because “the requirements of reading/writing are essentially the same regardless of content areas” (Fang, 2012a, p. 104). The sociocultural approach considers both social and cultural aspects of reading and writing. Although it is not deemed as strong of an approach as the cognitive, the sociocultural approach values the home literacies, funds of knowledge, and culture of students in the reading and writing process (Fang, 2012a). The linguistic approach assumes that “content areas texts are constructed in language patterns that differ significantly from those that construct everyday texts” (Fang, 2012a, p. 105) and that this language should be explicitly taught. Finally, the critical approach, also known as the sociopolitical approach, examines the social justice issues related to texts. This approach has a low evidence base in regard to successfully teaching literacy, but it “engages students in analyzing texts and interrogating the values, prejudices, and ideologies underpinning these texts, helping them better understand the politics of representation and the constructedness of knowledge” (Fang, 2012a, p. 107). Fang (2012a) encouraged teachers to avoid focusing on one single approach as all of the approaches augment one another and can be used to provide focused literacy instruction to students.

According to Fang, Sun, Chiu, and Trutschel (2014), some proponents of the linguistic approach have expanded that concept further into functional language analysis (FLA) (Fang & Schleppegrell, 2010) which takes into consideration the unique language used in each specific discipline. Specifically, the content, organization, and style of the text is considered and analyzed. In their study, Fang et al. (2014) sought to investigate the perceptions of FLA from practicing teachers enrolled in an online graduate reading course. Results of the study revealed that although the teachers felt FLA was a feasible approach for content reading instruction, they were uncertain of how to implement the approach into their existing, full curriculums. The
practicing teachers were also anxious about the in-depth knowledge of language needed to successfully implement the approach (Fang et al., 2014). According to Fang et al. (2014), FLA can be used to address the content literacy standards of the Common Core, but implementing such an approach would be immensely difficult without administrator support and quality professional development opportunities.

**Technology and literacy.** With the increase in availability of technology in classrooms as well as the abundance of Wi-Fi hotspots and smart phones accessed by students, teachers have connections to a vast amount of technological resources to address content literacy learning. Young readers are globally connected through social media and interactive technologies, yet many teachers fail to recognize this form of reading as a legitimate resource to address literacy in the content classroom (Alvermann, 2006). Alvermann and Heron (2001) described the literacy practices of a young man named Robert as he intensely read about Dragon Ball Z on the internet. Although many may assume these literacy practices to be less “educational” than others, Alvermann and Heron (2001) concluded that Robert was actually participating in practices similar to those found in language arts classrooms that involved “strategic thinking and learning” (p. 119) as well as a “meaning-making practice” (p. 120). Alvermann and Heron (2001) suggested educators explore the incorporation of these popular media texts into the classroom as a way to address true literacy practices and engage students’ interests at the same time.

Jetton and Lee (2012b) discussed the differences in hard copy texts and digital texts in regard to student comprehension. According to Jetton and Lee (2012b), students reading traditional texts comprehend the information in a more linear way, trusting that the information is true and accurate. Although some connections of ideas among sections of a chapter must be made, limited information is provided with traditional texts. With online information, readers
have access to a plethora of linked information that is far from linear. In fact, “The navigational process becomes an integral part of the meaning that an individual constructs” (Jetton & Lee, 2012b, p. 12). Furthermore, readers must discern credible sources and information from the erroneous. To assist students in effectively navigating and utilizing online information, Jetton and Lee (2012b) suggested the use of prior knowledge to help determine trustworthy sources, vast knowledge of vocabulary so that appropriate hyperlinks can be accessed, and understanding of how online texts are arranged as well as the collaborative nature of the information.

To assist teachers wanting to address literacy through technology, King-Sears, Swanson, and Mainzer (2011) provided a framework for incorporating technology into the classroom that was connected to learning goals and promoted literacy learning. Although their framework was intended for adolescents with disabilities, they emphasized that it was practical for choosing classroom technology for all students. The TECH mnemonic guides teachers to first determine “what the students’ literacy needs are related to the learning outcomes” (King-Sears et al., 2011, p. 570), then examine “which technology may be used to fulfill the specific literacy needs” (p. 570). Finally, teachers must merge the technology with instruction as well as manage the logistics of the technology and assess its impact on student learning. Following this framework can allow teachers to incorporate a variety of resources for content literacy as well as fostering 21st century skills and Web 2.0 interactions. Interactive Web 2.0 functions such as blogging, tweeting, and posting videos along with other technological applications such as speech-to-text capabilities are useful in encouraging learning disabled or any apprehensive student with converting thoughts into words and improving reading and writing skills. These skills are also familiar to today’s multiliterate students and can be adapted for pedagogical use in the classroom (King-Sears et al., 2011).
Sweeny (2010) advocated the use of “current information and communication technologies (ICTs)” (p. 121) when addressing literacy in the classroom. These ICTs include text messaging, e-mails, social networking, and the like. Sweeny (2010) argued that these are the technologies that are being utilized by students in the world outside of school, so teachers should not be afraid to embrace them as pedagogical strategies to promote literacy. According to Sweeny (2010), “Schools need to embrace ICTs so that students are prepared to function in a world where new literacies are the expectation and the norm” (p. 122). New literacies refer to those skills that one must have to navigate the numerous technological applications available. Sweeny (2010) discussed several suggestions for incorporating ICTs into the curriculum such as employing online resources for editing and revising written documents, creating multimedia documents where students decide on the mode and medium of their product, utilizing Twitter for posting responses to assignments, and participating in online forums such as blogs or wikis.

Wendt (2013) concurred that “students must master the New Literacies in order to be competitive in the future workforce” (p. 44). Wendt (2013) also advised the use of digital texts instead of solely relying on printed reading material. Although Bean and O’Brien (2012) advocated the use of digital texts as well as other text media in classrooms, they also cautioned about totally abandoning print texts that have served literacy purposes in the past. In addition, they were concerned about the digital divide that can occur when some schools provide students with technological resources such as personal laptops or iPads and some cannot provide these resources. According to Wendt (2013), “the implementation of technology may not only lead to increased literacy, but also to increased student interest, motivation, and self-efficacy” (p. 44).

Planning for literacy instruction. Although well documented that content literacy should be addressed in secondary schools, there is a lack of discussion of how content area
teachers prepare and plan for this literacy instruction. This is especially significant for content area teachers such as science that have not been trained or prepared to implement literacy in their curriculum. Jetton and Lee (2012a) reviewed the research surrounding teacher planning and described many influences on this process. One factor affecting planning significant to this study was the influence of state and/or national directives; in this case the CCRS content literacy standards. Jetton and Lee (2012a) also stressed the importance of planning lessons that consider “culturally responsive pedagogy” (p. 95) so that the sociocultural constructs and identity narratives of students are acknowledged. “Teachers who practice culturally responsive pedagogy construct and develop lessons with applications to the various disciplinary content that is relevant to the students” (Jetton & Lee, 2012a, p. 96). Jetton and Lee (2012a) stressed incorporating discipline-specific literacy practices, social interaction, and “texts that tap adolescents’ curiosity, and explicitly teach strategies for engaging with these texts” (p. 100). They continued that even when utilizing general literacy strategies such as activating prior knowledge and comprehension monitoring, each content area teacher should plan how to use these strategies most effectively within the specific discipline.

Content literacy preparation for teachers. Jewett (2013) reviewed the re-designing of a K-12 content literacy course specifically focusing on science and math content areas. Jewett (2013) believed that students will develop a more in-depth understanding of the discipline if content specific literacy practices are employed. Teachers enrolled in the course as participants in the study documented their change in thinking as the course progressed. Findings illustrated changes in the ways teachers thought about literacy from the traditional reading and writing of printed text to “anything that conveys meaning and should be determined by the disciplinary purpose of those who ‘read’ that particular text” (Jewett, 2013, p. 23). Teachers in the course
also reflected on the specific language needed for each discipline and how it contributed to the development of a certain content-specific cultural group. However, Jewett (2013) cautioned against totally disregarding English/language arts focused strategies such as literature circles and reading fiction texts as they can be adjusted to fit with the math and science curriculum as well.

Conley (2012) discussed connecting the pedagogical content literacy courses with the disciplinary courses in teacher education programs. These courses are many times developed, offered, and taken in isolation of one another, yet in the age of Common Core, the thorough understanding of both is essential. The re-designed secondary literacy course allowed teacher candidates to make decisions of the best literacy strategies to be used for their particular discipline while utilizing specific content curriculum standards and the Common Core literacy standards as references. Teacher candidates also had ample opportunities to try out their strategies in order to reflect on their effectiveness before beginning their official student internship. The course sought to have teacher candidates demonstrate their proficiency in several areas important to engaging students in disciplinary literacy. These included knowing the discipline, how to engage students in multiple types of disciplinary texts, your students’ backgrounds and cultures, the function of literacy instruction in the particular content, and how to assess students in various ways. The course culminated in teacher candidates exploring the question “Who Am I as a Teacher?” According to Conley (2012), the absence of content literacy courses that highlight literacy within the specific discipline can be detrimental to students’ disciplinary literacy achievement as well as teachers’ comprehension of disciplinary literacy. However, “foregrounding and reaching out for disciplinary ideas increases the likelihood that teacher candidates will integrate literacy practices into authentic disciplinary problems of practice” (Conley, 2012, 149).
Ruiz, Many, and Aoulou (2011) also examined several secondary education courses for how the use of young adult literature was promoted and how secondary pre-service teachers were trained to utilize young adult literature in their content area. Syllabi were studied from the content areas of English, math, social studies, and science, yet English syllabi made up the majority. The findings indicated that English secondary courses were primarily the only courses to address the use of young adult literature in any way. According to Ruiz et al. (2011), “references to adolescent literature were used (a) to ensure preservice teacher knowledge of texts, (b) to address issues of diversity in the classroom, and (c) as a means of effective classroom instruction” (p. 25). Based on their findings, Ruiz et al. (2011) stressed the importance of promoting the use of young adult literature in content areas other than English and providing the preparation to do so in secondary education courses.

The Language of Science

There is a common belief that science’s dominate language is math, yet when authentic science practices are examined, written and spoken language are the predominately used medium (Fang & Wei, 2010; Hand et al., 2003; Lemke, 2004; Yore, 2004; Yore et al., 2003). Furthermore, “in much of science education, language is pushed into the background or ignored, while thinking or doing are brought into the foreground as if these tasks had little to do with language” (Gee, 2004, p. 13). Because the doing of science is so unique, the written and spoken language used in science is not the same “type” that would be used in other aspects of life (Fang, 2004; Fang & Wei, 2010; Wellington & Osborne, 2001). Consequently, the learning of science cannot be isolated to only learning specific facts, theories, and principles without adjusting everyday discourse in order to understand and use the language of science (Fang, 2004; Jetton & Lee, 2012a). For example, Baker et al. (2009) discussed a professional development program to
teach science teachers the importance of utilizing science oral discourse and argument in the classroom to promote scientific literacy among all students. The PD program proposed the development of science classroom discourse communities so that students have ample opportunities to discuss, interact, and participate in science conversations in a safe environment where science discourse norms can be modeled and learned. Teachers were also encouraged to access student’s prior knowledge and connect science discourse to real life experiences during the program. According to Baker et al. (2009), the program had positive results for the science teachers and the science classroom discourse community supported “achievement in science by promoting peer-to-peer interaction and discourse experiences” (p. 260).

The “Island Group” (Hand et al., 2003) discussed the “literacy” component of scientific literacy as well. According to the Island Group, in secondary science classrooms, formal school literacy is advocated over more informal literacy. However, when only this formal literacy is accepted by the science teacher, there may be missed opportunities for students to express their knowledge of scientific concepts and ideas using informal literacy; hence, these students may not see themselves as learners of science or see science as valuable outside of the classroom (Hand et al., 2003). In addition, Hand et al. (2003) supported valuing students’ informal dialects in the teaching of science, but they also promoted acquiring “new ways with words” (p. 611) so that all students can be comfortable with formal school literacy to strive for equitable education. The Island Group fervently expressed the need for literacy to be “embedded in authentic science inquiry to construct meaningful understanding as well as to develop language strategies and understanding of scientific discourse” (p. 614).

Science discourse can be problematic for all students, even those that are not considered marginalized. According to Chinn (2012), in order to become fluent in science language,
students must “code switch” (p. 443) among home discourse, instruction discourse, and science discourse. Fang (2012b) discussed the two types of technical vocabulary found in science: “words that are unique to the realm of science” (Fang, 2012b, p. 39) and “words that occur with regularity in students’ everyday language but assume specialized or metaphorical meanings when used in scientific context” (p. 39). Examples of the first type would include tornado, bacteria, and photosynthesis. Examples of the second type include front, strain, and harbor. Although these words may be easy for secondary students to read, they may still have difficulty in comprehending them in the correct scientific context (Fang, 2012b).

Wellington and Osborne (2001) related learning science to learning a new language. For example, many scientific vocabulary words have an alternate meaning when used in everyday language (work, law, charge, etc.); therefore, students must learn a new meaning for a word they may already use quite often in their normal discourse. Furthermore, Wellington and Osborne (2001) discussed how the “non-technical words used in talking or writing about science” (p. 17) are equally problematic for students. Wellington and Osborne (2001) also stressed the importance of science language acquisition in creating a life-long learner of science. Students who successfully grasp the language of science will be more likely to critically read science related materials and critique scientific media stories for accuracy once they reach adulthood, leading to increased scientific literacy after formal schooling (Wellington & Osborne, 2001).

Gee (2004) explained how simply learning the definition of a word in order to pass a standardized test is not the same as learning a word and using it within social practice. According to Gee (2004), words have situated meanings based on various contexts and Discourses; consequently, words are incessantly tied to experiences. This has implications for classroom teachers because they must provide experiences for students to use these words, in this
case science vocabulary, in socially situated contexts so that students can truly learn the word, not just memorize the definition. Jetton and Lee (2012a) concurred with Gee (2004) and stressed the need for teachers to “explore ways they can show students how the experts in that discipline think, talk, and write” (p. 100). Gee (2004) cautioned about utilizing face-to-face conversations when “teaching” science language because students will depend on the context and others more knowledgeable of the language in use to participate in the conversation. He suggested instead that these conversations require students to “take longer turns, expand their language, and make clear their reasoning and its connections to what others have said” (Gee, 2004, p. 31). Gee (2004) also suggested utilizing additional texts, discussing these texts, and modeling how to read such texts.

The Influence of Capital “D” Discourse on Learning Science

Gee (2005) discussed how the discourse or words that we use are influenced by a variety of other factors that help us form certain identities as well as recognize the identities of others. Since language is inherently social (Gee, 2012), when conversations occur there are other factors involved that support understanding of the words in use. Gee (2005, 2012) identified these other factors together as Discourse (capital “D”) and defined it as “ways of combining and integrating language, actions, interactions, ways of thinking, believing, valuing, and using various symbols, tools, and objects to enact a particular sort of socially recognizable identity” (2005, p. 21). Everyone has various identities that are molded through language use in different situations; however, problems can occur with the development of these identities when a person does not have the opportunity to practice language in certain situations resulting in possible inequality (Gee, 2005). For example, many students struggle in science because they have limited
experience using the language of science, plus their Discourses inhibit their development of a socially situated identity of someone that “does science.”

Science teachers are also influenced by various Discourses. They may also have a preconceived idea of what constitutes a scientifically literate student based on their own Discourses. When the teacher’s conception of a scientifically literate student and the student’s conception are at odds, successful science learning is unlikely to take place. According to Gee (2005), the key to successfully achieving a Discourse is that others recognize the particular identity while that identity is participating in a certain corresponding activity. Hence, a science teacher may only recognize a student as learning science if the student is using the technical science language and performing a science experiment.

Although both teachers and students may have Discourses that affect leaning science, Gee (2005) offers hope in that Discourses are not rigid, unchangeable entities. Instead, they are fluid conceptions that evolve, merge, split, and even disappear. In fact, Gee (2005) suggested that it is the “fundamental job of education to give people bigger and better Discourse maps, ones that reflect the working of Discourses throughout society, the world, and history in relationship to each other and to the learner” (p. 32). Consequently, both students and teachers can adjust their Discourses related to science learning. When these Discourses are changed, students can realize they do have the capability of understanding and doing science because science is not restricted to the stereotypical white, male Einstein figure mixing chemicals in a laboratory. In turn, teachers can begin to see their students as pursuing scientific literacy in various other ways than just through the regurgitation of science facts on a test or being able to perform certain lab experiments.
New and altered Discourses cannot be accomplished by overt teaching or by learning only. Discourses must be developed through a type of apprenticeship, which Gee (2012) referred to as acquisition, that includes modeling and extensive social practice. The Discourse required of a scientifically literate student or an excellent science teacher is what Gee (2012) referred to as secondary Discourses. These Discourses are considered secondary because they were acquired through a socialization process external to the home (Gee, 2012). Gee (2012) continued in that teaching that leads to acquisition means to apprentice students in a master-apprentice relationship in a Discourse wherein the teacher scaffolds the students’ growing abilities to say, do, value, believe, and so forth within that Discourse, through demonstrating her mastery and supporting theirs even when it barely exists. (p. 175)

Accordingly, Gee (2012) defined literacy as “mastery of a secondary Discourse involving print in some fashion” (p. 173). He continued that print could be replaced with other content to describe explicitly the type of literacy to be achieved through a certain Discourse; specifically in this case, science literacy. Hence, it can be inferred that scientific literacy can be accomplished when students master the science secondary Discourse, which is most likely to occur through the learning of science in context instead of through memorization of unconnected science facts.

**Marginalized Students**

There is much research that documents the lack of minorities and women in the field of science, especially the physical sciences (Gee, 2012; Kanter & Konstantopoulos, 2010; Lemke, 2004; Norman, 1998). Gee (2012) discussed a general issue related to the struggle of minority children in school, the issue of differing school and home Discourses. According to Gee (2012), school-based Discourses are prone to ostracize many minority children and children from lower socioeconomic statuses because their Discourses are not considered appropriate or the norm. This problem becomes compounded in the area of science where specialized language not commonly utilized in any of the students’ home Discourses becomes a necessity. Gee (2012)
referred to this as conflicting Discourses; the Discourse required to be a competent science student contrasts with the everyday home Discourse. This issue is exacerbated when students are for the first time taking part in the social practices and modeling required of the acquisition of this secondary Discourse late in their schooling careers (i.e., secondary school) (Gee, 2012). This is the reality of many of the marginalized students because their primary home Discourse is very different from not only the “scientifically literate student” Discourse, but also the school-based Discourse in general. Gee (2012) offered suggestions to teachers on how to assist with the acquisition of these secondary Discourses by providing a classroom environment that embraces the social practices of the particular secondary Discourse (in this case science) and by also ensuring that students relate the particular Discourse to its place in the world outside the classroom.

Corresponding with Gee’s (2005, 2012) idea of D/discourse, Brown et al. (2005) investigated the influence of language and discursive identity on the learning of science. Brown et al. (2005) discussed how a student’s “discursive identity” (p. 783) is established within the classroom as they utilize specific language and interact with other members of the discourse community. This has important implications as science teachers guide students in their pursuit of scientific literacy since both teachers and students must be aware of the identity labels that are applied to students. Brown et al. (2005) specifically discussed how this might be an issue with marginalized students in a standard science class versus students in an advance science class; would the students develop different discursive identities in each of these classes because of different language use and expectations, and would the teacher assist in this co-construction based on the institutional label of the class? When these discursive identities are recognized and addressed by the science teacher, “science literacy development can be seen as a dynamic social
process that is co-constructed through dialogic exchanges that also include choices and positioning regarding cultural affiliation” (Brown et al., 2005, p. 790). The nurturing of discursive identities in the science classroom is especially significant for marginalized students as they many times struggle to recognize themselves as scientifically literate or successful learners of science.

Lee and Fradd (1998) added to the discussion of marginalized students and scientific literacy through their development of the conceptual framework for instructional congruence in science and literacy. The authors noted that science is predominantly taught with emphasis placed on science related factors such as science knowledge and habits of mind instead of sharing the focus with the literacy component, which considers discourse and culture as well. To reach instructional congruence, both science and literacy would be equally considered in instruction and assessment. Lee and Fradd (1998) stressed the importance of considering prior knowledge, oral discourse, and cultures in teaching science to non-English language background (NELB) students. They warned, however, that if science teachers were overly influenced by science education standards and the traditions and methods of teaching mainstream, Western science, instructional congruence may not be obtained. Lee and Fradd (1998) continued that it can still be problematic for teachers to reach instructional congruence, even if they do try to marry science and literacy in the classroom, because it would require teachers to have a greater understanding of the background and culture of their students as well as how to relate science content to their NELB students.

Norman (1998) suggested addressing the historical issues in science that led to the marginalized discourses of so many as one way to increase scientific literacy of all students. Although Norman (1998) felt that this pedagogical approach could be problematic to incorporate
into an already overloaded science content curriculum, he assured that it would lead to a greater attainment of scientific literacy for all students. Norman (1998) stated, “with this level of scientific literacy, both consumers and producers of science will be in a position to recognize and, if need be, resist modern attempts to appropriate science for undesirable cultural agendas” (p. 372). According to Lee and Ready (2000), equitable education and student choice are ideals of American schooling; however, “traditionally disadvantaged students are less likely to select advanced courses or programs, and the knowledge and skills not gained by these students may affect their educational and economic futures” (p. 150). Kanter and Konstantopoulos (2010) recognized that this trend many times begins in middle school when student attitudes regarding science change negatively and they no longer want to or feel they can pursue careers in science and therefore, do not take advanced science courses. In addition, low science achievement scores may also prevent marginalized students from taking the more advanced science courses (Kanter & Konstantopoulos, 2010).

**Educational Discourses**

Along the lines of Gee’s (2005, 2012) explanation of D/discourses, Sammel (2008) discussed how educational discourses affect the classroom teacher. Although she did not use Gee’s (2005, 2012) explanation of capital D discourse, her clarification of discourse coincides with Gee’s (2005, 2012). According to Sammel (2008), teachers are “subjects who have been ‘produced’ by the dominant educational discourse, its language, and the meanings hidden within that language” (p. 846) resulting in teachers that no longer question the status quo. Consequently, the desire to be a “good” teacher will be very different if one chooses to commit to the dominant educational discourse versus upsetting the dominant educational discourse (Sammel, 2008).
Sammel (2008) described the teaching of science as it is negotiated in different science educational discourses from the over-arching vantage point that she referred to as the *eagle view* and then the more focused point of view that is the *mouse view*. From the eagle view of the dominant educational discourse, science is seen as a clean, uncomplicated, ethically sound content subject that can be mastered by all students if they try hard enough. A second educational discourse found in many science classrooms is that of constructivism. From the eagle view, constructivist classrooms promote critical thinking and understanding where the teacher acts more of a facilitator as opposed to pedagogy based on the memorization and regurgitation of facts. Furthermore, students’ prior knowledge, experiences, and opinions are more valued in science learning but only if their views “mirror the knowledge, values, understandings, and codes of practice of the scientific community” (Sammel, 2008, p. 849). Sammel (2008) continued with the eagle view perspective of the Nature of Science, which from this view, is made up of historical, political, and social aspects related to science that are recommended to be incorporated into the daily science content lessons and activities. Sammel’s (2008) final critique of science educational discourse involved that of White privilege. From the eagle view, science education is socially constructed and favors White ideals and values over others. Accordingly, all students have the same basic education and it becomes the responsibility of the marginalized student to ensure their own success in science.

According to Sammel’s (2008) experiences of being a science teacher (the mouse view), being a good science teacher as defined by the dominant educational discourse means covering the appropriate amount of science content as outlined in the state curriculum while still being engaging and somewhat authentic, yet making sure students achieved high grades on standardized tests. A constructivist classroom from the mouse view may be the “fun” science
class where students are not constantly listening to a lecture. However, more input and participation are required from the students, but eventually they knew they would obtain the needed information whether they participated or not. In regard to the Nature of Science, science related issues of ethics, politics, power, and equity were discussed in Sammel’s (2008) classroom; however, from this mouse view, she soon began to realize how science education ignored many issues and people in favor of promoting the White, Eurocentric view of science. Her struggle then became how to question controversial and hard issues and encourage her pre-service science teachers to do the same since she was “socially constructed into the dominant discourse” (Sammel, 2008, p. 854). Sammel (2008) concluded that all science teachers are socially constructed and affected by the current educational discourses that tend to promote white, Eurocentric ideals while ignoring many other people and situations. To be a truly successful science teacher, Sammel (2008) suggested reflecting on these current discourses as well as our own teaching practices so that all students can better understand science.

Juffermans and Van der Aa (2013) continued with the discussion of educational discourses through their examination of voice in school institutions. According to Juffermans and Van der Aa (2013), “voice is the instrument through which education and schooling is possible” (p. 112). Through interactions among teachers, students and other educational voices (administrators, parents, media, politicians, etc.) as well as the influence of nonverbal factors, voice can be both magnified and subdued through the process of schooling. Classroom teachers are more likely to have the dominant voice within the classroom, but due to the heteroglossic nature of educational discourses they may not be cognizant of the influential power of their voice or the persuasive nature of other educational discourses on the voice they choose to convey (Juffermans & Van der Aa, 2013). This idea of voice in the classroom can have significant
implications for science teachers as they attempt to teach all students equally as directed by science education reform movements, yet still must contend with other factors that influence the classroom.

**Best Practices for Teaching Science**

With the adoption and implementation of the *Common Core State Standards* (NGA Center & CCSSO, 2010a) and the *Next Generation Science Standards* (NGSS Lead States, 2013), one can assume a consensus exists that understands educational reform efforts of the past do not adequately address the schooling issues of the 21st century student. As discussed by Hurd (2000), the 21st century student has different life and schooling experiences than students of the past. A deeper comprehension of science and technology is needed by current students in order to be considered a responsible, global citizen (Hurd, 1998; Hurd, 2000; NGA Center & CCSSO, 2010a; NGSS Lead States, 2013). According to Hurd (2000), the emphasis placed on the learning of disconnected science content and vocabulary imparted by the teacher should be replaced with a comprehensive and integrated science curriculum that allows students to interactively experience science through authentic experiences and the incorporation of socio-scientific and ethical issues. Hurd (1998) referred to this type of curriculum as a “lived curriculum” (p. 411) and stressed that this lived curriculum is necessary so that students can navigate the changing scientific and technological world in which they live and can appreciate and find science useful in their lives external to the classroom.

In addition, Yager (2004a) criticized current science educational practices as being ineffective in their effort to promote scientific literacy. Yager (2004a) provided a detailed discussion of how “mind engagement” (p. 408) is necessary for science learning. For students to be involved in mind engagement, the science curriculum must provide unique opportunities for
student reflection, questioning, and choice in their learning where they can create identities and feel empowered, which is lacking in most current science teaching practices (Yager, 2004a). Furthermore, students will be actively engaged if they see the science curriculum as relevant to their life both in and out of school, and if they participate in doing science in a way similar to actual scientists (Yager, 2004a).

Through his work with the NSTA, Aldridge (1992) came to criticize the biology/chemistry/physics “layer cake” (p. 13) idea of separating the science disciplines in secondary schools as well as the common practice of encouraging the most advanced students into these classes. Aldridge (1992) also warned against introducing too many advanced concepts, vocabulary, laws, etc. to secondary students before they have had a chance to experience the concept and negotiate their own understanding. Aldridge (1992) continued that in order for true science learning to take place, no matter how elaborate, extensive, or exciting a scientific explanation offered by the teacher is, it is still imperative that students get to experience science phenomena on their own, starting with simple, concrete concepts and building to more advanced, abstract concepts. Furthermore, Aldridge (1992) discussed the motivating factors that accompany this type of science learning. Examples of these motivating factors included “hands-on experience with phenomena before terms are defined or concepts named” (p. 13), sequencing from concrete to abstract ideas, confronting student assumptions through experiences, and providing real-life, relevant science based problems.

In their examination of language arts and science research, Yore et al. (2003) emphasized the need for a constructivist classroom environment where interaction and science connections to student’s real lives were far more successful in achieving science learning than the traditional, transmissionist practices. Yore et al. (2004) discussed the importance of oral argumentation,
scientific writing, and critical thinking in the science classroom to encourage scientific literacy. Hand et al. (2003) added that “educators need to focus on the language of science, not just thinking and doing science inquiries” (p. 611). Pratt and Pratt (2004) affirmed that the learning of science content is dependent on the combination of science and literacy where a deep understanding of science is fostered. This deep understanding cannot be achieved through memorization techniques but depends on other factors such as recognition of student prior knowledge, revision of established knowledge, application of knowledge into new situations, and social interaction and discussions about content (Pratt & Pratt, 2004).

Hand et al. (1999) encouraged communication, argumentation, and interaction surrounding real-world scientific issues in the science classroom in order to promote scientific literacy. They stressed the need for classroom teachers to incorporate examples of where scientific literacy would be useful to understanding the issue. Hand et al. (1999) continued that students should understand that learning science is not restricted to “technical competence” (p. 1024), but also involves personal beliefs, imagination, and logic. Yager (2004b) continued this idea with his discussion about the importance of context in regard to learning science. According to Yager (2004b), science concepts should be applied to various contexts that are relevant and related to the experiences of students. True science learning is not about what an authority figure such as the teacher deems as worth learning or what is outlined as important in the textbook; it is about questioning and discussing the real-life examples of science and technology as it occurs in the world of the students.

Argumentation and discussion in science classrooms is a needed pedagogical practice in order to promote scientific literacy (Hand et al., 1999; Llewellyn, 2013; Yore et al., 2004; Wellington & Osborne, 2001). According to Wellington and Osborne (2001), discussion in the
science classroom is dominated mainly by the teacher as they tell students about a scientific concept and then ask a few questions regarding this concept, which most students will not even answer. However, more in-depth discussion where students do the majority of the talking and are able to think and reason about the science concept is more likely to lead to learning (Wellington & Osborne, 2001). According to Wellington and Osborne (2001), “students must have an opportunity to practise its [science language] use through structured activities that require them to talk about science, to use scientific words and to share and construct their own meanings of these words” (p. 84). However, science teachers should be careful to provide structured discussion and argumentation activities where students are taught to follow certain guidelines in a cooperative manner with some distinct purpose or goal in mind (Llewellyn, 2013; Wellington & Osborne, 2001).

In his discussion about argumentation in the science classroom, Llewellyn (2013) stressed the need for teachers to model and prepare students to form scientific arguments where there is not necessarily a winner or a loser, but instead may result in a “revised model or explanation” (p. 37). Many times, in science classrooms the basis of this classroom argumentation will come from hands-on activities, experiments, and inquiry investigations. However, according to Llewellyn (2013), to meet literacy standards, argumentations can be generated from print, text, and Internet resources.

Another current science teaching practice supported by educational reform documents is inquiry learning in the science classroom (Llewellyn, 2005, 2013). Much of the time inquiry learning is associated strictly with hands on science activities, however, inquiry learning also encompasses the use of science language to create and relate students’ ideas and questions about science (Llewellyn, 2005). For instance, Ford (2004) affirmed that the use of various types of
books in addition to the textbook is necessary in science inquiry learning because “no scientific investigation is ever text-free” (p. 277). Alvermann (2004) stressed the use of diversified types of literacy as a stimulus to inquiry and as a compliment to hands-on activities in science. She viewed science instruction that considers multiliteracies as more aligned to the concept of scientific literacy as outlined in the *National Science Education Standards* (NRC, 1996).

According to Pratt and Pratt (2004), inquiry and literacy should be integrated together in order to learn science content. In addition, Ford (2004) discussed non-textbook alternatives in her discussion of inquiry science in an elementary classroom. She stated that information books, although they provide a narrow view of science, can be used to complement inquiry learning through critical thinking and questioning when a hands-on activity is not possible (Ford, 2004).

The current paradigm for effective teaching and learning in secondary science is constructivism (Llewellyn, 2005, 2013). Generally, constructivists believe that learning takes place through a continuous and fluid process of “constructing” new knowledge based on prior experiences and knowledge and social interaction and engagement (Llewellyn, 2005, 2013). Eisenhart et al. (1996) discussed a specific type of constructivism known as sociohistorical constructivism or activity theory that could be more useful in developing scientific literacy in all students because it “emphasizes that knowledge construction in addition to being active and adaptive work on the part of individuals, is historically and culturally constituted” (p. 279). Additionally, sociohistorical constructivism can be helpful in making science more relevant to students because “attention is directed to *external* forces that make or produce the ways in which people think, feel, and act” (p. 279) instead of concentrating explicitly on science facts or broader science concepts. In essence, sociohistorical constructivism considers the social, controversial, and ethical aspects of science along with the facts and concepts.
Yore (2004) proposed another category of constructivism, interactive-constructivism, as a way to successfully teach science and promote scientific literacy. Interactive-constructivism is characterized by many of the other facets of constructivism as well as “assumes that discourse reveals the variety of alternative interpretations but that consensus need not be reached” (Yore, 2004, p. 85). Yore (2004) promoted the interactive-constructivist approach because it addressed language-oriented tasks that are authentic in nature to what real scientists do. This transforms science from an inactive form that relies heavily on large amounts of facts and vocabulary to an active form of authentically doing science while navigating the human and emotional aspects that make science muddled (Yore, 2004).

According to Holbrook and Rannikmae (2007), science teachers should focus on the education of students through science as opposed to emphasizing science and hoping that students will become educated. They questioned the idea of teaching school science in a way that represents science done by practicing scientists when other subjects such as history and language are not taught in a way to create historians or linguists. In their proposed “education through science,” the major tasks and ideas of science such as scientific problem-solving, ethical issues, and the nature of science are philosophically founded in socio-scientific issues instead of scientific endeavors of practicing scientists. As previously discussed, Holbrook and Rannikmae (2007) have also supported the inclusion of technology with science to promote scientific and technological literacy (STL) as a goal for science education in schools. However, they do differentiate between two differing views of how this can be accomplished. The predominant view held by current, practicing science teachers is that “the nature of science education is dominated by the conceptual science component and scant attention is focused on personal and social aspects” (Holbrook & Rannikmae, 2007, p. 1357-1358). Conversely, Holbrook and
Rannikmae (2007) supported a second view of STL in science education, which considered the global, 21st century world in which students exist. This view “recognises the need for reasoning skills in a social context that are based on sound scientific ideas, derived from conceptual understanding and linked to the nature of science” (Holbrook & Rannikmae, 2007, p. 1358).

Students in today’s classrooms have grown up with constant technological and scientific advances and the social and ethical issues that accompany these advances (Kim, 2005). Furthermore, through global media, the ramifications of these issues are no longer isolated to a student’s immediate community. It is imperative that teachers consider this “globalness” when promoting scientific literacy in the classroom and make every effort that “scientific literacy be internalized in students’ understandings of their lived experiences and ethical relations to others in the shared world” (Kim, 2005, p. 55). Kim (2005) asserted that this be done in the most safe and unbiased environment possible so that students can develop their critical thinking skills.

When science is connected to a student’s life, it becomes real and relevant. Once applied to their lives, students can visualize how science is currently affecting them and how it will possibly affect them in the future (Lemke, 2001). Students spend the majority of their day outside of the science classroom where they form all sorts of beliefs, opinions, and experiences that are then brought into the science classroom. These social influences are necessary for students to participate in science learning and thus become scientifically literate (Lemke, 2001).

**Standards and Programs**

The *Benchmarks for Science Literacy* (AAAS, 1993) and the *National Education Standards* (NRC, 1996) were developed to provide a framework for improving science education (Bybee, 1997; DeBoer, 2000). These reform tools offered usable suggestions and recommendations for local school districts and state curriculum developers so that science
education transformation can take place at the classroom level where it will be more effective. Because these were policy statements that are focused on the same goal and were developed with the understanding of one another, there are many similarities between the two. Some notable similarities are their support for achieving high levels of scientific literacy for every student, even those marginalized students who are typically underrepresented in science (Bybee, 1997; Eisenhart et al., 1996). The *Benchmarks* and *Standards* also proposed the integration of societal issues into the science curriculum with a deeper and more meaningful understanding of science concepts (Bybee, 1997; Laugksch, 2000). Of course, confusion does arise among educators because of the two very similar reports. The *Benchmarks* have been around longer than the *Standards*, so many follow their guidelines; but, according to Bybee (1997), both policies can be used to develop a proficient and successful science education program. Eisenhart et al. (1996) added that the *Standards* are more explicit in their pedagogical guidelines and emphasis on experiences of real world scientists.

Eisenhart et al. (1996) reviewed the major science education reform documents (*Project 2061, Science for All Americans, Project on Scope, Sequence, and Coordination, National Science Education Standards, and Benchmarks for Scientific Literacy*) for how they promote scientific literacy. Eisenhart et al. (1996) discussed how these reform proposals acknowledged the importance of socially responsible science, yet failed to consider the problems and issues with the way science is taught in schools. Specifically, the content and discourse of science as it is taught in American schools is mostly disconnected from what students find interesting or useful in their lives outside the classroom; this is even more significant for minorities and females (Eisenhart et al., 1996). When science knowledge is not valued in school settings, it would be unlikely that it would carry over into a student’s life after graduation, when socio-
scientific issues are more likely to be experienced. Although, the *Next Generation Science Standards* (NGSS Lead States, 2013) have been finalized and may replace the standards of the past, it can be assumed that the traditional teaching methods discussed by Eisenhart et al. (1996) have stuck around.

In regard to the *National Science Education Standards* (NSES) (NRC, 1996), these standards were intended to promote scientific literacy and science education reform to support all students regardless of race, gender, or socioeconomic status. Rodriguez (1997), however, criticized the NSES for actually not addressing these issues in a way that can enhance science teaching for diverse student populations. Rodriguez (1997) discussed how the NSES use a “discourse of invisibility” (p. 20) to address marginalized students. This discourse of invisibility found in the NSES is dangerous to science education for all because it superficially acknowledges the struggles of marginalized students without addressing the deep issues that affect the teaching and learning of diverse student populations. Rodriguez (1997) continued that the NSES do not provide the support and encouragement needed to facilitate a more equitable science education for all. Eisenhart et al. (1996) concurred that even though the NSES seek to include all students in the learning of science by recommending a more holistic approach to teaching science, the final goal of students learning the practices of real scientists remains the same. Furthermore, Eisenhart et al. (1996) disagreed with the assumption of the NSES, as well as other reform proposals of the time, that “teaching students key concepts and scientific methods of inquiry will necessarily lead to socially responsible use or to a larger and more diverse citizenry who participate in discussion and debate of scientific issues” (p. 268). Thus, even though the NSES appear to support the learning of science by all students, they do not emphasize this enough or provide enough useful teaching strategies to be truly successful.
Currently, there has been much debate over the adoption of the Common Core State Standards (CCSS) (NGA Center & CCSSO, 2010a) across the nation. Proponents of the standards commend the CCSS for their supposed focus away from “drill and kill” test-prep pedagogical practices to more emphasis on critical thinking and reasoning that are considered 21st century skills (Conley, 2011). However, according to Conley (2011), for the CCSS to be successful, course curriculum must include “interesting problems, investigations, debates, simulations, games, Socratic questioning, presentations, projects, and other forms of learning that demand engagement” (p. 20). Advocates also praise the CCSS for providing guidelines to raise the achievement bar of U.S. students to be commensurate to other exceptional educational systems across the globe, as well as the provision of a national consistency where students in every state are held to the same standards (Conley, 2011; Porter et al., 2011; Raising Expectations, 2011; Rothman, 2012). Porter et al. (2011) summarized the benefits of the nationwide adoption of the CCSS as shared expectations, focus, efficiency, and quality of assessments. Shared expectations refer to the national consistency of standards; CCSS require a greater curricular focus on math, language arts, and literacy than current stand-alone state standards; adoption of CCSS would be more efficient because each individual state would not have to develop its own standards and assessments; and the quality of assessments would be improved through computer adaptation and delivery (Porter et al., 2011).

Opponents of the CCSS (NGA Center & CCSSO, 2010a) cited many issues of concern from funding to classroom implementation. One criticism is the fact that funding from the “Race to the Top” (2009) competitive grant program will not be provided to states that do not adopt some form of CCSS (Haycock, 2010; Porter et al., 2011). Haycock (2010) also mentioned concerns over the execution of the CCSS by classroom teachers, discussing the need for a
rigorous curriculum and high-quality assessments based on the CCSS for teachers to utilize in the classroom. Ivey (2011) noted her concern over the idea that past literacy instruction did not truly prepare students for essential college and career literacy skills where reading and writing in context and social learning are necessary. Ivey (2011) cautioned against the use of this same antiquated approach to literacy instruction when implementing the CCSS. This approach would direct students to “manage, navigate, or perform existing texts individually rather than to create new texts or generate knowledge within a community” (p. 98). In addition, Ivey (2011) mentioned her surprise that the CCSS did not address the issue of student engagement, which is a major impediment to learning and literacy development in high schools. Tienken (2012) likened the implementation of the CCSS across the nation as a “social experiment” where students from kindergarten through high school are being required to learn content possibly too advanced for their developmental stage. Furthermore, Tienken (2012) warned that the emphasis on a narrow curriculum, such as is found in the CCSS, is not adequate to truly prepare students for the multitude of college and career options currently available. Tienken (2012) summarized his opinions about the CCSS in the following quote: “They have no independently affirmed data that demonstrates the validity of the standards as a vehicle to improve economic strength, build 21st century skills, or achieve the things they claim are lacking in the current public school system” (p. 155).

As with the Common Core State Standards, there are both criticisms and accolades attributed to the Next Generation Science Standards. According to Krajcik (2013), the NGSS’s concentration on a small number of core ideas allows students to form deeper understandings of these ideas, creating “integrated understanding” and real-life connections of science across disciplines. Krajcik (2013) also praised the NGSS and Framework for building on student prior
knowledge, developing deeper science understanding with each grade level from kindergarten through 12th grade. These characteristics of the NGSS should provide a more comprehensive and systematic approach to science education. Conversely, Krajcik (2013) voiced concern over the lack of instructional components such as curricular materials and assessments that correspond with the guidelines of the standards. Without quality instructional components, effective classroom instruction, and valuable student experiences, the vision of the NGSS may not be realized. Bybee (2013) also had the same concerns related to curricular materials and assessments aligned to the NGSS. According to Bybee (2013), “if there is no curriculum for teachers, I predict the standards will be implemented with far less integrity than intended by the Framework and those who developed the Next Generation Science Standards” (p. 32).

DeBoer (2000) warned against the regimented nature of standards. He suggested that standards are created as guides for classroom teachers based on expert knowledge and educational information as understood at that time. For example, the National Science Education Standards (NRC, 1996) have now been disregarded for the Next Generation Science Standards (NGSS Lead States, 2013) because the NGSS represent an updated and revised curriculum for the 21st century student. He continued that classroom science teachers should be able to use their professional expertise in the classroom, following standards as a general guideline to science education (DeBoer, 2000). The traditional science classroom depends on text-book driven coverage of science content, but according to DeBoer (2000), teachers should be able to teach the science content they feel is needed for their students regardless of the discipline “as long as that content is meaningful and important to them and is taught in a way that students are able to comprehend and appreciate” (p. 599).
The National Science Teachers Association (NSTA) conducted a survey of science teachers regarding the implementation of the Common Core State Standards. Although most teachers surveyed were in favor of the CCSS, many were concerned with science teaching taking a backseat to literacy (Robelen, 2012). Other parts of the survey revealed that science teachers were implementing the literacy standards in science classrooms more than the math standards, and most teachers felt that the addition of these literacy standards helped with science instruction at least somewhat (Robelen, 2012).

An example of science education reform from the state of Alabama can be found in the implementation of the Alabama Science and Technology Initiative (AMSTI) and Alabama Science in Motion (SIM). According to Newman et al. (2012), AMSTI was instigated in part by the low performance of Alabama 4th through 8th grade students in math and low performance of 8th grade students in science based on the scores of the 1996 National Assessment of Educational Progress. The program was designed to take into consideration state and national teaching standards and increase student achievement as well as teacher professional development. Servicing about half of the Alabama public schools, AMSTI promotes the use of inquiry learning and higher order critical thinking in the classroom and provides the materials for this to be realized (ALSDE, n.d.b). AMSTI schools consistently perform higher on standardized tests, especially in the areas of math and science, than do non-AMSTI schools, and participating in the AMSTI program is the first priority of teachers, parents, and school districts. In addition, teachers participating in the AMSTI program seem to expand their content knowledge of math and science (ALSDE, n.d.b). Statistically, AMSTI is equally successful for all subgroups of Alabama students in the areas of math and science; yet there is a significant increase in reading achievement for white students only (Newman et al., 2012).
The Alabama Science in Motion program (ASIM) is the high school version of AMSTI. ASIM was already established prior to the development of AMSTI, but now they are housed under the same umbrella. Any secondary teacher participating in the ASIM program will have access to much of the expensive and sophisticated science equipment that most schools could not afford on their own (ALSDE, n.d.a, n.d.b). Consequently, diverse students from all backgrounds are allowed access to the same equipment in the content areas of biology, chemistry, and physics. ASIM and AMSTI move away from the large group professional development of science teachers to a more mentor based relationship. Teachers are trained by ASIM facilitators in summer training sessions, but the mentor relationship continues throughout the school year as ASIM facilitators deliver kits and visit schools (ALSDE, n.d.b).

Another important Alabama initiative is the Alabama Reading Initiative (ARI). ARI promotes reading and literacy instruction across all grades (Bacevich & Salinger, 2006). Although there is much emphasis placed on reading and literacy in the early grades, mainly K-3, very few programs focus on reading and literacy issues in secondary grades (Alliance for Excellent Education, 2007; American Youth Policy Forum, 2009). As reported in an issue brief, the Alliance for Excellent Education (2007) stated that reading programs focused on the early grades are no longer adequate for students if they plan to enter our ever-changing global and technological society. Previous emphasis on reading and literacy in the early grades has now been redirected to focus on the unique and complex tasks that are required in secondary grades. The brief also reported that very few U.S. adolescents read on grade level, with an even greater deficit among low socioeconomic students. The American Youth Policy Forum (2009) added that the U.S. ranks near the bottom in math and science literacy among the 30 countries participating in the Organization for the Economic Co-Operation and Development (OECD).
Even though policymakers and educators have become more aware of the need for a focused reading and literacy program in secondary grades, priority remains on literacy in the early grades for most of the U.S. (Alliance for Excellent Education, 2007; American Youth Policy Forum, 2009). Nevertheless, the state of Alabama has realized these deficiencies in secondary literacy instruction and has taken steps to improve the literacy skills of secondary students in Alabama by revamping the original ARI started in 1998. As with other programs, the original ARI emphasized early grade literacy and allocated most program resources to K-3 literacy instruction; however, in 2006 ARI was revised to center on the unique needs of secondary students in hopes to prepare Alabama students to be independent and critical learners (American Youth Policy Forum, 2009).

The secondary component of ARI is referred to as the Alabama Reading Initiative Project for Adolescent Literacy (ARI-PAL) and is housed under the original ARI program. ARI-PAL emphasizes collaboration among content area teachers, reading coaches, and administrators, offering much needed support to content area teachers as they incorporate reading across the curriculum. Even though ARI was to cover K-12, secondary teachers did not possess the knowledge to “teach reading” as did elementary teachers; hence, support and professional development for secondary content area teachers in literacy instruction was a major component missing from the original initiative (Bacevich & Salinger, 2006). While the implementation of ARI-PAL is a step in the right direction for Alabama students, as noted in a study by Bacevich and Salinger (2006), the secondary component of ARI is still struggling amid the national and state bureaucracy. Although support to secondary teachers through reading coaches and professional development is necessary, most of the state department staff have elementary backgrounds and experiences which make it difficult to understand the unique needs of
adolescent students. In addition, Bacevich and Salinger (2006) report that very few secondary staff members are available to assist at the numerous secondary schools where ARI-PAL is being implemented. Funding for the secondary component is still an issue even though there has been increased support for reading instruction in the secondary grades in the state of Alabama. National support is still predominantly focused on K-3 reading instruction so federal funds are not provided to the secondary component (Bacevich & Salinger, 2006).

Despite the issues, Bacevich and Salinger (2006) found that ARI-PAL was “working” in secondary schools. Their study examined standardized test scores as well as input from individuals invested in the program which included students, teachers, reading coaches, administrators and state department staff. According to students, the program supported their confidence and engagement in reading, and they were able to use many of the ARI strategies on their own. Students also stated that they now understand that the “teaching of reading” is a cross-curricular endeavor in all classes. Teachers and administrators reported an interest in extra-curricular reading activities such as reading clubs and after-school tutoring programs as well as an increase in library use amongst the students. Other positive results included fewer disciplinary and special education referrals, content area teachers being able to better teach content along with literacy, and an increased awareness of struggling readers in secondary classes. Finally, standardized test scores, especially those on the Alabama High School Graduation Exam (AHSGE), increased in ARI schools. One significant concern in these results however, is that these positive outcomes were more prominent for higher socioeconomic white and Asian students than for lower socioeconomic minority students. Considering that about a quarter of Alabama students come from a low socioeconomic household, this exception is significant.
The Teacher’s Situated Learning

Discussed thus far has been a myriad of reform movements, standards, curricular mandates, and classroom best practices all affecting the science classroom teacher, either directly or indirectly. In some cases, the science teacher may not even be aware of certain factors until they are revealed in a beginning of the year faculty meeting and directed to be implemented right then. In addition to these factors and mandates, the science teacher is also responsible for the day to day activities of the classroom including classroom management, assessment, and instruction, as well as non-student related tasks such as paperwork, lesson planning, classroom/lab upkeep, professional development and on and on. When new tasks are added or the teacher desires to try out new approaches or tools, he must take on these new and sometimes unfamiliar responsibilities in the classroom, learning while teaching. Consequently, the situated cognition of the science teacher is the specific and realistic view as he goes about his day-to-day activities, while acting as both learner and teacher in the classroom. Because situated cognition is learning influenced by the context and social constructs of the situation (Lave & Wenger, 1991), the science teacher must many times learn “on the fly,” with flexibility being a necessity. In situated cognition beliefs, learning is unavoidable, takes place all the time, and involves creating an identity that corresponds with the new knowledge (Brickhouse, 2001). Furthermore, learning involves displaying a new behavior as opposed to simply storing new information (Núñez et al., 1999). During this section, I will explore the research related to situated cognition and learning, but instead of focusing on student learning, I will focus on the science teacher’s learning and experience as he implements a new tool, the science fiction novel, into the classroom. Utilizing a new, unfamiliar tool situates this research participant as both learner and teacher in the classroom.
Situated Learning

Gee (2005, 2012) explained that all people enact different identities (a “who” and a “what”) in different contexts. The identity a person enacts in different situations is intricate and created by the use of various “social languages” (Gee, 2004, 2005, 2012). Gee (2005) referred to social languages as “different varieties of language that allow us to express different socially significant identities…and enact different socially meaningful activities” (p. 35). Therefore, the social languages utilized by an individual are part of their personal Discourse (capital D) in various situations. Gee (2012) continued that our “who” and “what” are created by the simultaneous interchange of “our social or cultural group memberships…, a particular social language or mixture of them…, [and] a particular context, that is, a configuration of people, objects, and a location” (p. 90). When this idea is applied to a science teacher in a classroom, there is usually a typical, expected identity that is perceived based on individual’s previous experiences with teachers and schooling. The science teacher will enact a certain identity as well that may be the same or different than what students, parents, administrators and others might perceive as a successful science teacher. This is one reason for the confusion that students may feel in a science classroom when the science teacher utilizes a tool such as a novel to teach science; reading a novel does not fit with the preconceived identity of what it means to learn or teach science.

Lave and Wenger (1991) described the situated learning of an individual within the context of “legitimate peripheral participation” (p. 29). According to Lave and Wenger (1991), learning is never a single, individual phenomenon, but instead takes place within a socially-mediated community of learners where both “masters” and “apprentices” learn from one another. This process does not occur simply by receiving information to be stored for later use, but
through actual participation in the activities and experiences required of the expert. Participation in these activities is at first limited, but increases until the person becomes a “full participant in a sociocultural practice” (Lave & Wenger, 1991, p. 29). In accordance with Gee (2004, 2005, 2012), Lave and Wenger (1991) also affirmed the importance of the development of identities in the learning process as well as the use of language (talk) within that specific identity.

Furthermore, this socially situated participation is “always based on situated negotiation and renegotiation of meaning in the world” (p. 51), and “is not merely a condition for membership, but is itself an evolving form of membership” (p. 53).

When applied to the field of education, legitimate peripheral participation has important implications for both the classroom teacher and the student. Lave and Wenger (1991) recognized that learning through legitimate peripheral participation will occur whether teaching is taking place or not because the classroom is a community of practice. Lave and Wenger (1991) support a learning curriculum as opposed to a teaching curriculum. In a learning curriculum, the learners are considered in the process whereas in the teaching curriculum the instructor is responsible for imparting the knowledge. According to Lave and Wenger (1991), a learning curriculum is situated, typical of a community, and “is not something that can be considered in isolation, manipulated in arbitrary didactic terms, or analyzed apart from the social relations that shape legitimate peripheral participation” (p. 97). In regard to the teacher-learner examined in this study, he can be envisioned as a legitimate peripheral participant within the community of English/literacy teachers. Throughout this review of literature it has been cited how science is predominantly perceived as a hands-on subject where students and teachers alike view “reading a science fiction novel” as a strange practice for learning science. However, when fiction novels are utilized as a pedagogical resource within an English classroom, the practice is
viewed as common and essential. It can then be assumed that the English teacher will be more astute in the pedagogical strategies and techniques of using a novel effectively within the classroom. Therefore, the science teacher must participate in the activities of an English teacher and learn through his own situated community of practice in order to reach full participation.

In the tradition of Lave and Wenger’s (1991) concept of situated learning, many other authors offered their ideas of situated cognition and learning. For example, Kim and Hannafin (2008) stated “situated knowledge indicates more than conceptual understanding; it represents a repertoire of important incidents paired with personal meanings, beliefs, and know-how within certain contexts and cultures” (p. 1838). Núñez et al. (1999) discussed how the pure nature of existing as an embodied human being affects one’s learning in that being “human” is characterized by certain ways of thinking, reasoning and understanding. They supported Lave and Wenger’s (1991) ideas of contextual and social learning, but broadened that concept to include the “nature of shared human bodily experience and action” (Núñez et al., 1999, p. 46) in situated cognition.

Kim and Hannafin (2008) discussed situated learning in regard to the teacher as learner. According to Kim and Hannafin (2008), as novice teachers experience situated learning, they “develop understandings of concepts in particular situations (conceptual case knowledge); they also learn strategies for using those concepts in future tasks (strategic knowledge)” (p. 1838). In regard to the science teacher participant in this study, his conceptual case knowledge of literacy strategies and reading in science would be developed as he participates in the act of using the science fiction novel in his classroom for the first time. His strategic knowledge would be demonstrated as he incorporates other reading resources into the science classroom or uses the novel again in subsequent classes, but utilizes certain strategies and routines that he deemed
successful during his initial experience with the science fiction novel. In addition, Kim and Hannafin (2008) stressed the importance of the social aspect of situated learning in that interaction and discussion amongst the community of learners is essential to attaining community membership and thus, learning.

Brown et al. (1989) discussed the disconnect between situated cognition, learning, and classroom pedagogical practices. According to Brown et al. (1989), schooling practices fail to consider the importance of context and activity on learning, favoring transfer of knowledge instead of situated learning. Brown et al. (1989) argued that school learning and teaching do not allow the student to fully participate in the culture of the new knowledge being learned (e.g. authentic practices of mathematicians, engineers, chemists, etc.), but rather adheres to the school culture. Specifically, students are deemed as knowledgeable and cognizant by successfully passing tests related to the content without really understanding how to authentically apply the knowledge. In addition, Brown et al. (1989) compared the leaning activities and processes that students, teachers, and “just plain folks” experience. They determined that the learning experiences of teachers and plain folks are very similar in that

Both have their activities situated in the cultures in which they work, within which they negotiate meanings, and construct understanding. The issues and problems that they face arise out of, are defined by, and are resolved within the constraints of the activity they are pursuing. (Brown et al., 1989, p. 35)

Consequently, even though the teacher as a learner is experiencing cognition in the situated apprenticeship of his or her authentic job as one would in the real world, students are predominantly being taught contradictory, lacking the true authentic experiences.

**Teacher Identities**

There are many pedagogical approaches and teaching philosophies that science teachers can embrace. These will help to shape their identity and Discourse in the classroom as they
interact with students. There are several studies that investigate different conceptual approaches to teaching science as well as examine the classroom teacher through different theoretical lenses. In one such study, Kelly-Jackson and Jackson (2011) studied a sixth grade science teacher in a predominantly minority school setting as she practiced culturally relevant pedagogy. Kelly-Jackson and Jackson (2011) found that the teacher did demonstrate the characteristics of culturally relevant pedagogy in her classroom. Specifically, the teacher had a strong connection with her students and realized her purpose in their lives as well as the greater community. Kelly-Jackson and Jackson (2011) continued that the teacher believed her students could learn and accepted only their best in the learning process by creating a safe classroom environment where knowledge was shared and learning was interactive and collaborative. Kelly-Jackson and Jackson (2011) concluded that “one’s pedagogical stance is just as important as content competency in effectively teaching science to students of color” (p. 412).

In another examination, O’Conner (2008) interpretively examined the emotions, specifically caring, of secondary school teachers. O’Conner (2008) described the identity of a teacher as socially situated “encompassing both an individual’s professional philosophy and their public actions” (p. 118). O’Conner’s (2008) results showed different types of caring behavior that could be classified as performative, professional, and philosophical/humanisitic. In addition, all teacher participants viewed caring as “both a professional choice and as a necessary part of their work” (O’Connor, 2008, p. 121). This has implications for these teachers as well as other classroom teachers because emotions and caring for students can be contradictory to the mandates of standards and other institutional factors. O’Conner’s (2008) findings determined that the reflexive and socially situated identity of teachers does value caring as an important part of the job of teaching whether external educational discourses accept this or not.
Feldman (2004) took a more discerning look at how science teachers teach science as well as how students learn science. In his discussion, he explained that teaching and learning science go much deeper than even situated cognition theory can discern. According to Feldman (2004), the student must renounce aspects of their identities in order to learn science and in return, the teacher must accept that her/his job requires guiding students as they relinquish beliefs and Discourses while learning science. Feldman (2004) suggested this occurs through an existentialist process where both the teacher and student are “*being* in the situation” (p. 146) as opposed to “*thinking* in the situation” (p. 146) as supported by situated cognition, constructing their self, and provided the freedom of choice and action. In Feldman’s (2004) examination of an action research project which took place in a middle school science class, students’ interest and excitement in learning science began to improve when an existentialist teaching approach was utilized. Although this result was not significant enough for objective and quantifiable measures of science learning, the teacher felt success in that the students were changing their identities from students bored with science to those excited and interested in science.

Finally, Llewellyn (2013) suggested that teachers take time to consider the personal and philosophical reasons behind their teaching practices along with the methods they employ. Reflecting on these personal and philosophical reasons will create a unique experience and journey for each individual teacher even when they utilize the same teaching methods and practices within the classroom (Llewellyn, 2013). Llewellyn (2013) continued that the “classroom culture” is significantly influenced by the teacher’s attitudes, beliefs, and principles that govern what they feel are best practices in teaching and learning. Accordingly, teachers cannot escape the situated reality of how they affect their students in the classroom.
The Science Fiction Novel: A Context for Teacher Learning

This study examined the experience of a science teacher as he utilized a science fiction novel in the classroom. Although the story of this science teacher provided an awareness that is transferable to many classroom teachers, it is also unique in that the pedagogical context of the story is created by the teacher utilizing a somewhat uncommon tool in the teaching of science, the science fiction novel. With the aforementioned review of the numerous educational and science discourses that affect the practices in the classroom and the necessity to consistently promote scientific literacy, science teachers must be creative in their choices of activities, resources, and lessons. In addition, with the current emphasis on the literacy standards of the Common Core State Standards (NGA Center & CCSSO, 2010b), science teachers are now in search of resources that can be used to address both science and literacy. As discussed in Chapter I, it was revealed that around half of all teachers surveyed used the textbook on a daily basis (Bunn, 2012). With inexperience in choosing other reading and literacy resources, teachers may excessively rely on the textbook as a means to satisfy the “literacy requirement.” The survey also revealed that science fiction novels were rarely or never used in the classroom. Accordingly, this study, which specifically involved a teacher using a science fiction novel, can provide insights into the practices and ideas that this teacher participant employed during the process. Science teachers may also gain an understanding of how a science fiction novel is a viable resource to address the CCSS literacy standards. During this discussion, I will first review issues associated with overdependence on the textbook in the classroom, then I will offer support for use of the science fiction novel.
Overutilization of the Textbook

“Textbooks are the greatest single source of information from printed materials used in high schools today” (Llewellyn, 2013, p. 90). Unfortunately, many science textbooks in both elementary and secondary schools are considered unsuitable as the primary textual resource. According to Yager (2004b), science textbooks are predominately expository in nature, omitting much of the interesting narratives that represent science holistically as it is in the real world. Wellington and Osborne (2001) criticized science texts for including very difficult vocabulary, having readability issues, containing too many distracting graphics and pictures, and not being engaging to students. Jetton and Lee (2012a) continued that students do not usually possess the essential prior knowledge to fully understand the information contained in the textbook. Llewellyn (2013) disapproved of how high school textbooks arranged material contrary to constructivist approaches, introducing new concepts and vocabulary before students were able to explore the information and apply prior knowledge. Even worse, according to Wellington and Osborne (2001), textbooks were used as punishment, to provide busy work to students, and for easy lessons for substitutes.

Fang (2012b) discussed the challenges of reading disciplinary texts for secondary students. According to Fang (2012b), secondary textbooks differ extensively from those used in elementary grades, especially in regard to language. Elementary texts use language and concepts more familiar and common to the elementary student whereas secondary texts use more technical language and complex concepts. Fang (2012b) stated, “In secondary schools, students are exposed to more advanced, abstract, and complex knowledge, which they are expected to not only assimilate and reproduce, but also question and critique” (p. 35). This makes comprehending these texts for secondary students very difficult. Specifically, Fang (2012b)
examined the major issues for science texts that contributed to their reading difficulty. These included advanced text types (explanation and exposition) used in secondary texts, technical vocabulary, long noun phrases, nominalizations, and metaphorical realizations of logical reasoning.

Even though they felt many issues with textbooks were improving, both Holliday (2004) and Shanahan (2004) discussed various problems with past textbooks including incorrect information, excessive vocabulary emphasis, inept wording, failure to address controversial and ethical science topics, and lack of connection to students’ prior knowledge. Furthermore, Shanahan (2004) stated that textbooks were many times not read by secondary students or even utilized by secondary teachers. In contrast, Greenleaf et al. (2011) contended that textbooks were not only read by teachers but dictated both lessons and strategies in many science classrooms.

Rutherford (2005) did not agree with the possible strive to improve textbooks relaying his disappointment with their revision throughout the years. Rutherford (2005) condemned textbooks for constantly adding information, yet never taking anything out, even though various standards designated the topics required for a sufficient science education. He also criticized the excessive use of elements, such as glossaries and practice tests, in textbooks that were not useful in the teaching of science and the inclusion of extensive technical and scientific vocabulary terms not needed. Rutherford (2005) also discussed various other resources that could be utilized in the science classroom such as science trade books and the internet. He admitted his surprise that these additional resources were not used more in the science classroom, even possibly replacing the traditional textbook all together. In addition, Jetton and Lee (2012a) affirmed the textbook as
still the main reading source in the classroom even with access to a multitude of other reading resources.

Olson and Mokhtari (2010) concurred with Rutherford’s (2005) view of science textbooks. They warned against teachers using the textbook as the primary resource in the classroom. Olson and Mokhtari (2010) also cited problematic issues with textbooks such as the preponderance of vocabulary and factual information, distorted illustrations, and sample problems that require no true understanding of the concept. Olson and Mokhtari (2010) continued that “science texts rarely provide a sense of purpose, take into account students’ ideas, engage students with relevant phenomena, develop fundamental scientific ideas and distinguish them from factual details, or promote student thinking” (p. 62). Furthermore, Gee (2012) discussed how the reading and understanding of various kinds of texts were dependent on social practices in situations where those certain types of texts would be utilized. In this case, it can be assumed that many students, especially marginalized students, are not accustomed to the reading of science textbooks any place other than at school. School, therefore, acts as the socializing factor where this type of practice takes place (Gee, 2012). Literacy then becomes more complicated because to understand a written text is not simplified to the decoding of words.

**Science Fiction Novels**

Science fiction (SF) novels are important in the science classroom because they offer many advantages related to the teaching, learning, and meaning making of science. Essentially, SF poses the question “what if?” to students (Czerneda, 1999; Gallo, 2007). The stories that are contained within science fiction and dystopian novels present an opening for ethical discussions, the themes of which many times will affect the lives of the students (Gallo, 2007; Groenke & Scherff, 2010; Zigo & Moore, 2004). According to Gallo (2007), SF plots involve conceivable
scientific and technological breakthroughs and will “combine common science fiction concepts with traditional coming-of-age themes found in other YA literature” (p. 121). These themes allow students to question and imagine the future world in which they will exist as science and technology continue to advance (Czerneda, 1999; Gallo, 2007; Raham, 2004). Zigo and Moore (2004) discussed how SF novels can also be a prompt for critical dialogue leading to various “interpretive possibilities” (p. 85). Czerneda (1999) suggested the use of SF as a way to address the misconceptions and stereotypical ideas of science and scientists as portrayed in the media and popular culture. Finally, Groenke and Scherff (2010) explained how SF novels could be a starting place for inquiry in the science classroom.

Raham (2004) specifically addressed four reasons that supported using SF to teach science fact. According to Raham (2004), SF tells a good story, tries out alternate futures, inspires students to create the future they want, and generates science-based revelations. Raham (2004) also explained that quality SF will be true to existing scientific principles unless authors offer valid explanations of why the principles are being violated. Furthermore, Raham (2004) suggested that comparative analysis of the ideas described in older SF stories to current scientific and technological developments could be used to merge SF with history content.

Smolkin and Donovan (2004) described four genres of trade books that could be used in the science classroom which included stories, dual-purpose texts, narrative and non-narrative information books. They explained that stories and dual purpose texts were the most engaging to students due to their incorporation of characters and a plot. Specifically, Raham (2004) praised the stories in SF because they incorporate presently accepted scientific principles with both negative and positive possibilities for the future. According to Raham (2004), students can learn through the stories about ways to negotiate these future possibilities if and when they are faced
with them. Furthermore, Smolkin and Donovan (2004) explained that stories usually do not contain as much technical vocabulary as other types of texts. Thus, when reading a science fiction novel, students may have to struggle less with specialized scientific terminology, yet the science/technology concept will still be incorporated into the story as well as the associated ethical implications.

Kilby-Goodwin (2010) merged reading, writing, and science fiction in her classroom project “Researching Science in Science Fiction” (p. 60). In this project, students chose and read a science fiction novel, completed a written review of the novel and a wrote a research paper surrounding a scientific topic in the novel. According to Kilby-Goodwin (2010), this project incorporated literacy into science, connected to real-world applications of science and technology, motivated students to learn science, and spanned all science disciplines. In addition, Singh (2014) incorporated science fiction into her college physics class. She had students read a science fiction story prior to reading a nonfiction article with the same physics concepts. Singh (2014) received mostly positive feedback from students in regard to this strategy, with students stating they had a deeper understanding of the article and a stronger personal connection to the physics concepts. According to Singh (2014), “an emotionally affecting science fiction story allows the science to intersect with social, psychological, and ultimately personal concerns while putting in the forefront the ‘wonder’ that so many people miss about science” (p. 108).

Clemmons and Sheehy (2011) also discussed projects utilizing contemporary young adult (YA) science fiction to enhance science learning. According to Clemmons and Sheehy (2011), the integration of YA science fiction literature into the science class can improve student motivation, allow for more real world connection of science concepts, develop critical thinking skills, and promotes 21st century skills. Specifically, “YA lit offers vital opportunities for high
school science teachers to help students build literacy, develop critical thinking, connect with technology, and prepare for the varied demands and modern literacies of our changing world” (Clemmons & Sheehy, 2011, p. 45). Finally, Bixler (2007) supported the use of science fiction to teach evolutionary biology. According to Bixler (2007), science fiction naturally encompasses a variety of disciplines, offers an interesting setting for the discussion of abstract ideas, provides numerous examples of evolution, and encourages true scientific thinking. Thus, science fiction books can be used as a tool in the science classroom to provide a rich and motivating science learning experience that is not dependent only on the science textbook.

The SF novel can be an outstanding tool to address many of the issues in the conversation surrounding the educational and science discourses discussed as well as a resource to promote scientific literacy. For example, Czerneda (1999) discussed how SF can be a conduit to scientific literacy because “they [students] learn to explore scientific concepts with a critical eye, to see the importance of context and source, and to recognize potential issues” (p. 1). In regard to the literacy standards, Ivey (2011) shared her concern that the CCSS did not consider student engagement or interaction in regard to literacy practices. The nature of the SF novel can lend itself to satisfy both of these issues. As discussed by various authors (Clemmons & Sheehy; 2011; Kilby-Goodwin, 2010; Singh, 2014; Smolkin & Donovan, 2004), the story found in the novel will naturally be more engaging than other forms of text. When using the novel with other strategies such as literature circles, students will also have opportunities to discuss the novel and interact with peers. This will provide that needed opportunity discussed by Hand et al. (2003) for students to transform their informal science language to a more formal literacy and provide an opportunity for students to use science terminology in a socially-situated context as deemed important by Gee (2004). Furthermore, topics and problems contained within the story of the SF
novel can act as a prompt for scientific arguments and ethical discussions (Gallo, 2007; Groenke & Scherff, 2010), both of which are essential to increased scientific literacy. The story within the novel can also prompt classroom discussions about societal inequities which can be beneficial to increasing the scientific literacy of marginalized students (Norman, 1998). This demonstrates yet again how a science fiction novel is an effective tool to address the modern concept of scientific literacy that values more than rote memorization of science facts.

Historical educational reform supported cross-curricular connections among math, science, and technology as a goal of scientific literacy (AAAS, 1989; AAAS, 1993; Bybee, 1997; DeBoer, 2000; Eisenhart et al., 1996; Hurd, 1998; Laugksch, 2000; Rutherford & Ahlgren, 1990; Shamos, 1995). The stories in SF novels are naturally cross-curricular (Bixler, 2007; Kilby-Goodwin, 2010) because science in the “real world” is not compartmentalized into subjects as found in normal school customs. SF novels demonstrate through the story how science, math, technology, and other subjects intertwine to create a futuristic reality (Clemmons & Sheehy, 2011; Czerneda, 1999; Gallo, 2007; Groenke & Scherff, 2010; Kilby-Goodwin, 2010; Raham, 2004; Zigo & Moore, 2004). Additionally, Ford (2004) relayed the importance of text to inquiry learning stating that various texts could provide a means to critical thinking when a lab exercise or related activity is not possible. Themes found in SF novels are a perfect fit for this aspect of inquiry learning because their stories offer vivid explanations and descriptions of a multitude of current and futuristic science and technology concepts.

Summary

Science educational reform has been a seemingly constant process throughout the years resulting in various directives and mandates that have at times affected the pedagogical and classroom practices of the science teacher. Throughout these years, pursuing scientific literacy,
regardless of the exact definition, has remained a goal of science education. However, as questioned earlier by Shamos (1995), have students or adults really become any more scientifically literate with each wave of science educational reform? Has science teaching or have science teachers changed in response to science educational reforms? Those questions may not have an exact answer, but it is true that with the implementation of the *College and Career Ready Standards* (ALSDE, 2010a) as well as the teacher evaluation system, *EDUCATEAlabama* (ALSDE, 2009), Alabama science teachers must address the literacy standards along with the other best practices of teaching science in order to preserve their job. This can become a daunting task, especially when the teacher must learn new methods and approaches simultaneously while teaching the students. Accordingly, this study relays the story of one science teacher as he addresses educational reform in the actual classroom through the use of a science fiction novel. Through the teacher’s voice and story, this study provides an awareness of how educational reform is realized while the teacher navigates a continuous whirlwind of issues. Open-ended and story-telling interviews, participant observation, and document analysis provide the details used to re-story this individual’s experience. Chapter III reviews the methods that were employed during this narrative inquiry.
CHAPTER III:
STUDY METHODOLOGY AND METHODS

Introduction

This chapter will discuss the methodological underpinnings and study methods of this qualitative narrative study. Methodological aspects of educational research are critically important to present upfront as they concern philosophical rationales that shape the study methods. The study methods are described in terms of technical plans for carrying out the research. Specifically, the research participant selection, study context, research design, data collection and analysis, and ethical considerations will be described. Because this study explored the ideas and practices of an Alabama secondary science teacher trying out a creative approach using a science fiction novel in the classroom, narrative inquiry within the research methodology of qualitative inquiry is appropriate. Narrative approach will address the experiences of the teacher as relayed through lived experience.

Rationale for Research Approach

Quantitative research strategies involve post-positivist views where numerical data is gathered and examined to “explain, predict, and/or control phenomena of interest” (Bloomberg & Volpe, 2012, p.30). Conversely, qualitative research approaches are more interpretivist focusing on the lived experiences of the subjects being studied (Bloomberg & Volpe, 2012). Furthermore, “qualitative research is typically enacted in naturalistic settings, focuses on context, and is emergent and evolving” (Bloomberg & Volpe, 2012, p. 30). Therefore, qualitative inquiry was most appropriate for this study for several reasons. First and foremost my personal research
philosophy is based on the characteristics of qualitative research because I believe that the “why” and “how” of a problem is vitally important in answering my research questions. I feel that the insights and findings related to my aforementioned research questions would be incomplete if they were dependent on quantitative data alone. Qualitative inquiry reveals a deeper story of the subject, in the subject’s natural setting, valuing both the subject and the researcher as active participants (Bloomberg & Volpe, 2012; Corbin & Strauss, 2008; Creswell, 2007; Hatch, 2002; Marshall & Rossman, 2011; Merriam, 1998).

The fact that I have already completed action research related to my dissertation topic is another reason why I preferred to use qualitative inquiry. Researcher positionality and reflexivity are vital components of qualitative research (Corbin & Strauss, 2008; Hatch, 2002; Marshall & Rossman, 2011). Since I already have biases and preconceived notions about what I would find, I felt that it was extremely important to acknowledge these biases so that I could represent my participant’s voice as ethically as possible. Quantitative research does not allow for as much interpretation (i.e. meaning making) in the research process. Furthermore, acknowledging my biases allowed my research investigation to take on the emergent design that is characteristic of qualitative research (Bloomberg & Volpe, 2012; Creswell, 2007; Hatch, 2002; Marshall & Rossman, 2011; Merriam, 1998) by removing the need for a rigid and prescribed research plan based on what I expected from my own experiences.

Narrative inquiry, which has Dewey’s theory of experience at its foundation, “is an approach to the study of human lives conceived as a way of honoring lived experience as a source of important knowledge and understanding” (Clandinin, 2013, p. 17). Narrative inquiry is the most appropriate qualitative approach for this investigation for several reasons. First, I had the story of a single teacher as the focus of my study, which conforms to the traditional narrative
research characteristic of telling the story of a single or few individuals (Bloomberg & Volpe, 2012; Creswell, 2007). Secondly, data collection included conversational interviews, emails, and stories that described the experience of this single teacher through the relationship that had been developed between researcher and participant. Since narrative inquiry is the retelling or re-storying of the research participant’s experiences and is dependent on an established, trusting relationship between researcher and participant (Clandinin, 2013; Connelly & Clandinin, 1990; Creswell, 2007; Marshall & Rossman, 2011), this again supports narrative as the appropriate choice for this study. Next, narrative research seeks to examine a special or unusual circumstance or event taking place in the life of the participant within a certain social context (Creswell, 2007). In this study, the special circumstance is the use of a somewhat uncommon tool, the science fiction novel, utilized in the science classroom (context) where the doing of science is mostly favored over reading and writing activities. Finally, narrative inquiry involves the reflection of the researcher on her own experiences (Creswell, 2007) and “mutual storytelling and re-storying as the research proceeds” (Connelly & Clandinin, 1990, p. 4). Since I was a science teacher who utilized a science fiction novel in the classroom, I had some understanding of the experience being studied. However, the teacher participant’s story was unique, and I articulated his voice over mine.

According to Connelly and Clandinin (1990), the narrative inquiry approach in educational studies is warranted because we all live storied lives and are naturally prone to storytelling within those lives. They view education as the “construction and reconstruction of personal and social stories” where “teachers and learners are storytellers and characters in their own and other’s stories” (Connelly & Clandinin, 1990, p. 2). The very nature of teaching and learning embraces the concept of story and experiences through the various strategies that
teachers employ to connect content to the real world and the student’s experiences. Even one of the appeals of using a science fiction novel in the science classroom is because it situates the science within a story, which is much more engaging and understandable to students (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010; Smolkin & Donovan, 2004). As discussed in Chapter II, learning is never a single, individual event, but instead a process of meaning making within a social context (Lave & Wenger, 1991); hence, learning cannot escape story. Connelly and Clandinin (1990) reinforced this through their work with educational narratives where they saw “teachers’ narratives as metaphors for teaching-learning relationships. In understanding ourselves and our students educationally, we need an understanding of people with a narrative of life experiences. Life’s narratives are the context for making meaning of school situations” (p. 3).

In this narrative inquiry, the teacher participant acted both as the teacher as well as the learner in the classroom. Although students were not specifically being studied in this investigation, they, along with the researcher, composed a community of learners in the classroom. Connelly and Clandinin (1990) stressed the need to give teachers a voice in the research process because they have been silenced in much of educational research. This study gave a voice to the teacher and his story of using a novel amongst the whirlwind of issues that affect all teachers on a daily basis. It is the teacher’s story of what it “means to educate and be educated” (Connelly & Clandinin, 1990, p. 12). The fact that this story needs to be told is yet another rationale for using the narrative inquiry approach.

**Theoretical Framework**

This study explored the ideas and practices of an Alabama secondary science teacher trying out a creative approach using a science fiction novel in his classroom at a time when there
is 1) a continual media backdrop characterizing “low performance” by Alabama’s students; 2) the dominant voice of Common Core Standards on K-12 curricular practices; 3) science teaching driven by STEM workforce discourses; and 4) low entry of future science teachers and persistent quit rates of novice science teachers in Alabama’s classrooms. Within this whirlwind of issues, the science teacher still must continuously seek, try, and find innovative pedagogical strategies, techniques, and lessons that keep students engaged and enhance their scientific literacy. This can be demanding even for seasoned teachers. Because narrative inquiry seeks to tell the story of lived experience (Clandinin, 2013, Connelly & Clandinin, 1990), a re-storying of this teacher’s experience will offer insights to other science teachers, and all teachers, of how to possibly negotiate these various issues. Furthermore, “the focus of narrative inquiry is not only valorizing individual’s experience but is also an exploration of the social, cultural, familial, linguistic, and institutional narratives within which individuals’ experiences were, and are, constituted, shaped, expressed, and enacted” (Clandinin, 2013, p. 18). Hence, narrative inquiry seeks to explore the multitude of factors that both inspire and impede the life and work of a classroom science teacher through the individual story. Of course all classroom situations and school cultures are unique, nevertheless this narrative will tell the story of a teacher which many will understand and empathize.

The pursuit of scientific literacy has been and continues to be a goal for science education (Bybee, 1997; Laugksch, 2000; Llewellyn, 2013; Pratt & Pratt, 2004; van Eijck & Roth, 2010). Consequently, the pedagogical approaches that are utilized within the science classroom should always keep that as a focus. However, as discussed in Chapter II, the concept of what it means to be scientifically literate and to what extent that can even be achieved is a contentious topic. Throughout the years, various standards, educational reform movements, and researchers have
tried to determine an exact definition of scientific literacy so that classroom science teachers could follow some type of plan to support all students in reaching the highest levels. Yet, in the classroom, it is the science teacher that ultimately decides on what his definition of scientific literacy is and how best to pursue that with students. In this study, the science teacher’s beliefs about the characteristics that define scientific literacy as well as the pedagogy that best realize those characteristics are important components of his story. If the science teacher viewed evidence of scientific literacy as regurgitation of science vocabulary and students’ ability to complete extensive laboratory experiments correctly, the use of a science fiction novel in the classroom would probably not be presumed a worthwhile teaching and learning tool.

A second segment of the story of this teacher is that while the science teacher is fulfilling his job of teaching, facilitating learning, and promoting scientific literacy within the science classroom, there is yet another whirlwind of educational and science discourses that are directly or indirectly influencing his teaching practices. Standards and mandates are only one aspect of the educational and science discourses that the science teacher must contend as he teaches and promotes scientific literacy in the classroom. As extensively discussed in Chapter II, science teachers must be aware of the 21st century skills deemed necessary for students entering society after graduation and the pedagogical best practices to achieve these skills. Furthermore, with the implementation of the Alabama College and Career Ready Standards (ALSDE, 2010a, 2010b), teaching content literacy and reading and writing in science has become a requirement as opposed to a best practice. Specifically in regard to teaching science, science teachers must be aware of the difficulty with the specialized language of science and how that can be troublesome for all students, especially marginalized students underrepresented in science. These educational and science discourses are the reality of the science teacher, yet how he conceives and addresses
these discourses is part of his identity of a science teacher. The creation of that identity is influenced by the teacher’s personal Discourse (Gee, 2005, 2012) and his “mouse view” (Sammel, 2008) of the science classroom. This part of the story not only reveals how this science teacher manages the various educational and science discourses affecting his day-to-day practices, but also how his personal Discourse and belief system factor into decisions.

A third segment of the story combines all the essence of what takes place in and outside of the classroom and situates it in the living reality of the science teacher. The situated cognition of the science teacher is located at the base of the whirlwind funnel because the other two swirling components influence and create this reality, regardless of whether the teacher is totally aware of these influences or not. Even though a classroom teacher is normally viewed as the content expert and scholar to impart knowledge to his students, in this narrative inquiry the teacher will also be the learner; simultaneously, teaching science utilizing a science fiction novel and learning how to best use this science fiction novel to teach science. Learning is a contextual and socially-mediated experience (Lave & Wenger, 1991) as is story (Connelly & Clandinin, 1990); therefore, this narrative inquiry re-stories this science teacher’s individual experience of using a science fiction novel within context of his situated reality. Although this teacher’s story is unique to him, it is a story that informs and transfers to other teachers in other classrooms as they experience similar realities.

The story of this research participant captured during this narrative inquiry was guided by the following research questions:

1. What is the experience of a science teacher as he utilizes a science fiction novel in the secondary science classroom?; and
2. How does a secondary science teacher meaningfully address scientific literacy through the use of a science fiction novel in a physical science classroom?

**Role of the Researcher**

Researcher positionality and reflexivity are vital components of qualitative research (Corbin & Strauss, 2008; Hatch, 2002; Marshall & Rossman, 2011; Merriam, 1998). Since I already have biases and preconceived notions about what I would find, I felt that it was extremely important to acknowledge these biases so that I would represent my participant’s voice and story as ethically as possible. Furthermore, acknowledging my biases allowed for my research investigation to take on the emergent design that is characteristic of qualitative research (Creswell, 2007; Hatch, 2002; Marshall & Rossman, 2011) by removing the need for a rigid and prescribed research plan based on what I expected from my own experiences.

The biases and preconceived notions that I acknowledged in my study originated from my own experiences of using science fiction novels in my classroom. I utilized the novel *Ender’s Game* (Card, 1991) in my advanced physical science class while teaching at a North Alabama high school. I also had my advanced biology students read *The Island of Dr. Moreau* (Wells, 1896). In my experience, reading of fiction or non-fiction, excluding the textbook and limited internet sources, does not occur in many classes other than English/Literature and occasionally History. My belief is that reading and writing should be promoted across all disciplines, and assigning the novels in my science classes was one way that I achieved this goal. I mainly chose science fiction novels based on my own fondness and appreciation of this type of fiction. However, even though I do personally enjoy reading science fiction, I also feel that this genre was not utilized as often during Literature classes at my school. I also chose these novels to expose my students to this genre of writing in a more detailed way, utilizing my expertise in
science to point out connections to the science content discussed in class; a benefit most likely missing when discussed in an English classroom (Shanahan, 2004).

During my experiences of using these uncommon tools to enhance my science teaching, I tried various strategies, approaches, and assignments to successfully accomplish my goals. I utilized literature circles (Daniels, 1994) with both novels to guide the students in their reading and make discussions more focused. Literature circles can be summarized as temporary discussion arrangements where each member of the group chooses a particular role to take on as they read the material, taking role specific notes and sharing these findings as appropriate (Daniels, 1994). Even though I utilized the literature circles and felt they were a successful strategy, I did not want to unduly pressure my research participant to employ the strategies and approaches that specifically worked for me. As an embodied participant in this investigation, I was willing to share my experiences if he so wished; however, this was the story of this science teacher utilizing a novel in the classroom.

The narrative inquiry method is new to this researcher as this is my first attempt at a study re-storying the experience of a participant, especially an experience of which I am so familiar. In reflecting on narrative inquiry, I realized that I have a long tradition of storytelling within my personal family history and as a pedagogical strategy. Stories were always an important part of entertainment and family time while growing up. My grandparents and great-grandparents were always telling stories, both fable and truth, to engage the children. Even now, family gatherings are always rich with tales of both past and current events. According to Connelly and Clandinin (1990), “teachers and learners are storytellers and characters in their own and other’s stories” (p. 2). Since both my parents are long-time educators and my brother as well, I find this statement coming true during many family conversations. Furthermore, I often
share stories with my pre-service teachers as a pedagogical strategy. Sharing stories of
experiences from actual events that occurred while I was teaching secondary school allows for
disconnected topics to be contextualized within a “real life” event. This made me realize just
how important accurately re-storying my teacher participant’s experience would be to other
educators. Connelly and Clandinin (1990) stressed the importance that the teacher participant is
allowed to share his story and be given a voice in the research process. Even though narrative
inquiry is a collaborative process, educator voices have been suppressed so many times in
research that I, as the researcher, must ensure his story was heard.

Research Context

Research Setting

This research study took place in a North Alabama high school, Eagle High
(pseudonym), located a very short distance from a very scientifically and technologically
innovative city. Student enrollment was approximately 900 students, 9-12, classifying it as 5A
school. The student population was approximately 65% white, with African-American and
Hispanic making up the majority of the minority population. Students receiving free and
reduced meals are well below the state and system percentage. The school offered a variety of
classes including advanced placement, dual enrollment, and career technical. The school also
had a wide range of extracurricular activities including a variety of male and female sports
teams, clubs and honor societies, and fine arts including band and drama. According to the
school website, U.S. news voted it one of America’s best high schools in 2008, 2009, 2012, and
2013. According to the Alabama State School Report Card for 2008-2009, 58 teachers were
employed at the school with 6% having doctorate degrees and 61% having master’s degrees. No
teachers were teaching on emergency certifications at that time. Eagle High School was the only
9-12 high school included in the city school system, thus students from all areas of city and community were zoned to attend this high school.

The study took place in a non-advanced physical science class predominantly made up of 10th grade students. Eagle High School was on the 90-minute block schedule so one semester of physical science was equivalent to an entire course. Since the course was non-advanced, many of the students taking the course were considered marginalized based on socio-economic status, disabilities (academic and physical), ethnicity, race, and linguistics. Students enrolled in physical science are typically not planning to take more advanced courses such as chemistry or physics.

**Research Participant**

Since this study investigated the experience of a typical Alabama science teacher as he incorporated a science fiction novel into the secondary classroom, participant selection involved typical purposeful sampling (Creswell, 2007; Marshall & Rossman, 2011; Merriam, 1998). The researcher wanted to choose a participant that taught physical science if possible, but any science teacher willing to use the novel in his science class would have been acceptable. The researcher contacted possible interested participants through a local university’s *Science in Motion* specialist who sent a mass email to *Science in Motion* participants, providing information regarding the study and the researcher’s contact information. Teachers that were contacted lived in the North Alabama area serviced by the university *Science in Motion* program. Teachers interested in possibly becoming a research participant then contacted the researcher. Meetings were conducted with possible participants individually to answer any questions and discuss the project further. Through this process, the researcher chose a participant who worked in a secondary school setting in an Alabama public school and was teaching physical science classes.
The original participant and the researcher also had a good rapport with one another, and the participant was enthusiastic and excited about using a new tool, the science fiction novel, in her classroom. Unfortunately, once the timeline for data collection was established, the chosen participant was not going to be teaching a class in which she felt comfortable using the novel. The replacement research participant was obtained through snowball or networking purposeful sampling (Merriam, 1998). The original research participant suggested the researcher contact another teacher within the same school who would be teaching physical science at the time of data collection. After a few email exchanges, the new participant agreed to participate and seemed equally excited about using the novel.

**Mr. Silas’s Story: The Beginning**

The research participant, Mr. Silas (pseudonym), is a white, male science teacher who is new to Eagle High School this year (2013-2014 school year). He was born and raised as well as attended school and college in Tennessee. He taught for 8½ years prior to coming to Eagle High. Mr. Silas’ career began in Tennessee where he taught human anatomy and physiology and biology for half a semester in 2004. He then moved to a high school in Georgia where he again taught human anatomy and physiology and also physical education for a year. In 2005, Mr. Silas began teaching at a high school in Alabama, where he stayed for seven years before moving to Eagle High. This high school is where he first taught physical science along with human anatomy and physiology. Currently, at Eagle High, Mr. Silas teaches human anatomy and physiology and physical science. He is also the head coach for the cross country team and the softball team. Mr. Silas has a bachelor’s degree in health and physical education with an endorsement in 6-12 general science. He also holds a master’s degree in curriculum and instruction.
The Science Fiction Novel

The science fiction novel that was used in this study is *Ender’s Game* by Orson Scott Card (1991). *Ender’s Game* is a fictional, futuristic story of a young boy, Ender, who must leave his family to join the world government’s military. In this future, parents are only allowed two children unless they promise the government the subsequent children if so asked. Ender is the third in his family, therefore his fate rests in the hands of the military leaders as he is taken and trained for the third alien attack on Earth. The military training that he receives, along with other children, is mainly in the form of games. The novel stimulates dialogue surrounding a variety of issues including science and technology; military, political, and technological ethics; manipulation; and power struggles. The novel also lends itself very well to be used within a physical science classroom due to the science content knowledge referenced through the story (i.e., Newton’s Laws applied to the battle room).

Ethical Considerations

Respect for persons in this narrative inquiry were assured by fully informing the participant of all requirements necessary for this investigation, that participation was voluntary, confidentiality of information and names were protected, and participation risks were minimal (Marshall & Rossman, 2011). Procedures as outlined by The University of Alabama’s Institutional Review Board (IRB) to ensure the safe and ethical treatment of humans as subjects in research were followed. The participant’s name was changed to a pseudonym in the final report to ensure confidentiality. The participant for this investigation signed an informed consent form. The superintendent of the school system also signed a form granting permission to conduct research in Eagle High School. IRB approval for study was obtained prior to data collection.
Research Design

Because this dissertation was a narrative inquiry of a science teacher’s experience, data generation methods were fitting to this type of qualitative study. According to Creswell (2007), the source of information typically collected during a narrative inquiry includes documents and archival material, open-ended interviews, subject journaling, participant observation, and casual chatting. The primary data collection methods that I utilized in this study were open-ended interviews that incorporated storytelling, casual chatting, participant observation, and document review (i.e., anecdotal records, emails, classroom work products, lesson plans, etc.). These data collection sources were analyzed to “re-story” the experience of the science teacher as he used the science fiction novel in his classroom (Creswell, 2007).

Interviews

According to Bloomberg and Volpe (2012), interviews allow researchers to interact with research participants, many times in the participant’s natural setting. Furthermore, interviews allow researchers to evoke “in-depth, context-rich personal accounts, perceptions, and perspectives” (Bloomberg & Volpe, 2012, p. 252) and reveal the meaning making of experiences and events that are usually concealed during observations (Hatch, 2002). For this inquiry, I used the open-ended or guided formal interview approach so that the “participant’s perspective on the phenomenon of interest should unfold as the participant views it…not as the researcher views it…” (Marshall & Rossman, 2011, p. 144). I also employed informal/casual chatting interviews as needed during other data collection methods to clarify information, elicit more detailed explanation of other data sources, and to build rapport with research participant (Hatch, 2002).

In narrative inquiry, it is important that the interviews are open-ended and conversational allowing participants as much flexibility as possible in telling their story (Clandinin, 2013;
Connelly & Clandinin, 1990). The open ended-guided interviews sought to inform the research participant’s experience as he employed a science fiction novel in his classroom. The guiding interview questions framed that experience within the study’s theoretical framework so that the story could be told within these parameters. Even though the interviews were guided by questions, storytelling was also encouraged during these one-on-one conversations. Storytelling was encouraged during narrative inquiry (Clandinin, 2013; Connelly & Clandinin, 1990) so the conversational interviews also allowed for the research participant to tell his story as opposed to only answering regimented interview questions. Through the emergent design of qualitative inquiry, the interview process conducted in this inquiry was an iterative process where interviews and other data sources informed subsequent interviews, conversations, and stories in order to seek the most accurate re-storying of the experience of the individual. Limitations of interviews in regard to this study involved the mutual rapport and relationship building between the researcher and research participant (Marshall & Rossman, 2011). If a trusting relationship was not established, the research participant may have been apprehensive in openly sharing information, especially if he felt that his teaching was being critiqued.

**Participant Observation**

According to Marshall and Rossman (2011), observation is a requirement of qualitative research because it “entails the systematic noting and recording of events, behaviors, and artifacts (objects) in the social setting” (p. 139). Specifically, this narrative inquiry required participant observation in order to fully experience the social context of the research participant. In participant observation, the researcher acts both as the observer and the participant to some extent (Marshall & Rossman, 2011), which addresses the co-construction of stories in the narrative inquiry tradition (Connelly & Clandinin, 1990). During participant observation,
“immersion in the setting permits the researcher to hear, see, and begin to experience reality as the participants do” (Marshall & Rossman, 1990, p. 140). The combination of interviews and participant observation produced an in-depth look into the everyday life activities of the research participant in order to capture his storied life.

Recorded field notes from the participant observation were of particular interest when re-storying the experience of the participant. According to Connelly and Clandinin (1990), “notes are an active reconstruction of the events rather than a passive recording” (p. 5). The field notes are considered active recordings because the researcher is participating in the story that is taking place within the specific context (Connelly & Clandinin, 1990).

**Document Review**

According to Hatch (2002), documents are rarely the main data source for a qualitative study. However, they do serve to supplement the primary data sources (interviews and observations) and do not “influence the social setting being examined” (Hatch, 2002, p. 25). For this narrative inquiry, various documents were obtained and reviewed to assist in constructing the story of the science teacher. These included emails, anecdotal records, classroom work products, lesson plans, and text messages. These documents were collected and analyzed throughout the study.

The following timeline summarizes the timeframe for data collection and gives an overview of data collected:

1. Fall semester 2013: Conducted initial contact/meeting with research participant to discuss the nature of the study, what is expected of the research participant, gather background information and demographics about research participant, provided
research participant with the science fiction novels, and answered any questions or concerns.

2. February-March 2014: First interview with participant was scheduled, established timeline for incorporating novel into the physical science curriculum schedule, and discussed timeframe for participant observations.

3. March-June 2014: Story-generating interviews and informal (casual chatting) interviews - Interviews were conducted prior, during, and after implementation of the science fiction novel into the classroom. All formal interviews were audio-recorded. Anecdotal notes from informal/causal chatting interviews were documented in researcher’s field notes journal. Interview discussions prior to implementation surrounded the following:

- Questions/concerns with study or using the science fiction novel
- The story of why participant wanted to participate in study/why he wanted to use a science fiction novel in his classroom
- The story of participant’s background with teaching science, content literacy, and reading in science
- The story of participant’s feelings toward personal reading and science fiction
- Participant’s beliefs about scientific literacy-what are characteristics, how do you achieve it, can you ever achieve it completely, how will science fiction novel help promote, etc.
- Ideas and strategies of how to use the science fiction novel
- The story of any professional development or educational experiences that have prepared participant to incorporate a novel into science classroom
• Participant awareness of various standards and educational reforms influencing classroom practices

• Description of school culture. Is it conducive to trying new tools and strategies?

Interview discussions during implementation surrounded the following:

• Strategies, approaches, techniques, etc. that worked and did not work during the implementation of the novel and why. Were they primarily student-centered or teacher-centered strategies?

• Specific stories of positives and negatives of using the book in regard to teacher and student

• Stories of how the teacher felt prepared and unprepared to use the novel and why

• Stories of the teacher as a learner using an unconventional tool in the classroom

Interview discussions after implementation of the novel surrounded the following:

• Stories of how participant’s identity of a science teacher has changed or stayed the same during the study

• Stories of how participant’s concept of scientific literacy and its achievement may have changed after implementing the novel

• Stories of how the participant would do things differently or the same if using novel again

• Stories of how the participant perceived the students felt about the novel
• Insights into what might better prepare other science teachers wanting to use a science fiction novel

4. April-May 2014: Participant observations 1-5-Classroom observations were scheduled with participant during the implementation of the novel. Specific dates and times were negotiated during the implementation interval. Observations were audio recorded. Field notes were also generated by the researcher.

5. April-August 2014: Document Review- Documents such as emails, text messages, work products, lesson plans, anecdotal records, and journaling notes were obtained and reviewed during the entirety of the study.

6. March 2015: Follow-up Interview-A final follow-up interview was conducted with participant a year after initial data was generated. The interview discussion surrounded the following:
   • Stories of how the incorporation and planning of literacy activities into the curriculum has changed or stayed the same since the initial study
   • Stories of any professional development opportunities in regard to literacy since initial study
   • Stories of literacy strategies or methods used to motivate the students that are not usually motivated to participate by any incentive
   • Stories of how the CCRS content literacy standards influenced changes to pedagogical practices and Discourses
   • Any additional insights or feelings to share after study was completed.
Data Analyses

Positivistic research has traditionally called for the researcher to present their study “findings” or “results.” Given that narrative researchers are clearly re-presenting their own storied perspectives, the notion of ‘finding’ an insight outside or apart from oneself is not possible. Consequently, data analysis presented insights gained in this study as re-presentations of stories told at this particular time, by these particular people, in this particular place. Data were “analyzed for the story…, a chronology of unfolding events, and turning points or epiphanies” (Creswell, 2007, p. 155). Data analysis began upon the first interaction with the research participant and continued throughout the entirety of data collection and the completion of the writing of the narrative story. Initially, transcribed interviews, journal field notes, and work documents were reviewed to attain an overall understanding of the participant’s story and to further develop subsequent questions representing the emergent design of qualitative inquiry (Bloomberg & Volpe, 2012; Creswell, 2007; Hatch, 2002).

According to Creswell (2007), qualitative data must be condensed into presentable findings through the method of coding. Once data had been initially reviewed, it was openly coded for themes or categories. “Coding is essentially a system of classification-the process of noting what is of interest or significance, identifying different segments of the data, and labeling them to organize the information contained in the data” (Bloomberg & Volpe, 2012, p. 142). Specifically, open coding is “coding the data for its major categories of information” (Creswell, 2007, p. 64). These initial categories determined from open coding were then placed into a schematic chart (see Figure 1) so that evidence for each category could be recorded as well as evidence represented in multiple categories could be recognized. These categories were compared and classified within the comparison chart through a process of axial coding, which is
“the act of relating concepts/categories to each other” (Corbin & Strauss, 2008, p. 198). During axial coding, categories were combined creating more focused story threads (Clandinin, 2013) that were then used to more accurately portray the research participant’s experience in his narrative account. In addition, throughout the data analysis process, informal memos, notes, and comments were created to inform questions, record reflections and reminders, and draft prompts (Bloomberg & Volpe, 2012; Hatch, 2002; Marshall & Rossman, 2011) in order to supplement the coded data and categories as well as address any inconsistencies in the data. The “findings” of this study were then told through an unfolding chronology of the research participant’s experience before, during, and after the implementation of the science fiction novel into his classroom. The larger story of the research participant was also analyzed for interpretive possibilities and insights that might be transferrable to other teachers and educators in similar situations.
Quality of Study Based Upon Trustworthiness

Criteria for a quality study in qualitative research involve the accurate representation of the evidence and careful analysis of data resulting in the most truthful account possible of the people or situations being studied (Bloomberg & Volpe, 2012). These criteria also ensure a trustworthy study that can be transferable to others. According to Bloomberg and Volpe (2012), transferability “is about how well the study has made it possible for readers to decide whether similar processes will be at work in their own settings and communities by understanding in depth how they occur at the research site” (p. 113). In order to ensure quality criteria and trustworthiness for this study, I employed several measures which included triangulation, prolonged engagement, member checking, peer review, and thick descriptions. Aspects of a “good” study as specific to narrative inquiry were also addressed.
Triangulation, which refers to the use of multiple sources of data in order to clarify and confirm the meaning of evidence (Bloomberg & Volpe, 2012; Lincoln & Guba, 1985; Merriam, 1998), was ensured by collecting multiple data sources through interviews, observations, and document review. Prolonged engagement with the research participant to provide an “in-depth understanding of the phenomenon under study, conveying detail about the site and the participants that lends credibility” (Bloomberg & Volpe, 2012, p. 113) was also assured. The research participant and I developed a trusting and honest relationship as we shared stories and experiences together throughout this process. Not only is prolonged engagement a criterion of trustworthiness for qualitative research in general, but it is a requisite of narrative inquiry as well. Since narrative inquiry is the re-storying of a lived experience of an individual, a trusting relationship is essential (Clandinin, 2013; Connelly & Clandinin, 1990; Creswell, 2007; Marshall & Rossman, 2011) and can only be accomplished through prolonged engagement with the participant.

Both member checking and peer review were conducted in this study to assure trustworthiness. Peer review, which consists of an external colleague reviewing study data, findings, and processes (Bloomberg & Volpe, 2012; Lincoln & Guba, 1985; Merriam, 1998), was primarily conducted by a colleague familiar with the traditions of narrative inquiry as well as an expert in secondary English/language arts. Throughout the study, findings and insights gained from the findings were shared and critically discussed with this colleague to assist in the re-storying of the participant’s experience. This colleague also assisted with the literacy issues that came about during the story that I, as a researcher with a science education background, struggled to fully understand. At times, other colleagues or teacher peers would also be asked to take part in peer review of certain segments of the study. Member checking by the research
participant is also a vital component of qualitative research as well as narrative inquiry. As continuously stated, narrative inquiry is a re-storying of an individual’s experience (Connelly & Clandinin, 1990), therefore, it is imperative that member checks be conducted to assure that the story is as accurate as possible. Since the research participant and I had developed a trusting relationship through prolonged engagement, member checking throughout the study was easily achieved by confirming details and interpretations of his stories through casual interactions.

Creswell (2007) described various aspects that characterize a “good,” quality narrative study: 1) focuses on a single individual (or two or three individuals); 2) collects stories about a significant issue related to this individual’s life; 3) develops a chronology that connects different phases or aspects of a story; 4) tells a story that re-stories the story of the participant in the study; 5) tells a persuasive story told in a literary way; 6) possibly reports themes that build from the story to tell a broader analysis; 7) and reflexively brings himself or herself into the study (p. 214-215). This specific narrative inquiry addressed these factors to ensure a quality study. For example, this inquiry focused on one science teacher as he utilized a science fiction novel in his classroom. The story of this individual was re-storied in a chronology of before novel implementation, during novel implementation, and after novel implementation. In addition to the story of the experience, themes and conclusions were explored that enhanced the individual story and made it more useful and transferable to other educators. Finally, because the researcher and participant were joined together in the re-storying of this experience, the findings were a “mutually constructed story created out of the lives of both researcher and participant” (Connelly & Clandinin, 1990, p. 12). The final result is a rich and thick description of this science teacher’s experience that can be useful and transferable to other teachers.
Summary

This chapter has outlined the methodological traditions to be used in this study, described the research context, and reviewed the data collection methods and analysis. The methodological approach used in this study is that of narrative inquiry. Because this study was an intense investigation of the experience of one science teacher as he used a science fiction novel in his classroom, narrative inquiry was the most rational due to the element of storytelling. Narrative inquiry is the re-storying of an individual’s experience through collaboration with the researcher (Clandinin, 2013; Connelly & Clandinin, 1990), and this participant’s story can be transferable and applicable to not only science teachers, but all educators in similar situations. Data were triangulated through formal and informal interviews, participant observations, and document review. Member checks and peer review occurred during the entirety of the study resulting in a rich, thick description of the story of this teacher. Insights and conclusions were gained from this story to address the research questions and inform pedagogical practices. Chapter IV will provide a grand narrative of the research participant’s experience and how this experience relates to the theoretical framework. Chapter V will then summarize his story in terms of the guiding research questions, discuss insights and conclusions gained from the study that are transferable to other educators, and provide implications and recommendations for future research.
CHAPTER IV:

THE RE-STORYING OF MR. SILAS’S EXPERIENCE
UTILIZING ENDER’S GAME IN HIS PHYSICAL SCIENCE CLASS

This narrative inquiry provides a re-storying of Mr. Silas’ experience with incorporating the science fiction novel, *Ender’s Game*, into his physical science classroom. What follows is a brief depiction into the whirlwind existence of a practicing teacher as his identity of a science teacher and his established pedagogical practices are “problematized” in order to try out a somewhat unique project to address the newly adopted Alabama *College and Career Ready Standards* (CCRS) for content literacy (Alabama State Department of Education [ALSDE], 2010b). Within the complex story of Mr. Silas’ experience implementing the novel, the more specific account of how a secondary science teacher meaningfully addresses scientific literacy while incorporating this unique project into his physical science classroom is also explored. Mr. Silas’ story is unveiled within a theoretical whirlwind where scientific literacy is the overarching goal of science educators and various educational and science discourses directly and indirectly influence teaching practices. As Mr. Silas navigates these two vortices, his situated cognition in the classroom creates a situation where he becomes both teacher and learner simultaneously. The stories that follow are “eye of the storm” glimpses unraveled by me as the researcher from this whirlwind of issues in order to most accurately portray his experience during this endeavor. Because this re-storying is a collaborative effort of researcher and participant, my own experiences with utilizing *Ender’s Game* in the classroom intertwine with the stories shared by Mr. Silas to create a rich and vivid account of what it is like to be a science teacher in the current
The *Ender’s Game* project refers to the entirety of implementing the novel and all that entailed, from start to finish. The project included, but is not limited to, the reading of the novel, other strategies and activities used with the novel, and the classroom discussions. To gain the most genuine understanding of what Mr. Silas experienced throughout his implementation of the *Ender’s Game* project, I sectioned his story into *before novel implementation*, *during novel implementation*, and *after novel implementation*. This was done with the intention of exploring Mr. Silas’ feelings, thoughts, and issues while he was preparing to try out this somewhat unique tool; then, to examine his reflections of the project both during and after completion. Since teachers must begin very far in advance planning and researching a new activity and then reflect and revise this activity to best meet the needs of the students, this arrangement seemed to be the most appropriate for re-storying “a chronology of unfolding events, and turning points or epiphanies” (Creswell, 2007, p. 155) in Mr. Silas’ experience. To uphold the richness of Mr. Silas’ experiences and maintain his voice, I have provided his stories verbatim. Additionally, I have added line numbers for ease of reference.

**Bracing for High Winds: Mr. Silas’ Story Prior to Implementing *Ender’s Game***

Initially, getting in touch with and subsequently meeting Mr. Silas was quite difficult. After he agreed to participate in the study and I provided him with the novels for his class, I began to email him at his school email address to set up times for us to meet. After several days and no word from Mr. Silas, I contacted another teacher that I knew at Eagle High School and asked her to check to see if Mr. Silas had received my emails. I heard back from her promptly with the reply that Mr. Silas had received my emails and would be in touch soon. The next day,
I received a reply from Mr. Silas. In response to my request to schedule interviews during his planning time or immediately after school, he informed me that he had no planning time and that he was the softball coach and had practice or a game after school most days. He also informed me that text message was a better way to contact him since he had limited time to check emails. With this information, I realized that Mr. Silas’ teaching experience was even more complex than I had originally anticipated.

Mr. Silas and I finally agreed to meet on a Wednesday evening after softball practice at 5:00 pm. He chose Wednesday afternoons for meetings because there were usually no softball games scheduled for Wednesdays. I arrived at the softball practice field to meet Mr. Silas at 5:00 pm as we agreed upon, but found practice still going strong. It was a crisp, cool day so I stayed inside my car and waited for practice to end. I received a text message from Mr. Silas apologizing for the delay and that he would be finished soon. About 5:30 pm, we went to his classroom to conduct the meeting. Mr. Silas’ face was rosy from the wind and showed undeniable signs of weariness. Mr. Silas thanked me when I gave him the chicken sandwich and bottle of water I had for him. He explained that this was the first time he had gotten to eat all day. Remembering similar days when I tried to balance yearbook or prom responsibilities with my other duties, I thanked him for making time to talk with me and encouraged him to catch his breath and relax a minute before we began. After a few moments, the rosiness began to dissipate from his cheeks and his expression appeared to be more focused, preparing to tackle the next item on his daily agenda.

**Introducing Mr. Silas**

1. I went to college at Jackson University. I was originally going to be a PE teacher so I got my PE certification. After that I went to graduate school and got my Master’s in curriculum and instruction. Then I took 12 more hours in science to get certified to teach science so I have an endorsement in science as well. I
5. went to Williams County Georgia and taught there for one year—I taught human
6. anatomy and PE. After that I went to Baker County and I was there for 8 years—
7. taught human anatomy, physical science, physics, meteorology, forensics
8. science (laughter). Yeah, I was the new guy. Can you teach this—yes—I’m not
9. tenured yet (laughter). Baker County was a very low, poor area—a lot of black
10. kids. You know the black kids you have there were very in poverty, poverty-
11. stricken, very low income families. You’re looking at about 75-80% free and
12. reduced lunch. Then I came here to Eagle High School. This is my first year
13. here.

Eagle High and School Culture

Mr. Silas began teaching anatomy and physical science at Eagle High School in 2013, so
this study took place during his first year as a non-tenured teacher. In addition to teaching
responsibilities, Mr. Silas had coaching duties, serving as the head cross country coach and head
softball coach at Eagle High School. As relayed in the following narrative, Mr. Silas described
Eagle High as having a very different culture than the other schools in which he had taught
previously. He stated that the professional (superintendent and administrators) discourses at
Eagle High emphasized a very student-centered, academically rigorous high school that focused
on reading. Since this was Mr. Silas’ first year teaching at Eagle High and he was non-tenured,
we discussed any apprehension he may have toward incorporating a science fiction novel into his
physical science classes. He commended the principal for being very supportive of trying new
strategies and activities in the classroom, even if they fail. Mr. Silas affirmed, “That kind of
makes me feel better about it [using novel] because I can try it and see what works…because
experience is the best teacher.”

1. You know Eagle High is a lot more of a stricter educational school, and they put a
2. lot of emphasis on academics. They put a lot of emphasis on reading in the
3. classroom. They’ve made it really clear that they want us to get out of standing in
4. front of the room lecturing. They want us going around, you know, they don’t
5. want us—fact after fact after fact, giving them a test—presenting those facts. I
6. mean, I think they would be all for this [Ender’s Game project]. On Thursdays,
7. we have at the beginning of second block, we have a 30 minute reading time.
8. We have that every week. So they are huge on reading. They are wanting to get
9. our reading levels up. We have kids reading on a 3rd or 4th grade level,
10. especially the ones I have in physical science. I mean, 85% of our faculty
11. meetings or our data meetings are “how do we get the bottom up? How do we
12. close the gap?” I mean, that’s the question of the year because to close the gap
13. you usually got to pull the top down and push the bottom up and that’s what
14. we’re trying to do. Next year we’re going to all Macbooks, so that’s going to be a
15. change. Our principal even says try new stuff, if you mess up, oh well, learn from
16. it, move on.

The professional discourses that impacted Eagle High School’s culture were extremely
influential on the choices and path that Mr. Silas took while implementing the *Ender’s Game*
project. Since the Eagle High principal seemed to be supportive of trying new and unique
strategies in order to motivate students and since there was a school wide support of reading
across the curriculum, Mr. Silas was less apprehensive about utilizing the science fiction novel
while still being scrutinized as a non-tenured teacher. Although Mr. Silas had already
incorporated various reading and writing activities into his physical science class, this was the
first time he had the students read a fiction novel with related activities separate from his science
lessons. Since utilizing a science fiction novel in a science class is somewhat strange to many
teachers and students alike, it is important that teachers understand the professional discourses
and the school culture before implementing this somewhat unconventional tool. As O’Brien et
al. (1995) relayed, school culture can influence content literacy pedagogy in regard to the teacher
and the students. Although the influences discussed by O’Brien et al. (1995) such as the
traditionalist compartmentalization of secondary subjects and the pedagogies of control and
telling were still a source of the educational and science discourses discussed in Chapter II, the
school culture and professional discourses of Eagle High presented Mr. Silas with an opportunity
to venture out of his comfort zone, if only for awhile. Later it will be revealed how this
opportunity was realized in the classroom.
In Mr. Silas’ narrative, the more dominant educational discourses supported by the Eagle High administration were also revealed. Not only was the school culture supportive of reading, but there was an expectation for teachers to focus on ways to “close the gap.” Furthermore, there was a strong support of technology since Macbooks were to be provided to all students in the next school year. This complicated the job of teaching science even further for Mr. Silas. He had to conform his own personal Discourses (Gee, 2005, 2012) related to the best practices of teaching science to address the CCRS content literacy standards as well as the other school wide directives. This very much influenced how he implemented the *Ender’s Game* project and created a unique situated reality for him as he commenced with the project. Mr. Silas was expected to teach science content, teach literacy to many struggling readers, and implement more innovative technology practices in anticipation of the Macbook initiative for the next year. Furthermore, Eagle High had many successful sports teams and encouraged a strong sports culture along with its academics. Consequently, in addition to his classroom duties, Mr. Silas was also expected to be a successful coach. The winds were surely beginning to escalate.

*Figure 2. Eagle High School Softball Field*
Classroom Literacy Insights

In the narrative to follow, Mr. Silas discussed two different themes in relation to what I termed classroom literacy insights. The first represented his views or insights about issues related to his students reading and writing in his class. In Alabama, the students that comprise the physical science classes are usually labeled as “non-advanced” or “standard” in regard to their academic abilities. In addition, these classes typically are taken by students receiving special services such as for learning disabilities or English language learning. Since both Mr. Silas and I had experience teaching physical science students, we discussed some of the issues that these students struggle with in regard to reading and writing. He maintained that the reading requirement kept them from answering the essay questions rather than the writing requirement.

1. What I’ve seen with kids, and it’s not a good thing in reading, you assign them something to read, you assign them an essay question on a test, and they’ll leave it blank. They don’t want to read the question, they don’t want to answer it.
2. I mean, you gonna have a couple, you gonna have a handful in a class that will read it and answer it correctly. They just see that and they just don’t like to read.
3. That’s what I see. When they do write, the kids can write pretty well. I just think they don’t like the reading. Sometimes I’ll give a test that’s nothing but the reading where they have to and when they answer them, they answer them well for the most part.

Although Mr. Silas believed that it was the reading requirement that was the issue with literacy in his classroom, he never really explained specifically what about the reading he felt was the problem. The research in science education and specifically with teaching marginalized students cites many issues that hinder successful learning of science. For example, several authors indicated how the specialized language of science can be problematic to read, write, and speak for all students (Chinn, 2012; Fang, 2004; Fang & Wei, 2010; Jetton & Lee, 2012a; Shanahan, 2012; Wellington & Osborne, 2001). Furthermore, Gee (2012) discussed the disconnect between home Discourses (note capital D) and academic Discourses of marginalized
students that can affect their learning of science. However, it is my belief that a combination of several factors contributed to this problem.

The second account to follow reviewed the literacy activities that Mr. Silas was implementing into his class prior to the *Ender’s Game* project. These insights demonstrated that Mr. Silas was already aware that he needed to incorporate reading and writing into his science curriculum even without the directive of the CCRS content literacy standards. Mr. Silas expressed many times during our conversations that he valued reading and writing in his physical science classes and integrated these practices into his science curriculum. In lines 10-21 (p. 136), Mr. Silas described a couple of the reading and writing activities he already implemented. Mr. Silas also described to me a few more literacy activities such as the “Physical Science Diary” where students must research an internet article, cite the article, post a picture, write a synopsis of the article, and then email that to him. Furthermore, he discussed several other ways he added reading and writing into the curriculum such as incorporating essay and discussion questions into tests and having students complete the chapter preview form (see Figure 3) for textbook reading.

10. I use, it’s called physical science in the news. It’s got to be from the last two
11. months. It’s just a way to get them to stay up to date with science. They’ll just
12. get an article and they’ll read it and they’ll send me an email of their synopsis of
13. it, just what they thought about it. It’s got to be a paragraph. But that’s one thing
14. I’ve done, of course today, we did a project on the periodic table where we took
15. the chemical families. Say one of them had the halogens-what they had to do
16. was research halogens and come up with an advertisement. They had to have
17. the advertisement for say Chlorine. They had to sell their class Chlorine, you
18. know, what’s it used for. You make them tell you the valence electrons and
19. make them tell you some characteristics but just stuff like that, but it gets them
20. interested. The science fiction, I mean, I’ve read a few things but I read comic
21. books so, it’s kind of similar to that, but oh I enjoyed this book.
The literacy activities that were already being incorporated into Mr. Silas’ physical science curriculum addressed some of the best practices of teaching science and the promotion of scientific literacy as discussed in Chapter II. These assignments encouraged a constructivist classroom environment as described by Llewellyn (2005, 2013) where students were not just listening to Mr. Silas tell them about science in the news or elements on the periodic table, but instead allowed the students to find out and connect the information on their own. As Yager (2004b) deemed necessary for science learning, these assignments took the science concepts out of the textbook and into the real world of the students. Furthermore, Mr. Silas was already uniting literacy strategies and activities with science content prior to beginning the *Ender’s*
Game project in order to bolster science learning (Fang & Wei, 2010; Greenleaf et al., 2011; Norris & Phillips, 2003; O’Brien et al., 1995; Shanahan, 2004). During this study, Mr. Silas demonstrated his commitment to his students and his profession by taking on a new and unconventional literacy activity such as reading a science fiction novel when he was already in many ways “satisfying” the educational and science discourses with his current pedagogical practices.

Mr. Silas’ classroom literacy insights are important to his experience with utilizing Ender’s Game because they help identify some of his thoughts in regard to the educational and science discourses that were already influencing his pedagogical practices such as teaching struggling readers, incorporating technology, and moving away from the traditionalist teaching approach of lecture and test. Mr. Silas was not a “lazy teacher/coach” depending on lecture and worksheets. Before introducing him to this project, he already included a variety of pedagogical activities and strategies including demonstrations, Science in Motion labs, and group projects. These insights also revealed his perceptions of what it means to be scientifically literate based on the types of assignments that he included. Within his situated reality of the classroom, his incorporation of literacy activities that were constructivist in nature prior to the CCRS mandate possibly made the Ender’s Game project less intimidating. Again, even though Mr. Silas was a non-tenured teacher in his first year at Eagle High School, due to the school culture established in part by the administration and Mr. Silas’ willingness to try out a variety of activities in order to best teach his students and promote scientific literacy, he was enthusiastic about finding a new and innovative activity to add to his classroom repertoire.
Mr. Silas’ Professional Development (or Lack of) with Content Literacy

Since 2013-2014 was the first school year that the CCRS content literacy standards (ALSDE, 2010b) were officially implemented into content area classes, I felt that it was important to find out about any professional development that Mr. Silas had attended or been offered in regard to these standards. As described in the narrative to follow, most of his formal professional development had been focused on technology or science content. Mr. Silas described professional development that took place at the beginning of the school year where teachers were presented and informed about features associated with the CCRS such as QualityCore, which is an interactive online assessment tool provided by ACT in conjunction with the CCRS. Other than that, he just mentioned receiving literacy strategies at faculty meetings or via emails with no real explanation or support in implementing them into the classroom. He also obtained a few useful strategies in his graduate courses. Unfortunately, because Mr. Silas had attended college in another state, he had not received any training through the Alabama Reading Initiative (ARI).

1. The professional development they’ve been pushing this year is us doing the MacBook training. It’s technology based because next year we’re getting
2. MacBooks. I went to a one day workshop, I believe Dale State put it on, it was
3. Science in Motion. They actually taught us labs. We did 11 science labs. It was
4. great. I loved it! I was sitting there like a student. You know back during the
5. inservice at the first of the year, we had several science workshops that we did.
6. Whenever we started the year, you know we had about a week before the kids
7. got here, and we spent a good two days where they took all the science and all
8. the history and put them all together for the whole county I think. Put us with the
9. county and they talked about QualityCore. I remember them talking about
10. QualityCore. But professional development on literacy strategies, there are no
11. real strategies. I mean, we’ll get a packet or we’ll get an email, “hey, you want to
12. try this or do this?”

13. Even in my education training, it was mainly content. It’s just stuff I’ve picked up.
14. This right here [referring to chapter preview form], this is from Jackson University.
15. It’s where I went to school. That’s a great education school. It was when I was
16. doing my Master’s degree. I got my Master’s in curriculum and instruction. It

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18. was in a content type class. It was just all kinds of strategies. You find stuff that
19. works, and you find stuff that doesn’t work.

This narrative illustrated both the direct and indirect nature of educational and science
discourses as they are realized at the school and classroom level. The importance of the state-
wide as well as National mandate to implement content literacy standards seemed to be trumped
by Eagle High’s focus on technology. Although, features related to the CCRS such as
QualityCore were discussed, it seemed from Mr. Silas’ point of view that he was left to figure
out how to implement the content literacy standards and utilize effective literacy strategies on his
own. There was no question that Mr. Silas was expected to implement technology and best
practices related to science content into his classroom as this was supported through professional
development. In contrast, the directive to implement the content literacy standards, although
maintained by the Eagle High administration, was not something that seemed to warrant much
consideration in regard to professional development. The unfamiliarity of how to implement
literacy into non-English content classrooms (Fang & Wei, 2010; Greenleaf et al., 2011) as well
as the lack of professional support in doing so (Brozo et al., 2013; Shanahan, 2012) are
unfortunately common problems among teachers. Mr. Silas’ lack of knowledge and professional
development support are extremely important to his overall experience with implementing
Ender’s Game because these issues created a situated reality in his classroom where Mr. Silas
was simultaneously the science and literacy teacher but also the learner having to experimentally
try out this literacy activity and the corresponding literacy strategies. Although Mr. Silas was
eager to use the novel for various reasons, he was very unsure about how to best go about this,
seeking out on his own help from colleagues as well as my recommendations.

Mr. Silas also mentioned that he had not attended ARI training, so most of the strategies
he used were just “picked up.” As described in the account above, Mr. Silas told me how he
used some strategies that he learned about and obtained in a class while he was working on his Master’s degree (see lines 14-19, p. 139-140). He affirmed that this class was strictly a general pedagogy class and not about teaching science, thus reinforcing that content and pedagogy are many times taught separately in schools of education. However, with the continued research on disciplinary literacy, the restructuring of pedagogical courses to address specific content and literacy together is increasing (Conley, 2012; Jewett, 2013; Ruiz et al., 2011). This is very significant for future pre-service teachers who will be prepared to implement content specific literacy and will not have to result to the “use what works” approach that Mr. Silas employed.

**Ender’s Game Implementation Plan**

During our first conversations in the spring 2014 semester, Mr. Silas shared his timeline and planned activities for implementing the novel (see Figure 4). He stated that he planned to read the novel during the final term for that semester, with at least two chapters to read each week and assignments due each Friday. Mr. Silas explained that he would give the students about 15 to 20 minutes every day at the beginning of class to read, except on test days. On test days, students would still be given the in-class reading time at the end of the test rather than the beginning of class. He stated that the assignments associated with the novel would include discussion bookmarks (see Figure 5), “tweets” recorded on a sequence chart, anonymous written responses to discussion bookmarks, and a survey (see Figure 6). In order to carry out his plan, Mr. Silas created a Twitter account for the class so that students could follow the book and tweet their responses actually on Twitter if they wished (see Figure 7). Once a week, usually on Fridays, Mr. Silas planned to discuss with the students the specific chapters, using information from the bookmarks to lead these discussions.
Figure 4. Ender’s Game Plan

Ender’s Game Plan

1. Use discussion bookmarks at the end of each chapter which give the students a chance to reflect on what they thought during the chapter, ask questions about what they read, and identify unfamiliar words.

2. Exchange completed bookmarks between classes to give other students a chance to respond to each other’s work. They will use post-it notes and be identified only by book number.

3. Tweet a summary of each chapter and record it on a sequence chart.

4. This novel study will allow me to focus on the following Content Literacy Standards (from Alabama’s College and Career Readiness Standards):

   Standard 1: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

   Standard 2: Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

   Standard 3: Analyze how and why individuals, events or ideas develop and interact over the course of a text.

   Standard 4: Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

   Standard 9: Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

   Standard 10: Read and comprehend complex literary and informational texts independently and proficiently.
Figure 5. Discussion Bookmark
Ender’s Game Survey

Please respond thoughtfully to the following questions about your experience in Physical Science with reading the book Ender’s Game.

1. What did you enjoy about the book?

2. What did you dislike about the book?

3. Was it a good idea to read it in Physical Science or was it a waste of time? Explain.


5. What was the best part about reading it?

6. What was the worst part about reading it? (Do not say “the bookmarks.” If that is what you think, what part of doing the bookmarks did you not like?)

Figure 6. Ender’s Game Survey
Mr. Silas planned to address the following Content Literacy Standards from the CCRS by incorporating *Ender's Game* into the class:

1. **Standard 1**: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from text;
2. **Standard 2**: Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas;
3. **Standard 3**: Analyze how and why individuals, events or ideas develop and interact over the course of a text;
4. **Standard 4**: Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone;
5. **Standard 9:** Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take; and

6. **Standard 10:** Read and comprehend complex literary and informational texts independently and proficiently. (ALSDE, 2010b)

Mr. Silas stressed that he wanted to incorporate writing along with the reading of the novel, which he seemed to achieve through these planned activities. He also incorporated technology through the Twitter aspect. The fact that Mr. Silas sectioned the novel off into two chapters per week, gave students reading time in class, and had them write short summaries or tweets would seem to result in more students actually completing the assignments. Furthermore, through our discussions, I found that the nature of his reading and writing assignments made them somewhat non-threatening to the students.

Through this tentative plan, Mr. Silas addressed not only the specific content literacy standards mentioned above, but also many of the best practices related to content literacy and teaching science. For instance, Mr. Silas’ plan moved away from “pedagogies of control and telling” (O’Brien et al., 1995, p. 450) into a more student-centered and interactive curriculum surrounding the novel. Furthermore, even though Mr. Silas had not been officially “trained” on many literacy strategies, he was utilizing them along with a reading source other than the textbook to expose his students to science and promote scientific literacy through alternative means (Fang & Wei, 2010; Wellington & Osborne, 2001). Finally, through student interaction encouraged by responses to bookmarks and tweets as well as the incorporation of technology through Twitter, Mr. Silas also advocated student engagement and 21st century skills (King-Sears et al., 2011; Sweeny, 2010; Wendt, 2013) through his *Ender’s Game* implementation plan.
As previously mentioned, the initial planning of how Mr. Silas would implement the *Ender’s Game* project into his already packed curriculum and busy teaching and coaching schedule was part of his overall experience. The planning of literacy strategies and activities by disciplinary teachers is an area somewhat lacking in research (Jetton & Lee, 2012a), so Mr. Silas’ planning process was significant to other content teachers facing the addition of new and possibly unfamiliar literacy methods being implemented into their classrooms. Although not specifically aware, Mr. Silas did heed some of the influences mentioned by Jetton and Lee (2012a) in regard to planning such as addressing state and national directives, providing social interaction, and providing engaging texts. In Mr. Silas’ situated reality, he was aware that he must plan literacy activities daily that would satisfy the CCRS content literacy standards (state and national directives), but through his role as an apprentice within the context of legitimate peripheral participation (Lave & Wenger, 1991) he sought masters to help with other aspects. For example, I approached him about trying out a science fiction novel, which he may have never considered or utilized had he not participated in this study. He also consulted with another science teacher colleague that had been a secondary reading coach, and she shared many of the literacy strategies he used in the project.

**Mr. Silas’ View of Scientific Literacy**

The concept of “scientific literacy” has been and still is a somewhat contentious topic among science educators. As discussed in Chapter II, not only has the definition and meaning of scientific literacy been debated for years (Brown et al., 2005; Bybee, 1997; DeBoer, 2000; Holbrook & Rannikmae, 2009; Laugksch, 2000; Liu, 2009; Norman, 1998; van Eijck & Roth, 2010; Roberts, 2007; Yager, 2004b), so has the possibility of anyone, other than maybe a practicing scientist, every truly attaining scientific literacy (Shamos, 1995). Consequently,
scholars have differing opinions on the best pedagogy of pursuing scientific literacy, but most support the pursuit of it, whatever that entails, as a goal for science education.

As I reflected on my time in the classroom utilizing the novel, I realized that I had my own idea of how to best pursue scientific literacy. I became aware that scientific literacy was fundamental to why I wanted to try out reading a science fiction novel in physical science in the first place. My idea of scientific literacy is aligned more with Roberts’ (2007) Vision II concept where the socio-scientific issues related to science are deemed as important as the strict factual content. I chose to use a science fiction novel so that students could see the applications of science concepts, in this case physical science concepts such as Newton’s Laws, through a narrative story with characters that not only find themselves dealing with the science and technology in the story, but the ethical and social implications as well. This created a more authentic learning experience than just memorizing vocabulary words and reading about Newton’s Laws in the textbook.

Because the ideas surrounding scientific literacy are so debated, I felt that it was important to inquire about Mr. Silas’ beliefs about scientific literacy before he actually started using the novel. I had assumed that if he felt strongly that scientific literacy was a measure of strict content knowledge then he would not be in favor of incorporating a science fiction novel into his curriculum. When I asked him about what a scientifically literate student would be able to do and what characteristics he/she would possess, the answer he relayed in the narrative (lines 1-8, p. 148-149) was somewhat surprising to me.

1. You know, the way it’s going, the way they’re pushing the ACT and stuff, I would have to say the regurgitation of facts [demonstrates scientific literacy] because you look at the ACT and it’s strictly gone to graphs and setting up experiments. I mean, that’s what it is so if you want these kids…and that’s what they’re pushing here to be successful on the ACT, they need to be able to know, how to do a controlled experiment and what an independent variable is and dependent
variable. They have to know that stuff so…I mean, I don’t want it to be that way
but I think that’s how it is.

Again in this narrative, Mr. Silas has alluded to another educational discourse maintained by Eagle High School, the achievement of high standardized test scores. The pressure for teachers to produce high standardized test results in their students is also a national and state wide sanction associated with the idea of school success. Mr. Silas’ teaching practices and personal Discourse and beliefs were not protected from this influence. Mr. Silas was responsible for promoting scientific literacy in his students, yet due to focus on high ACT test scores, he felt more factual knowledge should be taught and that learning and recitation of stringent science content created the more scientifically literate student. Consequently, Mr. Silas endorsed the Vision I (Roberts, 2007) perspective of scientific literacy as well as the concept of derived scientific literacy (Norris & Phillips, 2003). From Mr. Silas’ last statement, however, it is obvious that he was not necessarily in favor of this approach. Although he felt that the Vision I (Roberts, 2007) concept of scientific literacy was being supported in the current school culture and through state mandates that required all students take the ACT, he did not necessarily personally support that vision. Even by incorporating a science fiction novel into his curriculum demonstrated his effort to address fundamental scientific literacy (Norris & Phillips, 2003). The current educational directives had created a two-faced teacher in Mr. Silas where he had to focus on teaching strict science facts for standardized tests and English concepts for the CCRS content literacy standards. As noted by Sammel (2008), Mr. Silas had to accept the status quo and follow the current educational discourses in order to be considered a quality teacher. This presented a unique opportunity for Mr. Silas as a science teacher attempting to promote scientific literacy and address the CCRS content literacy standards. However, utilizing Ender’s Game in
his classroom could possibly be the beacon of light he needed to find his way through the swirling winds, at least for this particular storm.

**The Unmotivated Five**

Motivation of students seemed to be an ever-present thought for Mr. Silas as he spoke of the “unmotivated five” or so students that did not seem to be inspired to participate by much of anything, even grades. As noted in the narrative (lines 1-16, p. 150), he really wanted to find a way to get them to take part and interact especially during the *Ender’s Game* project. In order to hopefully motivate all the students to participate, Mr. Silas added in elements such as class discussions, response notes, and tweets to provide more authentic, real-life experiences and social interaction that differed from the more traditional lecture format.

1. Out of about say twenty, there are five or so that just would not do it, didn’t care
2. what grade you gave them, didn’t care. I need to find a way to motivate them
3. other than a grade because the grade don’t matter to them. That’s what I want to
4. find out is what I need to do to get that other five involved. I think it’s a
5. combination of they just don’t like reading and they just…”uh science fiction, I
don’t like science.” They’ll just say that so, I don’t know. That’s why I tried to add
6. the tweet aspect to it. It’s something they can do, you know, I just need to find
7. some kind of strategy to get those others because I want everybody to be
8. involved.
9. When we started this I pulled up the movie trailer and played the movie trailer.
10. They were like “oh man that’s pretty…” It kind of gets them motivated to read it.
11. It’s getting out of the norm of them sitting here and listening to me lecture and all
12. this stuff. I really think it’s good because, we just took a test and the class
13. average was 68 on the test. I’ve got some kids that just aren’t good kids, they’re
14. not good students, they just show up because they have to be here; but I’ve got
15. some that really, really try, and I think this will help them when we read it.

As previously noted, the student population of Mr. Silas’ physical science classes consisted of primarily marginalized students (i.e., minority, special needs, ELL). According to the research, providing social interaction in the science classroom will guide students to use the secondary science Discourse (Gee, 2012) and foster their discursive identities as learners of science (Brown et al., 2005), which are both extremely important in regard to marginalized
students. Connections to real-life experiences and classroom interactions are also motivating factors for students that promote scientific literacy and science learning (Hand et al., 1999; Lemke, 2001; Pratt & Pratt, 2004; Wellington & Osborne, 2001; Yager, 2004b; Yore et al., 2003). Furthermore, the use of an ICT such as Twitter supported the development of new literacies and 21st century skills (King-Sears et al., 2011; Sweeny, 2010; Wendt, 2013) as well as fostered student motivation (Wendt, 2013). Mr. Silas also explained that he felt reading a science fiction novel in science, which is a somewhat uncommon practice, is a break from the traditional science class of lecturing and taking notes. He felt reading the novel would “get them more interested in science; it’ll get them more motivated to learn about that stuff.” Accordingly, the use of science fiction stories is more engaging and motivating for students and provides examples of authentic applications of science (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010; Smolkin & Donovan, 2004).

As Mr. Silas’ experience with implementing the *Ender’s Game* project began to unfold, I realized that his rationale for incorporating this project included more than just finding some literacy activities and strategies to address the CCRS content literacy standards. He truly cared about teaching all of his students and helping them be successful in his classroom as noted in the narrative above. Through engaging the students and providing more authentic applications of science, he was also promoting scientific literacy in all of his students. Taking on this new project amidst all of his other duties was not an easy task for Mr. Silas, but he did it anyway, not for his own ratification, but for the betterment of his students.

**Out of His Comfort Zone: Mr. Silas’ Feelings Prior to Implementing the Novel**

During our conversation time prior to implementing the *Ender’s Game* project, Mr. Silas and I discussed his feelings about implementing a science fiction novel and addressing the CCRS
content literacy standards with virtually no assistance. I felt these reflective investigations into his feelings were important to his overall experience because they revealed his personal Discourses (Gee, 2005, 2012) throughout the project. These Discourses informed Mr. Silas’ decisions and approaches and could possibly evolve as he continued with the project through the semester. Mr. Silas admitted in lines 1-11 on page 152 that he was a little nervous and described himself as a “baby” in regard to the literacy standards. Even his previous experience with teaching did not help with the addition of literacy standards into his science curriculum. Mr. Silas’ entire classroom routine was influenced by these new standards. He stated that he was now having to add the reading and writing standards in addition to the content objectives to his lesson plans, which took much longer. He had to adjust his teaching routine and add more assignments. He also had to take on the role of an English teacher in his science class.

Furthermore, he described his predilection for teaching life sciences over physical sciences. Although he had taught physical science for many years, he still relied on his knowledge of the human body to make real-life connections for students. From our conversations, I inferred that another source of Mr. Silas’ apprehension about using the novel was because the physical science concepts in the story would have to be addressed without the assistance of the textbook.

1. It’s a change. I’m a baby, you know, in this stuff right here. I mean, our principal
2. he does a good job because he said, “try this stuff, we’re going to fail, but in the
3. long run we’re going to be successful at it.” So that kind of makes me feel better
4. about it because I can try it and see what works you know, because experience
5. is the best teacher. But I’m nervous about it, just learning it, to be honest with
6. you because I’m not a new teacher but I’m new to this. I did PE, that was my
7. Bachelor’s degree. I was actually going to be an athletic trainer so the human
8. body, the kinesiology, I mean I know how all that stuff works. The chemistry, the
9. physics side of it, I mean, I’ve been teaching it for 10 years so I feel adequate in
10. doing it, but that’s [life sciences] still my comfort zone. I can just flow, but with
11. this stuff [physical science], I have to really study it.

Delving into this project brought Mr. Silas out of his comfort zone in many ways.
First, he was having students read a science fiction novel in science class, which is seen by many as a strange practice for teaching science (Fang & Wei, 2010; Greenleaf et al., 2011; O’Brien et al., 1995). Second, he was abandoning his more traditionalist way of teaching science for a more constructivist approach that involved lots of student interaction and connections to authentic experiences (Llewellyn, 2005, 2013; O’Brien et al., 1995; Yore et al., 2003). Finally, he was taking on the role of an English teacher in that he had not been prepared through education or professional development on how to actually “teach” a fiction novel (Brickhouse, 2001; Fang & Wei, 2010; Lave & Wenger, 1991; Núñez et al., 1999). In the situated cognition of Mr. Silas, he was taking on many new additions to his already busy schedule, so the fact that he was not more overwhelmed and apprehensive than he was speaks to his commitment to his students and the teaching profession. As the story of Mr. Silas’ experience with utilizing *Ender’s Game* in his physical science classroom continues, we see how he navigated this whirlwind of issues and how successful he felt the project was in his classroom and with his students.

**High Winds Abound: Mr. Silas’s Story While Implementing *Ender’s Game***

Finding time to meet individually with Mr. Silas during the implementation of the *Ender’s Game* project proved as difficult to schedule as before. We not only had to battle Mr. Silas’ teaching schedule but we also had to battle the weather and the rescheduling of softball games. Again we attempted to schedule a meeting for a Wednesday evening after softball practice. The Monday before this particular Wednesday was filled with spring thunderstorms throughout the day so the softball game originally scheduled for Monday afternoon was rescheduled for Wednesday afternoon. Our meeting had to then be rescheduled for the following Wednesday. This time, good weather prevailed and we were able to meet after softball practice. Although the weather was warmer this time than when our previous meetings took place, Mr.
Silas still appeared quite drained and tired from the long day of teaching and then practice. In addition, the softball season was well under way and Mr. Silas was both traveling to and hosting softball games. Again, I brought him a chicken sandwich and bottle of water and thanked him for taking time out of his busy schedule for the interview. We settled into the conversation as Mr. Silas shared student stories of how the project was progressing thus far.

During this phase of the project implementation, I also visited Mr. Silas’ classroom so that I could observe him in the social context as he implemented the various activities and discussions that he had shared with me prior to implementation of the novel. My presence in the classroom did seem to limit the students’ interaction with Mr. Silas during discussions at first. I got many strange stares from students obviously wondering who I was and why I was there. I explained to Mr. Silas that he could share what I was doing which might help with the tension. He introduced me, and the students seemed to get used to my presence after awhile. The following represents information gathered through both classroom observations and our conversations.

**Introduction to Mr. Silas’ Classroom**

As I walked into the classroom for my first observation on a very early and rainy Monday morning, Mr. Silas seemed as nervous as the students seemed curious. He did not really offer any explanation of who I was or why I was there at first, which elicited whispering and staring from the students. This was easily accomplished as students were sitting two to a lab table for easy access to each other’s ear. Mr. Silas was posed at the front of the class and quickly reminded the students that they were supposed to be using the time for reading. Class was once again disturbed, however, as two students came in late drawing the attention away from the reading. During the reading time, Mr. Silas returned graded papers and prepared to transition
into his physical science lesson on simple machines. The *Ender’s Game* project was well underway and Mr. Silas had established what seemed to be a practical routine.

The class that I observed was a very diverse group of students in terms of race, background, and academic abilities. As I perused the room, I saw some students reading from the novels I had provided for the class; one student was looking at his phone where he had downloaded the book; other students had their heads lying on the desk or were otherwise engaged with something other than reading; and one deaf student was signing with his inclusion assistant. As I studied the young faces in the classroom, I reflected on how very extraordinary and complicated the job of teaching is. Many of the educational discourses and mandates as well as the critics of public education try to make the profession of teaching out to be a cookie-cutter job that can be done successfully by anyone with a pulse; yet, the story that unfolds as the high winds abound for Mr. Silas during the implementation of a new and unique project to address new standards is far from cookie-cutter.

*Ender’s Game Implementation Procedure*

As we began discussing the actual procedure used for the novel, Mr. Silas shared that he was actually following the plan that he outlined with me prior to implementation of the novel. This was also substantiated through my classroom observations. Mr. Silas established the routine of allowing fifteen to twenty minutes of reading time at the beginning of every class period. I observed Mr. Silas using the reading time to take role, pass back papers, check the bookmarks that had already been turned in, or even read himself. The discussion bookmarks (see Figure 5) were due every Friday when Mr. Silas quickly checked them and made notes of unknown vocabulary words, questions, and thoughts to guide classroom discussions. Class
discussions took place predominately on Fridays except when Mr. Silas had to miss a couple of Fridays in a row due to softball state playoffs and championship.

Mr. Silas pointed out that another teacher at Eagle High actually developed the work products (discussion bookmarks, tweet sheets, etc.) that he used with the project. This was the same teacher that I had originally planned to work with for my narrative inquiry. This teacher shared with me that she had once been a secondary reading coach and was excited to try out a new literacy project. Due to unforeseen circumstances, however, she was no longer going to be teaching physical science classes when this narrative inquiry took place, but was happy to pass her already developed *Ender’s Game* products and literacy strategies to Mr. Silas for use with his students. Since this teacher had previously worked as a reading coach, she was more familiar with literacy strategies than Mr. Silas so he was most grateful for her sharing these ideas. The plan for incorporating these strategies, however, belonged to Mr. Silas. The Discussion Bookmark (see Figure 5) used in the project was an instructional strategy that supported several reading strategies such as considering interest, questioning, determining importance, monitoring, and clarifying (Jetton & Lee, 2012b). The use of Twitter, an ICT (Sweeney, 2010), was also incorporated into the *Ender’s Game* project. Requiring students to “tweet” about the novel, even if it was not technically posted to the actual social media site, was a pedagogical strategy that advanced and supported students’ development of new literacies and 21st century skills (King-Sears et al., 2011; Sweeney, 2010; Wendt, 2013).

Mr. Silas also shared in lines 1-41 on pages 157-158 that his grading procedures for the project. He stated that he kept a spreadsheet of student submissions of bookmarks and tweets. He made sure that students received a checkmark for each completed assignment. In our conversations, I deduced that Mr. Silas wanted the *Ender’s Game* project to be non-threatening
to his students. He stated that he was not giving them any kind of official test, opting for the bookmarks, tweets, and a final survey instead. Consequently, the spreadsheet seemed to be an organized way to keep up with completion of assignments, but offered no way to assess the assignments for “correctness” and/or rigor.

1. I just thought if you did the same time every period, it would be more routine.
2. They would start coming in here and getting their books soon as they come in here, and hopefully I can get them to start reading within the first few minutes. I give them 15 to 20 minutes to read. What I do is that every chapter has a discussion bookmark. So they put chapter 5, this is their discussion for chapter 6. On the back of it is chapter 6. You’ve got to turn in two [chapters] at a time. There’s 15 total chapters so I keep a spreadsheet, and every time they turn one in I’ll take it-number 53-and I’ll put an X that they turned in that bookmark.
3. That’s their book number. So at the end, whenever we’re done, I’ll see how many out of the 15 bookmarks they turned in on time because they are due every Friday. I also keep up with the tweet sheet. What I’ll do here is whenever they turn them in, I’ll check it so at the end they’ve got 15 checks. I do it on a spreadsheet too. This is just to show them that I’ve got it. What they’ll do like on Monday…see these are already the ones that have been turned in this week, then on Friday, I’ll check them and read them. That’s how I do that. What I have to do because, like I said, lower level high school kids, I have to give them probably about 5 or 10 minutes to complete these [bookmarks]. Then I’ll take them and I’ll just sit a few of them out on my podium. I mean it may take 20 to 30 minutes. We’ll just talk about it. I’ll just pick this out and say “here’s a question we got.” I don’t have to talk much because they start taking over. If they’re awake that is [laughter].

22. I have the bookmarks, the tweet sheets. They’re not doing as much on Twitter. I think they don’t want to be on the school/class Twitter page. I really think what it is, they don’t want me to see their page because you don’t know what they’re putting out there. I don’t want them to tweet something and then it pops up on there that they didn’t want me to see. I made the page. It’s @AHS PHYsscience (see Figure 7). I’ve had a few but for the most part they had rather do this [tweet sheet], I think.

29. I’ll tell you what really works whenever we do the discussion, you’d be amazed at how many of the kids will tell the other kids what they think that [vocabulary word] means. I’ll look through them and I’ll pull out a few that two or three people put down and I’ll go over. We might even look it up. It’s amazing how many of them will say “well that means this, that means this.” They’ll help each other out.
34. Keeping it confidential and responding to other people and other classes and that type thing. Because they’re high school kids, I mean, especially girls. But you know if you keep it confidential, you’re going to say a little bit more of what you
think. You’re not going to hold anything back if nobody knows it’s you. But if somebody in 3rd period gets Mr. Silas’ paper, I don’t like him, I might write something nasty. It’s crazy how many times I’ll have kids, “who’s number 15?” Like if 15 asked me…like they’re going to fight them or something. [laughter] I’m like, I’m not telling you who 15 is.

During my observations, it appeared that Mr. Silas, as well as the students, were accustomed and familiar with the established procedure. Mr. Silas still reminded students of when assignments were due and also reminded them to protect confidentiality when they were tweeting and responding to tweets. Many students would turn in their work early, but there were always a few who seemed to be scrambling to get something on the bookmark by the Friday due date.

Again through this story, it is apparent that students had ample opportunities for interaction and discussion highlighting the constructivist nature of this project. During this implementation, Mr. Silas was following many of the best practices of teaching science as discussed in chapter two such as authentic connections to real-life (Lemke, 2001; Yager, 2004b; Yore et al., 2003), socially-mediated interactions (Gee, 2004, 2012; Hand et al., 1999; Pratt & Pratt, 2004; Wendt, 2013; Yore et al., 2003), and opportunities to use science language in their own way, applying science vocabulary through more informal means (Hand et al., 2003; Wellington & Osborne, 2001) than normally found in the traditional classroom. In addition, many of these best practices are important in promoting science learning in marginalized students, which make-up the majority of the student population in Mr. Silas’ classes.

The implementation procedure was a major segment in Mr. Silas’ overall experience with the Ender’s Game project because it highlights the procedures and strategies he actually used while incorporating the novel. Had the novel not been a viable tool to be used in the classroom to support the above mentioned best practices, address the CCRS content literacy standards, and promote scientific literacy, then Mr. Silas’ story would essentially be over. Yet, through his
plan, he thoughtfully incorporated many elements into his novel lessons that motivated and encouraged students to learn. However, Mr. Silas’ situated reality while implementing this plan positioned him in a trial and error situation since this was a new tool being implemented into his already established curriculum. He had an implementation plan in place, but as all teachers understand, sometimes the plan is not fully successful. Nevertheless, from Mr. Silas’ own words, one can see how this implementation plan including the schedule, the activities, the timeframe, and the non-threatening nature of the project was focused on the utmost way for HIS students to reap the benefits of this learning opportunity. Mr. Silas was not teaching the advanced, most elite college-bound students in the school, but he was still devoted to providing his students with the best and most engaging lessons through the most beneficial routine for them.

**My Observations of Classroom Discussions**

My observations of classroom discussions reinforced Mr. Silas’ own narratives of his experience with implementing *Ender’s Game* into his classroom. Mr. Silas used the information from the discussion bookmarks to guide his Friday class discussions about the novel. Before the discussion “officially” began, a few students would scramble to get something quickly written down on their bookmark and submitted to Mr. Silas. He accepted these with a chastising look. The bookmarks (see Figure 5) consisted of sections titled “thoughts to share,” “questions,” and “world builder.” Mr. Silas began the class discussions by reviewing and summarizing what happened in each chapter. He then engaged the students in a more in-depth discussion of the plot and characters. Mr. Silas chose certain questions from the bookmarks, especially those that were common for multiple students in the class, and posed those to the students for open discussion. Mr. Silas pointed out many scientific and cross-curricular connections tied to the plot and
characters in the novel. After a couple of observations, it became obvious that the same few students were actually participating actively in the discussions. The nature of some of these discussions will be discussed in greater detail in later sections.

For every chapter, Mr. Silas identified vocabulary words from the Discussion Bookmarks that students seemed to be confused about (see Figure 8). He first asked for input from the students on what they thought the word meant. Next, he used the word in a sentence, sometimes an excerpt from the novel, pointing out any context clues. Then he read the actual definition of the word. Finally, Mr. Silas connected the vocabulary word to a real-life example or content area such as history or science. For instance, with the word vigor, Mr. Silas used the example sentence “Arnold Schwarzenegger had a lot of vigor.” This sparked a lively, although off topic, conversation about the Terminator movies. A second illustration came with the vocabulary word incognito. The real-life example that Mr. Silas utilized was “when you put on a costume, you are incognito.” A final example occurred with the word vertigo, where Mr. Silas actually directed students to close their eyes and turn head. He asked if they were aware that their head turned and why. He then began to explain how the fluid in our ears helps to keep balance and that if someone was suffering from vertigo, he or she was struggling with keeping balance. This was an example of a scientific connection inspired by reading the novel which is discussed more in the next section.
Although some scientific connections were made during novel discussions, I noted the disconnect between the “teaching of science” and the “teaching of literacy.” Mr. Silas was using these instructional strategies mainly to focus on the “literacy” aspects of the novel such as general vocabulary, characters, and plot instead of merging the teaching of literacy and science together. I observed Mr. Silas enacting an “English teacher” identity where he used the language and activities more common in English classrooms than science classrooms (Gee, 2005, 2012; Lave & Wenger, 1991). When the novel discussion was over, he would then revert back to his science teacher identity to teach his science lesson. In subsequent discussions, I will explore this phenomenon in greater detail and how this “doublespeak” contributed to Mr. Silas’ overall experience as well as how he addressed scientific literacy through the novel project.

The Pursuit of Scientific Literacy

Since one of the research questions I wanted to explore through this study was how a secondary science teacher would meaningfully address scientific literacy through the incorporation of *Ender’s Game* into the physical science classroom, the scientific connections that the students made were important to this inquiry. The narrative (lines 1-5, p. 162) revealed

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**Figure 8. Example Vocabulary Words Documented on Discussion Bookmarks**

<table>
<thead>
<tr>
<th>Salaam</th>
<th>Mettlesome</th>
<th>Malicious</th>
<th>Desiccate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigor</td>
<td>Insubstantial</td>
<td>Bureaucratic</td>
<td>Contention</td>
</tr>
<tr>
<td>Vertigo</td>
<td>Nonchalance</td>
<td>Empathy</td>
<td>Camaraderie</td>
</tr>
<tr>
<td>Incognito</td>
<td>Megalomania</td>
<td>Chauvinist</td>
<td>Fastidious</td>
</tr>
<tr>
<td>Derisive</td>
<td>Atrophy</td>
<td>Impromptu</td>
<td>Gluttonous</td>
</tr>
<tr>
<td>Wince</td>
<td>Irony</td>
<td>Prostrate</td>
<td>Demagogue</td>
</tr>
<tr>
<td>Itinerant</td>
<td>Errant</td>
<td>Provocateur</td>
<td>Conferred</td>
</tr>
</tbody>
</table>
that connections between the novel and science were facilitated during classroom discussions. In my observations though, I found this to be done many times through implicit means. As mentioned previously, the discussions focused on more of the literary aspects of the novel, but since there was so much storied science described in the novel, it was difficult not to make these scientific connections. In Mr. Silas’ view, the discussions helped connect the content literacy standards to scientific content and promote science learning although he did not seem to realize how his teaching of the novel was conducted more from an English/literacy disciplinary approach rather than science. However, he did at times explicitly discuss the scientific connections in the novel. These connections were at times specific to physical science (Newton’s Laws), but also included other science content areas such as biology, human anatomy, and the corresponding technological advances associated with science.

1. They love talking about where they do battles, you know with the zero gravity.
2. They love talking about that stuff. We just did Newton’s Laws. We talked about
3. weight, we talked about the acceleration due to gravity, terminal velocity, and it
4. makes them understand. You’ll see in class, I’ve even had comments where
5. they’ll say “oh, that was just like in the book.”

During my classroom observations, I witnessed Mr. Silas explaining how the battle scenes from the novel took place in zero gravity and free fall, which were very different from Earth’s gravity. He also construed how Ender and the other soldiers moved around in the battle room by Newton’s Third Law (action-reaction). After pointing out the action-reaction movement in the battle room, he reminded the students that this was the same principle that made a rocket propel into the sky. The key was that the soldiers as well as the rocket needed something in which to push off.

Mr. Silas referenced several other areas of science and technology during his class discussions. As previously mentioned, he explained how the fluid in the inner ear could cause an issue with vertigo. *Atrophy* was another vocabulary word that was pointed out and connected to
anatomy. Mr. Silas explained how muscles will waste away or atrophy when they are not used. In addition, he referred to a technological program in the novel that was very similar to the Internet. Mr. Silas made the point that the novel was originally written in 1977 before the Internet as we know it even existed, highlighting the technologically advanced futures so common in the science fiction genre (Czerneda, 1999; Gallo, 2007; Raham, 2004). Mr. Silas even got into an ethical discussion related to science based on a quote from the last sentences from the last chapter in *Ender's Game* that he wrote on the board:

> Wherever they stopped, he was always Andrew Wiggin, itinerant speaker for the dead, and she was always Valentine, historian errant, writing down the stories of the living while Ender spoke the stories of the dead. And always Ender carried with him a dry white cocoon, looking for the world where the hive-queen could awaken and thrive in peace. He looked a long time. (Card, 1991, pp. 323-324)

The class discussion around this quote dealt with the ethics of wiping out an entire species that was never intending to harm humans ever again. Mr. Silas pointed out that Ender was declaring that he would always try to understand other species instead of destroying them out of fear. Again, using the story found in a science fiction novel to prompt ethical discussions is a common characteristic of the genre (Gall, 2007; Groenke & Scherff, 2010; Zigo & Moore, 2004).

I chose to title this section *The Pursuit of Scientific Literacy* because, based on the discussion Mr. Silas and I had about what he felt demonstrated scientific literacy prior to implementing the novel, these science related discussions contributed to this purpose. Through the novel’s story, students were becoming more familiar with physical science vocabulary such as acceleration, weight, and Newton’s Laws, which could be repeated as answers to standardized test questions. This is what Mr. Silas felt was a measure of scientific literacy in the era of standardized tests and the current mandates he had to follow. However, providing an opportunity for students to use this science language during these discussions also developed
their scientific literacy external to answering standardized test questions (Wellington & Osborne, 2001; Yore et al., 2004). Even the act of reading a novel that described scientific concepts contributed to the advancement of scientific literacy (Norris & Phillips, 2003). In addition, the discussions included elements of ethical and social issues related to science, which embraced the Vision II (Roberts, 2007) type of scientific literacy that Mr. Silas seemed to personally wish could be taught more.

Although there were many times that novel-science connections were made, I did observe a few missed opportunities for going deeper with the connections. For example, in regard to the previously mentioned final quote that was discussed, the ethical discussion could have been elaborated on and extended in more depth. For instance, the issue of species elimination is of great ethical concern in our current society. Connections could have been made to related topics such as destruction of the rainforest, poaching and the wildlife trade, and human demand of species and their habitats. This would have certainly brought out the socio-scientific issues that are deemed so vital by many to promote scientific literacy (Bybee, 1997; Hurd, 1998; Roberts, 2007). The fact that this was the last chapter of the book, the end of the school year was fast approaching, and Mr. Silas had already had to reschedule the discussion day due to softball games could have possibly contributed to the missed opportunity for an in-depth ethical conversation. Another missed opportunity for a science connection that I noted was related to the fact that Ender had aged two years in space for every fifty years on Earth. Instead of explaining how planets have different rotations and revolutions which contribute to the different day and year lengths, Mr. Silas concentrated more on the characters and plot of the story, channeling once again the English teacher identity more so than the science teacher identity. One student even asked why this was so, but I presumed that Mr. Silas did not hear the question
since he offered no explanation. In Mr. Silas’ situated reality while teaching the novel, he seemed to alternate between two different identities-the English/literacy teacher and the science content teacher. I did see times when the two would merge, but mostly Mr. Silas was still teaching science as he had previously and teaching the novel as an English teacher apprentice. The students did make some scientific connections that seemed to advance their scientific literacy but had there not been a disconnect between Mr. Silas’ two identities, science connections could have been much more profound.

**Cross-curricular Connections**

Through my classroom observations, I discovered Mr. Silas made connections between *Ender’s Game* and other content areas during his discussion time as well. It has already been noted that Mr. Silas approached the teaching of *Ender’s Game* from the English-language arts (ELA) perspective, but he also referenced other content areas such as history. In one example, Mr. Silas compared Peter (Ender’s brother) to Adolf Hitler. He continued that Hitler wanted to kill the Jews just because he did not like them and Peter seemed to share that same attitude.

From the ELA approach, class discussions centered on the plot, characters, themes, and general vocabulary more so than the science content in the novel. Mr. Silas essentially focused more on the literacy aspects of the novel as opposed to the science aspects, even though related science content was discussed at times. During my observations, at the beginning of every discussion, he reviewed the plot of the chapter, continued with character analysis, and finished up with a review of various vocabulary words. In one specific example, Mr. Silas explained the symbolism in chapter 9 where “the snake in his [Ender] hands thickened and bent into another shape. A human shape. It was Valentine…” (Card, 1991, p. 152). He explained that was illustrating that Ender saw Valentine (Ender’s sister) as evil now. Mr. Silas also pointed out
ways to better understand and remember vocabulary words. For instance, he compared the
prefix of *hyper* in hypertrophy to that of *a* in atrophy, specifying that *hyper* meant an increase
and *a* meant a decrease. Furthermore, he indicated the relationship between *itinerant* and
*itinerary* to help students understand and remember the definition.

In regard to Mr. Silas’ experience with implementing the *Ender’s Game* project, the
cross-curricular nature of the discussions were beneficial to the students because they provided a
break from the traditional, compartmentalized subjects emphasized in most secondary school
settings (O’Brien et al., 1995). Through the novel, students were able to see the multiple subject
areas addressed, and Mr. Silas was allowed an opportunity to incorporate literacy into science
content. However, the disconnected nature of how Mr. Silas taught science and literacy hindered
the achievement of instructional congruence between science and literacy, which Lee and Fradd
(1998) deemed critical for marginalized and ELL students. As previously mentioned, these were
typical of the majority of the student population that made up Mr. Silas’ classes.

These ELA connections were characteristic of Mr. Silas’ legitimate peripheral
participation within the community of English/literacy teachers (Lave & Wenger, 1991). He
took on the identity of an English/literacy teacher because he had not been trained to “teach” a
science fiction novel or specifically address literacy during his preparation to become a science
teacher. Thus, Mr. Silas experienced the situated cognition of a teacher and learner
simultaneously as he utilized a somewhat strange tool in the science classroom. In order to reach
full participation in this apprenticeship and feel that he had successfully implemented the
*Ender’s Game* project, Mr. Silas established new behaviors and actions of an English/literacy
teacher while in the context of the science classroom (Brickhouse, 2001; Lave & Wenger, 1991;
Núñez et al., 1999).
Multiple Vortices: Diversions from the Mission of Teaching

As a teacher attempts to navigate the whirlwind that is created by education today, he must try to keep the actual task of teaching students located in the calm, eye of the storm while all other demands of his time and focus swirl around to be dealt with later. To complicate matters further, in the increasingly demanding career of being a classroom teacher in public schools, it is common for teachers to have added duties such as coaching and sponsoring extracurricular activities that create numerous whirlwind vortices that engulf the focus and attention from teaching to other details. Mr. Silas was no exception. As previously mentioned, he was the head coach of both the cross country team and the softball team. During the time that this study took place, the softball season was in full swing, and it was always a challenge to find time to schedule meetings among his busy schedule. As the softball championships began and Eagle High School was in the play-offs and eventually the state championship tournament, these “multiple vortices” became distractions and diversions affecting the classroom environment and the novel implementation routine originally established. Because of the softball tournaments taking place on Fridays and Saturdays, Mr. Silas had to miss school two consecutive Fridays. Since Fridays were the due day to turn in weekly bookmarks and conduct novel discussions, Mr. Silas had to rely on the substitute teacher to take up the work as well as reschedule the discussion days. When I observed on one of these alternate days, it seemed as if fewer students had read the assigned chapters or were participating in the discussion. Mr. Silas must have felt the same as he asked the question, “Did only three people read the book?”

Even when Mr. Silas was at school during the final state softball tournaments, the classroom learning environment was not protected from disturbances. Several times during my observations, the class phone would ring. At first, Mr. Silas would ignore it and, with obvious
frustration, even stated to the class and me, “Let it go to voicemail.” However, in a few minutes it would ring again and Mr. Silas would indubitably answer. Most calls that he received during the time I was observing were about issues related to the softball state play-offs and championship such as questions about hotel reservations and game times. One phone call, however, did seem to be more of a congratulatory conversation than that of someone needing questions answered. Some phone calls resulted in quite a lengthy conversation, during which students would begin talking and get off task. Each time, Mr. Silas would have to refocus their attention. Mr. Silas shared with me that sometimes he would receive phone calls all day due to softball. My final observation took place after the season was officially over, yet the phone still rang during class. This time it was to call a student to the office so there was not that extra down time where the students got off task as much.

During this time, the dominate identity in the situated reality of the classroom seemed to be Mr. Silas “the coach” instead of the science teacher or even English teacher. According to Gee (2005, 2012), different identities are created within different contexts. In this specific context, Mr. Silas had to focus so much on coaching duties that both his science teaching and literacy teaching suffered. The Eagle High School culture was also influential in creating this identity context. Although Mr. Silas shared in a previous narrative that Eagle High’s culture was much more rigorous, the school’s emphasis on sports was overtaking the academics at this point in Mr. Silas’ experience. This is substantiated by the school allowing the continued interruption of class time by phone calls regarding the softball tournament.

The multiple diversions and distractions that plagued Mr. Silas while trying to implement this new tool and teach the newly adopted CCRS content literacy standards contributed greatly to understanding his overall experience with the project. I can also relate to these multiple vortices
from my experience with implementing *Ender’s Game*. During the time that I utilized the novel in my classroom, I was the yearbook and prom sponsor. I would also receive phone calls many times during my class time regarding issues with each of these. It was very frustrating for me as a teacher having to stop my lesson and then regain the attention of the students after taking a phone call about something that did not necessarily have to be handled at that exact moment. I detected the same signs of indignation in Mr. Silas. After thinking about my own experiences and then observing the same type issues occur with him, it made me question the importance placed on protecting instructional time versus the importance of taking care of extracurricular activities. This is one facet that makes Mr. Silas’ experience so complex and important for all teachers as they try out new things in their classroom. The nature of many secondary schools is to provide a wide variety of athletics and extracurricular activities to their students, many times sponsored and coached by classroom teachers. There is an expectation that these teachers will address all of the national, state, and system educational directives, demonstrate pedagogical best practices of their particular discipline, and have a successful athletic team or other extracurricular activity. Needless to say, for teachers it can become overwhelming at times. This story of Mr. Silas’ multiple vortices demonstrated that he was no exception to the rule. Just like Mr. Silas and me, all teachers must navigate the whirlwind of issues in their own situated realities to provide the best learning environment for their students.

#StudentStoriesDuringImplementation

Although this study concentrated on the experience of Mr. Silas as he utilized a science fiction novel, *Ender’s Game*, in his classroom, the students he taught were interactive characters in his story. Accordingly, Mr. Silas shared many accounts that focused on the students’ experiences with the novel and how using the novel helped them or did not help them with the
CCRS content literacy standards and scientific literacy. Mr. Silas felt 85 to 90% of the students enjoyed reading the book, once they actually started reading. He stated that many of the students were apprehensive when the novel was first introduced, but “after the first chapter…they love it.” One female student even shared that her mom had read the novel as well.

Mr. Silas shared in lines 1-12 on pages 170-171 about how many of the students would give their opinions on the bookmarks and the tweets. He continued that the students would even hash tag certain words, for instance #confused or #whathappened to denote their questions and/or opinions about the novel. As previously discussed, Mr. Silas told about how the students would connect the science aspects in the novel with the science concepts that were discussed in class. Mr. Silas stated, “they love talking about where they do battles. You know with the zero gravity, they love talking about that stuff.” He also shared, “I’ve had comments where they’ll say, oh, that was just like in the book.” In addition, the students would discuss what they thought the vocabulary words meant before Mr. Silas would actually tell them the definition. Mr. Silas affirmed “you’d be amazed at how many of the other kids will tell the other kids what they think that [vocabulary word] means.” In general, Mr. Silas seemed to have plenty of student stories that demonstrated that the majority were reading the book and participating in both the written activities and discussions. I also witnessed some of these examples during my classroom observations.

1. They’ll say “why didn’t people believe Ender would do good at the Battle School?” and we would just discuss. It’s surprising how many different opinions, how many people, what people think. “Why did he break that kids arm?” “Why did he do this?” The kids really, they really have opinions about the book, which is good. Of course in every class, you’ll have a couple of outspoken ones, and sometimes what we’ll do is we’ll take a post it note and I’ll give 1st period, 3rd period’s. It’s anonymous. They don’t know who it is, and they might just add something on the post it note: “Hey, he might have did this or this is why he did this.” It gets them to write. They’ll even hashtag it [on the tweet sheets]. Like
2. #confused, #whathappened. I mean, “why are Ender and Bernard all of sudden
11. friends? #curious, #wonder.” I mean I’m not just Twitter savvy, but I know enough about it.

The student stories described by Mr. Silas highlighted several components of his proposed *Ender’s Game* project plan and demonstrated that the plan was actually being carried out with participation from the students. First, not only did Mr. Silas plan to incorporate interaction into the *Ender’s Game* project, but he illustrated in his stories and comments that the students were actually interacting with one another utilizing the novel as a prompt (Llewellyn, 2013). Second, the use of “hashtag” phrases in the spirit of Twitter and other social media, allowed the students to reveal their questions and comments in a way that was familiar to the students, bridging home and academic literacy (Hinchmann et al., 2003). Finally, this interaction was done through writing as well as discussion, so this project not only fulfilled the CCRS content literacy standards for reading, but addressed some of the CCRS writing standards as well (ALSDE, 2010b). These student stories, as well as my classroom observations, verified that the *Ender’s Game* novel was a viable tool to be utilized in a science classroom to address literacy and science. Regardless of how flawless Mr. Silas’ initial implementation plan had been on paper, if the students were not learning anything while using the novel, it would all be for naught. Although Mr. Silas had struggled somewhat with his classroom identities (science teacher, English teacher, coach) through the project, his student stories were mostly of a positive nature through this point in his experience.
Non-Threatening Literacy Activities

From Mr. Silas’ narrative in lines 1-18 on pages 172-173, as well as from his other stories, I conceived the concept of non-threatening literacy activities or NTLAs. NTLAs are those literacy activities that require reading and writing, but are more familiar to students because they are common in their everyday lives and/or are more informal than other literacy activities. For example, a tweet on a social media site would be an NTLA where an essay question would not. NTLAs also reduce the stress and anxiety that some students feel when faced with traditional school writing and reading assignments. For instance, grammar usage, sentence structure, and conventional spelling would not be emphasized with NTLAs. As can be seen from his narrative, Mr. Silas intentionally incorporated several NTLAs into this project. However, I actually identified the use of NTLAs in my first interviews with Mr. Silas, even before students started reading the novel or participating in any activities related to the novel. Before novel implementation, Mr. Silas shared that he liked the “tweet” aspect as a way of incorporating reading and writing into the class, and tweeting was something familiar to the students. He affirmed, “Well, they’re writing and they’re reading, and it’s stuff that they are used to doing.” Mr. Silas also added, “You know, that’s why I tried to add the tweet aspect to it. It’s something they can do.”

1. It’s [tweet] got to be less than 140 characters, it can’t be more. So it’s “Hey, I ain’t got to write anything, I can write just a small…” and it suffices. It takes some of that “oh, I’ve got to write” away. It’s like if you give them a test question, you know, essay. As soon as they see essay, “I’m not answering that,” but this right here, you call it a tweet, they’re writing.

6. The discussion bookmark, one thing that’s good about it is that it’s not a whole page. They see this, “Ahh, I can do this.” You know it says thoughts to share, it’s not discuss or write an essay or write 3 or 4 sentences. Even though they were writing 3 or 4 sentences, it’s not saying write 3 or 4 sentences. That’s one thing I told them to try to get them to do it. I said I’m not going test you over this. I want you to participate in this. There’s not anything you’re going to be tested over so it

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12. takes that nervousness, I guess, off of it. But they do have a survey. We just call
13. it a survey so it’s not a test or an exam or quiz. It will just get you some
14. feedback.

15. Like with these kids, you know, science books sitting here on their desk. A
16. question on their study guide or whatever, they won’t flip the page to look it up,
17. they’ll Google it. They want to Google what the answer is and they’ll find
18. probably a better answer there.

Although not formally identified as such, the use of pedagogical activities considered as
NTLAs are supported by research. For example, King-Sears et al. (2011) advocated the use of
interactive Web 2.0 functions such as tweeting to encourage students apprehensive in their
writing abilities. Both Sweeney (2010) and Wendt (2013) encouraged teachers to utilize ICTs
such as Twitter and text messaging in the curriculum to develop students’ use of new literacies,
mastery of which will be essential in the future workforce. Furthermore, the incorporation of
NTLAs help to connect home and school literacy as suggested by Hinchmann et al. (2003). As
described in Mr. Silas’ story, the students were more inclined to write a tweet or their thoughts as
opposed to a formal discussion or essay question. They even Googled information they did not
know instead of looking it up in the textbook. While formal reading and writing activities are
certainly necessary in the classroom, there are many times when these NTLAs can be valuable to
literacy development. In our fast paced and technologically connected world, it may seem
strange and outdated to students when asked to take part in what they view as “old school”
assignments. In this case, Mr. Silas was more interested in what the students knew and thought
than he was in having them formally write something. Teachers need to evaluate their intentions
for the literacy activity, but try not to disregard social media and interactive technologies as
legitimate resources for literacy applications (Alvermann, 2006).

I am unsure if Mr. Silas was aware of the research surrounding what I considered non-
threatening literacy activities, but within his situated cognition, he felt he needed to incorporate
these types of activities into the project. Regardless of what approach he took with the novel or how familiar and confident he was in his understanding of the CCRS content literacy standards, he knew his students. He was committed to motivating them to participate and finding out what they knew without the major stress of academic writing. Mr. Silas’ personal Discourse (Gee, 2005, 2012) guided his decisions throughout this process. He believed the use of Ender’s Game with his students and in his classroom would best be utilized without the formal assessments of most other academic endeavors. It will be revealed later in Mr. Silas’ story if his Discourse in this regard was altered in any way after the project was over.

**Motivation of ALL Students**

Motivating students to actively participate in educational activities is a common concern among most teachers; again, Mr. Silas was no exception. According to Mr. Silas, he had many students in his classes that had low reading levels and struggled academically, which is common in non-advanced physical science classes (Lee & Ready, 2000). He even mentioned a few who had little to no motivation to participate in class. The educational and science discourses discussed in Chapter II support the motivation and active participation in science learning and literacy for ALL students. Specifically, the *Benchmarks for Science Literacy* (AAAS, 1993) and the *National Science Education Standards* (NRC, 1996) support the pursuit of scientific literacy for all students, even those that are marginalized (Bybee, 1997; DeBoer, 2000) such as were found in Mr. Silas’ physical science classes. Although not officially adopted by Alabama yet, the *Next Generation Science Standards* (NGSS) (NGSS Lead States, 2013) also support the teaching of science to all students.

In addition to these directives to teach science and promote scientific literacy to all students, the CCRS content literacy standards mandate that science teachers address literacy in
the science classroom as well. Consequently, Mr. Silas was very concerned with motivating all of his students to participate in the *Ender’s Game* project even though he may not have been fully aware of the influence of these standards on his pedagogical practices and his personal Discourse (Gee, 2005, 2012). As relayed in the narrative (lines 1-8, p. 175), he felt that since the Eagle High School culture stressed the importance of reading across the curriculum, the students would not be surprised by reading a science fiction novel in science class (O’Brien et al., 1995), a practice somewhat uncommon in many science curriculums where hands-on activities dominate (Greenleaf et al., 2011). In addition, Mr. Silas shared with me that one reason he wanted to try out *Ender’s Game* with his students was to deviate from the more traditional classroom pedagogy of lecturing and tests. He believed that the novel project could possibly motivate all the students to participate in class and help them better understand aspects of physical science (O’Brien et al., 1995).

1. They’re pushing it [reading] so much now that, you know, even history, some of his classes read as well. I haven’t actually got a comment of where “why are we reading in science?” When I started, like the first day I introduced it, “alright, we’re going to be reading,” you’ll see [sighs and shrugs shoulders]. I promise you after the first chapter they’re just…they love it. I have some that just put their head down, “I’m not doing this, I don’t care what….” But I’d say it’s a good 85-90% of them are into it. Once they read it, “are we going to watch the movie?” Yeah, if ya’ll all read the book, we’ll watch the movie.

Another way that Mr. Silas tried to motivate the students was by showing the movie trailer before they actually started to read the book, stating, “It kind of gets them motivated to read it.” I shared with Mr. Silas and the class that I had watched the movie, and it was very close to the book except that they left some of the storylines from the novel out of the movie. Through our conversations, I determined that Mr. Silas also incorporated NTLAs into the project in order to motivate some of the more at-risk students to participate. By utilizing these non-threatening literacy activities, some of the pressure and anxiety was removed from the task and more
familiarity was added, which hopefully resulted in motivation to participate increasing. The story of what happened with these unmotivated students after the novel project was completed will be discussed in greater detail in the final segment.

The motivation of all students is another important segment to Mr. Silas’ overall experience because as a teacher, he was responsible for facilitating learning with his students. As all teachers know, sometimes this can be a daunting task, especially when trying to find creative activities and strategies for those students that seem impossible to inspire. Mr. Silas knew the background and motivation level of his students quite well and carefully considered the details of the *Ender’s Game* project in order to best fit their needs. As shared earlier, motivation of the “unmotivated five” was an important reason why Mr. Silas wanted to try out reading *Ender’s Game* in the first place. Of course, he was mandated to address literacy by the CCRS, but as discussed previously, he was already incorporating several reading and writing activities into his curriculum. In the realm of Mr. Silas’ situated cognition, he left his comfort zone as a science teacher, apprenticed as an English teacher, and incorporated new and contemporary activities surrounding the *Ender’s Game* project all for the betterment of his students. Thus, Mr. Silas’ students became members of the socially-mediated community of learners that influenced his pedagogical decisions as he attempted to develop his literacy teaching skills (Lave & Wenger, 1991).

**Mr. Silas’ Feelings During Implementation of Novel**

Mr. Silas’ feelings of uneasiness about using *Ender’s Game* with his physical science classes, shown in lines 1-6 on page 177, had decreased tremendously once he got into the weekly implementation routine. His ability to anticipate questions and comments made Mr. Silas feel more comfortable and in control of the learning context. In the beginning of this project, Mr.
Silas was a science teacher taking on the role of an English teacher with virtually no training or support in this endeavor. After implementation began and he was able to go through his weekly procedure several times, Mr. Silas learned on his own, through first-hand experience, how to best take on both roles in his classroom (Gee, 2005, 2012; Lave & Wenger, 1991). As discussed previously, Mr. Silas transitioned between the identity of science teacher and literacy teacher many times while utilizing the novel. However, whichever identity he embraced, at this point in the implementation process, he felt more confident in his abilities to successfully facilitate the project.

1. When it first started, it’s like whenever you teach the lesson first period, well
2. second period you’re kind of anticipating what questions are going to come. By
3. third period, it’s just…It’s kind of like that. The first time through you don’t know
4. what’s going to happen. Now I can kind of see what they’re going to ask or what
5. they’re going to be thinking about this chapter or what they thought about this.
6. It’s not as new. And I can anticipate a little bit better.

Mr. Silas’ feelings throughout the novel implementation process revealed important insights into his experience with utilizing *Ender’s Game* in his classroom. Consistently throughout his story, Mr. Silas’ Discourses (Gee, 2005, 2012) have influenced his classroom decisions and pedagogical practices. Mr. Silas was very much out of his comfort zone at the beginning of the project and was unsure about all of the activities, strategies, and discussions taking place. Now from this narrative, it is clear that he was settling more into this new situated reality where he was a science teacher addressing the CCRS content literacy standards and promoting scientific literacy through a science fiction novel. He seemed to have a better grasp on his English teacher identity and was, at this point, successfully navigating the whirlwind of issues in his classroom and attending to his coaching duties as well. Yet, the end of the project and the end of the school year were fast approaching, so would Mr. Silas be able to continue with this process?
The Calm After the Storm? Mr. Silas’ Story After Implementation of *Ender’s Game*

When I arrived for the meeting with Mr. Silas after completion of the *Ender’s Game* project, it was a different atmosphere; it was the calm after the storm. This meeting took place on one of the last school days after the students had left from morning exams. Not only was the *Ender’s Game* project and the school year almost over, so was softball season. For this meeting, we were able to set a definitive time that was not dependent on how long softball practice went that day. When I walked into Mr. Silas’ classroom, he was grading what I assumed to be final exam papers, while his little girl played “scientist” with goggles, pipettes, beakers, and water at one of the lab desks. Immediately, I detected a more relaxed and tranquil teacher. He had that “end of the year look” on his face that any teacher would recognize and understand. This time, Mr. Silas offered me something to drink or eat (the school was providing the teachers a meal of barbeque that day). He put down his papers and sat down across from me at one of the lab desks and we began our longest conversation since we took on this endeavor.

During this conversation, Mr. Silas shared many student stories based on the survey he gave the students to conclude the novel implementation as well as shared his feelings and beliefs about incorporating the novel and what revisions he would make next time. As we talked, Mr. Silas did not seem as uncertain in his answers to my queries as if he was trying to tell me what I wanted to hear or the politically correct version. During this conversation, he seemed to hold nothing back in discussing the successes, failures, and his frustrations with the project and the CCRS content literacy standards. This conversation was not inhibited by the whirlwind issues that plagued the previous conversations because, for a brief moment, the storm was over. For a brief moment, I experienced Mr. Silas as a father and husband (his wife who also worked at Eagle High stopped by to check on their daughter) and not just an overwhelmed teacher and
coach. Yet how long would this calm last? I predict not long, as Mr. Silas had shared he was also the head cross country coach and conditioning for this would begin during the summer. Of course, any teacher knows that the summer is gone in an instant anyway, and then we are plummeted into yet another whirlwind of a school year; but not yet. On this day, Mr. Silas and I were able to both enjoy talking and briefly forget about the craziness of our profession and concentrate on why we put up with it all-the students.

**And the Survey Says…**

To reiterate, the students were not the focus of this particular study, but their stories became part of Mr. Silas’ overall experience. As mentioned previously, Mr. Silas gave the students a final survey (see Figure 6) to find out their experience in physical science with reading the novel. Generally, the survey asked students what they liked, did not like, and how they felt the book related to their physical science class (see Figure 6). As can be seen in the narrative (lines 1-28, p. 179-180), most of the students mentioned that the book related to gravity, inertia, and Newton’s Laws of Motion. Although the survey responses were anonymous, Mr. Silas felt he could distinguish the students who participated and read the novel from the ones who had not based on their responses.

1. Question number 4 says “in what ways did the book relate to what you learned in physical science?” Pretty much what I got from this-definitely talking about the laws of gravity. They mentioned that a lot. Several of them mentioned inertia.
2. They mentioned space, but for the most part it was gravity and inertia. As I’m looking through them now, that’s the biggest thing they said it related to and of course if these kids, if they can remember gravity and can remember inertia that’s…. Some of them even refer to Newton’s Laws of Motion.
3. Question number 3: Was it a good idea to read it in physical science? Um, a lot of people put it was a waste of time because it didn’t have much to do with what we were talking about. But yet they said right here, the very same person put gravity. I mean so…. I told them to be honest. I told them to tell me what they thought, “yes, it is an interesting book and it shows the world... how the world might change in many years.” “It was a good idea because some of the stuff in
the book related to stuff we learned about in physical science.” So, you’re going
to get these people, and most of the time if you look at it, the ones that said it
was a waste of time probably didn’t read it. You can look and I can kind of see
who actually took the time to write stuff because end of the year, they’re probably
ready to get out of here so they just wrote whatever. I was reading this comment
right here, it says “the tweets to me were pointless, the bookmarks were fine.” I
think that’s a girl that, she wasn’t supposed to put her name on it, but I think
that’s one that did read it and she pulled an A in my class so that’s one of them
that’s pretty intelligent. A lot of stuff they said they liked about the book was the
plotting of the scenes, the fight scenes, you know, the characters. What was the
best part of us reading a book? “It was a good book” [laughter]. Several
comments that I’ve been looking at is that this would have been good to do in
English and not Science. Just to tell you, you know, we’re trying to get reading
across the curriculum. This shows how they still see English as the place where
you read and not in Science and not in math.

In this account, Mr. Silas mentioned many of the things the students liked and disliked
about the project; however, one notable comment shared from the survey stated that reading the
novel would have been better to do in English instead of science (lines 24-28). There were a few
other comments similar to this on other surveys. The unfamiliarity and strangeness of reading a
novel in science, or any other books for that matter other than the textbook, were also issues that
I experienced with my physical science students when I implemented Ender’s Game. Mr. Silas
seemed to share the same frustration since he commented about Eagle High’s strong emphasis on
reading across the curriculum, yet the students still found it odd to be reading a novel in science.
In earlier narrative accounts before the Ender’s Game implementation, Mr. Silas felt fairly self-
assured that the students would not have an issue with the strangeness of reading a novel in
science because of the Eagle High school culture that supported reading and trying out new
strategies. However, the survey revealed that some of the students rejected and disliked the
change in customary pedagogical practices of the secondary science classroom for what they felt
were more “English” teaching practices (Fang & Wei, 2010; Gee, 2012; O’Brien et al., 1995;
Wellington & Osborne, 2001). Yet, what the students did not understand, and to some extent
neither did Mr. Silas, was that reading Ender’s Game in an English class would have been a
different experience. Even though Mr. Silas did approach the novel from an English-language arts perspective at times, reading it in science allowed the science in the story to be highlighted, and the students benefited from Mr. Silas’ content knowledge as he connected the science concepts in the novel with what was actually being studied in class (Shanahan, 2004). Mr. Silas noted that even though some students found reading a novel strange, it did help them learn and apply the science concepts, which contributed to improving scientific literacy. This account in Mr. Silas’ experience illustrated that he believed the focus on reading and writing at Eagle High School as well as the mandate to teach the CCRS content literacy standards would contribute to his students acknowledging these discourses and embracing the Ender’s Game project as a fitting activity for science. However, in reality, many of the students still clung to the secondary subject divisions as the norm and were somewhat resistant to exiting that paradigm. This mindset is prevalent with secondary students, secondary teachers, and even infiltrates the secondary educational programs since many programs emphasize content over pedagogy (Conley, 2012; Fang & Wei, 2010; Wendt, 2013). To truly incorporate a variety of literacy activities and assist struggling readers in every classroom, a major paradigm shift in those associated with secondary curriculum must occur.

Some Had Never Read a Book Before: Student Stories After Implementation

In addition to discussing the student responses to the survey, Mr. Silas shared additional student stories related to the Ender’s Game novel implementation. Through our conversations and my classroom observations, it was apparent that many of the students were very motivated to read the novel and participated fully in the process. Mr. Silas said that some students did not want to stop reading once the allotted fifteen minutes of class reading time was over. According to Mr. Silas, “I had some of them that would be upset when I did have to stop them. They would
try to keep reading while I was teaching.” As shared by Mr. Silas (lines 1-24, p. 182), the more introverted students would speak out when I was not in the classroom observing. This account also illustrated the diverse student population that made up Mr. Silas’ physical science classes. Yet, many of the students considered academically below average or receiving special education services participated fully in the reading and discussions. I noticed their excellent insights during my observations as well.

1. After you would leave some of them would speak out more. They would
2. sometimes come up to my desk and talk to me about it because they just don’t
3. want people to think there’s is a stupid question. Three of the participants were
4. special ed. The girl back here, she’s pretty low. The guy behind her, he’s real
5. low. The girl right here, she probably had it done within the first two weeks,
6. completely done. She actually read the second one. You could tell she was
7. really into it. The kid right here, he had already read it real quick. But you know,
8. I see some of the other ones whenever it’s time to turn in their tweets, they’ll
9. have their book open writing stuff out of the book.

10. For the most part, with my first period class, I think they got into it a lot more. I
11. think it being first period, I mean you saw how a lot of them were, and you’ve
12. taught so you know how it is-second period, they’re hungry; third period, they’re
13. tired from eating lunch so…. Second and third period just didn’t…. I almost just
14. based everything off what first period did because second and third period, by
15. the end of the year, they had stopped doing a lot of their work, a lot of their
16. tweets. It was good to do it with those that aren’t into reading. Some of them,
17. they said they’d never read a book before. You know, you would see those light
18. bulb moments.

19. They loved the movie. You’re always going to have a few kids that sit back and
20. they’ll like to talk during some videos that I show or something like that. I mean
21. everybody, when that first scene started, they all watched it. The first day we
22. didn’t get through with it and when I had to cut it off, they all “No!” Didn’t want
23. me to cut it off, so I think they really enjoyed it, and I was just thinking that’s a lot
24. of our society today is kids just don’t like to read.

Even with the positive student stories relayed here, Mr. Silas was aware that some of the students did not actually read the novel nor participate in the class discussions. On Fridays, when the tweet sheets and bookmarks were due, Mr. Silas noticed some students would have their novel out scrambling to find things to put down (lines 7-9, p. 182). I noticed this during my
observations as well. Mr. Silas also attributed some of this lack of motivation to the fact that it was the end of the school year and students were ready to be finished with everything.

Even though there was frustration detected when Mr. Silas discussed some of the less motivated students, there was excitement when he told stories of students who enjoyed reading and discussing the novel and the physical science connections they made. His exhilaration at the “light bulb moments” and the fact that this project encouraged students to read an entire book when they never had before was easily recognized. Mr. Silas said that many times during his physical science lessons, students would relate something from the lesson to the novel. Mr. Silas also shared stories of the “re-tweets” that were made by students. He said these re-tweets centered mainly around the plot and characters of the book and the students’ thoughts and opinions about what was happening in the novel. Overall, he felt the students’ knowledge of science and vocabulary was improved through the use of *Ender’s Game*.

As shared in his story, Mr. Silas described how much the students enjoyed the movie, which he showed to the class after the full project had been completed. According to Mr. Silas, even the students who normally disrupted or did not pay attention during videos and movies were hooked once the movie started. Mr. Silas preferred that the students read the book since this was a project to incorporate reading and address the CCRS content literacy standards, but he felt that with access to entertainment and technology everywhere, students did not like to read when not required. Nevertheless, he did feel that watching the movie helped the students understand the novel better, especially the physical science concepts such as zero gravity that were represented in the battle scenes.

The descriptive accounts of the students’ participation in this project revealed their expansion into a more academic Discourse (Gee, 2012). The student demographics of Mr. Silas’
classes consisted of many students from low-socioeconomic backgrounds, students receiving special services, and students performing very low academically. According to Gee (2012), these marginalized students many times struggle in school because their home Discourse is so different from the school Discourse. From his descriptions and my observations, this seemed to exemplify the issue with Mr. Silas’ students as well. The fact that some of the students had never even read an entire book confirmed a home Discourse that did not emphasize reading, which differs greatly from school. Nevertheless, by providing these students that were not “into reading” an alternative reading resource to the textbook (Jetton & Lee, 2012a; Olson & Mokhtari, 2010; Rutherford, 2005), Mr. Silas provided an opportunity and motivation (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010; Smolkin & Donovan, 2004) for some students to read their very first book from beginning to end. Furthermore, presenting an opportunity for the students to socially interact around the novel and authentically connect the concepts in the novel, Mr. Silas was facilitating the development of their secondary academic Discourse (Gee, 2005, 2012) to improve science learning.

As previously stated, this study was not focused on the students, but stories of their participation and insights into the Ender’s Game project strengthened the story of Mr. Silas’ overall experience with the novel. The students were part of the socially-mediated community of learners that impacted Mr. Silas’ situated cognition as he tried out this new approach to addressing content literacy. In Mr. Silas’ situated reality of the science classroom, he had to contend with outside influences on the students such as differing home and academic Discourses, barriers to learning caused by physical, mental, emotional, and language issues, and lack of motivation. These matters combined with the educational and science discourses that directed his pedagogical decisions and practices created the swirling whirlwind that Mr. Silas had to
maneuver daily. With all of these influential components, Mr. Silas had to reflect on the practicality and appropriateness of this project as a viable activity to address the CCRS content literacy standards as well as promote scientific literacy. Did enough of the students participate and improve their scientific literacy and understanding of science concepts? At the same time, were literacy skills improved? Was it an activity that could be reasonably implemented into an already packed curriculum with limited support and professional development on how to do so? As Mr. Silas’ story continues, we will explore these thoughts further.

**Inertia, That’s Newton’s First Law!**

Mr. Silas unequivocally felt that reading *Ender’s Game* helped improve and advance scientific literacy in his physical science students. The main reason for this belief was that the students could refer back to scientific concepts in the novel when they were discussed in the actual physical science lesson and vice versa. As illustrated in his story (lines 1-25, p. 185-186), the physical science topics that were the most relevant during the novel implementation consisted of Newton’s Laws of Motion, inertia, speed, velocity, and acceleration. Mr. Silas felt that the novel was most helpful in promoting scientific literacy when these same concepts were being covered in the lessons as opposed to when the lessons involved electricity and magnetism. As previously discussed, student responses to the final survey also revealed an increase in scientific literacy. Mr. Silas and I both felt this was encouraging. Students remembering and comprehending these somewhat difficult physical science vocabulary words and concepts were definitely a positive outcome of the *Ender’s Game* implementation.

1. Several of them [students] mentioned inertia. They mentioned space, but for the most part it was gravity and inertia. That’s the biggest thing they said it related to and of course if these kids, if they can remember gravity and can remember inertia that’s…. Some of them even refer to Newton’s Laws of Motion so that’s what I got from the surveys. Several times during lessons, I wouldn’t even have to bring it in, they would bring it in, “Oh, that’s like that time this happened.”
7. There for about two lessons, we were really laws of motion, inertia, speed, velocity, acceleration, after that we got into electricity and magnetism where it didn’t have as much to do with, but I did see the kids bring that up in discussion during my lesson. Just them referring back to, even if it’s not knowing every word per se, but just them chiming in about zero gravity. Inertia was a big one, just them being able to remember talking about it in class. Just them saying, “Hey, that inertia, that’s Newton’s First Law.” Yea, it is! You know…Bingo! When they’re talking about gravity, when the guy threw up in the bag, they’re like “Close the bag, close the bag!” They knew that zero gravity was from them being in free fall. Just them knowing that, I was amazed by that because they’re always amazed with free fall-taking two objects and dropping them at the same time and having them fall at the same rate. I mean, that’s just amazing that they could put those two things together; just getting them out of “you just don’t read in reading class.” You know science can have its reading, you can read in science. It’s not just you putting notes up here on the board and reading what inertia is and gravity is. It’s seeing it in a movie, it’s seeing it on Youtube, it’s seeing it in a book because they have to be able to take that battle scene and, you know, it’s just so much better if they can see it, but they’ve got to be able to read it too.

Before Mr. Silas ever began the Ender’s Game project, we discussed his view of scientific literacy, which centered more around Roberts’ (2007) Vision I idea of learning science facts and Norris and Phillips’ (2003) concept of derived scientific literacy. Teaching science through the storied format of the novel, however, aligned more closely with Roberts’ (2007) Vision II idea, and including reading and writing in science embraced more fundamental scientific literacy (Norris & Phillips, 2003). Mr. Silas changed his opinion quite a bit about how to best pursue scientific literacy and teach science for optimal science learning. In lines 20-25 on page 186, he mentioned moving away from the more traditionalist approach of lecture and talking TO students about science to providing opportunities for students to experience science in varied formats (Holbrook & Rannikmae, 2007; Lemke, 2004; Norris & Phillips, 2003; van Eijck & Roth, 2010). Although these various pedagogical practices and philosophies constitute many of the educational and science discourses relayed in Chapter II, Mr. Silas was not necessarily adjusting his pedagogical practices based on these discourses. He wanted to try out using the novel for purposes of addressing the CCRS content literacy standards, but the change
in his personal Discourse (Gee, 2005, 2012) about how to teach science and promote scientific literacy came from witnessing his students learn the science vocabulary words, discuss the concepts in class using science language, and connect the science to real world examples. In this case, *Ender’s Game* was true to many of the reasons cited as why to utilize a science fiction novel in the science classroom such as a prompt for ethical discussions (Gallo, 2007; Groenke & Scherff, 2010; Zigo & Moore, 2004); a way to imagine future scientific and technological advances (Czerneda, 1999; Gallo, 2007; Raham, 2004); connections to other content areas and disciplines of science (Bixler, 2007; Kilby-Goodwin, 2010; Raham, 2004); incorporation of science concepts without the confusing technical vocabulary (Smolkin & Donovan, 2004); and authentic examples of science and technology (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010; Singh, 2014). Yet, probably the most important and beneficial reasons to this study were that utilizing *Ender’s Game* incorporated literacy into the science classroom (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010) and promoted scientific literacy (Czerneda, 1999; Fang & Wei, 2010; Norman, 1998; Wellington & Osborne, 2001).

**Additional Classroom Literacy Insights**

As explored in “Classroom Literacy Insights” before implementation of the novel, Mr. Silas once again shared stories around two differing themes in regard to his literacy insights after implementation of the novel. Again, these themes consisted of issues related to the struggles of his students with reading and writing, and the other involved a more in-depth explanation about one of Mr. Silas’ favorite literacy strategies, the chapter preview form (Figure 3). Before the implementation of the novel, he shared his “literacy insights” about the struggles that some students seemed to have with completing essay questions and other literacy activities. He also discussed reading and writing activities he incorporated prior to this project. However, this time
Mr. Silas specified that the students not wanting to write was the problem instead of students not reading the questions as he relayed in the narrative prior to implementation. He also felt the abundance of, and emphasis on, standardized testing affected the writing skills of students. Additionally, he added that with the ease of access to technology such as computers and cell phones, students were just not as interested in sitting and reading a hard copy novel.

Other issues that Mr. Silas felt affected some of his students in regard to literacy were their home lives, learning challenges, and English language learning. Mr. Silas allowed the students to read for fifteen minutes every day during the first part of the class. He surmised in lines 1-27 (p. 188-189) that if he did not allow the fifteen minutes of reading time in class, that the students would not do it at home. As was discussed in “Student Stories After Implementation,” many of Mr. Silas’ students struggled with the academic Discourse (Gee, 2012) needed for motivation and successful completion of assignments out of the classroom.

1. You know on my tests, if it’s not a multiple choice question, they [students] don’t want to answer it. It don’t matter if they miss it. If I make an essay question worth ten points and all the other ones worth two, they still don’t answer it. They just don’t want to write. I mean, I say they as a broad term. You’re going to have some that do. It’s like with any homework nowadays with kids like this, if it’s not done at school, it’s not done. Some of these kids are struggling to have electricity. Some of them are struggling to eat. Some of them, their only meals are at school. So just, you know, getting them to do it at home is a challenge because they don’t have parents that are pushing, “Hey, you need to get that read tonight.” You know, their parents may not even be at home. They may live with grandparents. I mean, that’s not an excuse for them because they need to be able to overcome that but, I think assigning it at home… Now if you’re doing it with an AP class, they’ll do whatever you tell them to do. They’ll read as much as you want them to read. A lot of these, they don’t understand, they don’t comprehend what they are reading. They’re reading comprehension is…even though to me it’s an easy read, to a lot of them… like you’ll watch them and I mean, they’ll read. Like the kid I had right here [points to a desk where a student was sitting in the class I observed], the deaf kid. He would read it, but his aide says he can read the words but he has no idea what they mean. And you know a lot of kids here are Mexican or Latino, and they’re English comprehension is not where it should be and they’re trying to read it. These kids have been molded in that they have facts on a board, they have facts in a book, and on their
test, they present those facts. It’s not about learning from reading, it’s taking this, this, this, and this and putting it on this, this, this, this test, because all that matter now are tests. I don’t like that but that’s just the way…. I wish we would get away from that. It’s about college and career ready, but let’s base it on the ACT.

Mr. Silas continued with how many of his students struggled immensely with reading comprehension, and even when reading the novel, they could not comprehend or understand what they were reading (lines 14-21). Since physical science is a non-advanced class, Mr. Silas had most of the inclusion students and English language learners (ELL) in his course. The student population that Mr. Silas was responsible for teaching contributed greatly to the whirlwind of his situation. As discussed previously, not only was learning science, especially because of the technical language (Chinn, 2012; Fang, 2004; Fang & Wei, 2010; Jetton & Lee, 2012a; Shanahan, 2012; Wellington & Osborne, 2001), extremely difficult for these students, Mr. Silas also had to address their literacy development. He had to take on this task with limited literacy training in college or professional development and with little to no support from English/literacy teachers, reading coaches, or special education teachers. Mr. Silas’ situated cognition in his classroom required him to learn as an apprentice “reading/English teacher” trying out strategies on his own to see what was most successful for his students (Brickhouse, 2001; Brown et al., 1989; Kim & Hannafin, 2008; Lave & Wenger, 1991; Núñez et al., 1999).

Mr. Silas expanded more (lines 1-11, p. 190) on the chapter preview form (see Figure 3), which he had briefly mentioned previously. Mr. Silas used this form for vocabulary and textbook work. Although textbooks are notoriously criticized for their reading difficulty (Fang, 2012b; Jetton & Lee, 2012a; Olson & Mokhtari, 2010; Wellington & Osborne, 2001) and overutilization in the classroom (Greenleaf et al., 2011; Jetton & Lee, 2012a; Llewellyn, 2013) their use as a classroom resource is still viable (Shanahan, 2012). The chapter preview form was a useful strategy to guide students through the process of using the textbook without simply
assigning “read the chapter and answer the questions at the end.” In his story, Mr. Silas explained that he utilized the chapter preview form because it served as a reading guide to help students explore all of the information in the textbook chapters (pictures, charts, headings, etc.) as well as provided an opportunity for his students to write (lines 1-6, p. 190). Although Mr. Silas had limited training and professional development regarding content literacy, he was still cognizant that his students struggled in reading and writing and needed opportunities embedded into his physical science curriculum to develop their skills.

1. What I do for vocabulary, it’s called a chapter preview. They’ll preview each section in the chapter, and they’ll take all the vocabulary terms and they’ll write the vocabulary out for those. Then I’ll make them ask a question from the title of the chapter, ask a question from that title. You know, it could be Matter-What is matter? Give me the definition of it. Then they’ll have to write, I make them write a lot, a lot. And it’s just from the textbook. They’re not just “read chapter 1 and answer these questions.” This is like that-read chapter title, convert it to a question. You know, read the chapter summary. I don’t have them read the chapter, I have them read the chapter summary, read the questions. It’s not just read this and that. I’ll make them look at the pictures and they’ll have to write something about the picture.

In this final section that explored Mr. Silas’ insights into literacy, most of his acumen remained the same after implementation as it was before. Mr. Silas was aware of many of the impediments that his students faced before they ever entered his classroom, and that these obstacles would essentially affect their learning and motivation. Again, these insights into his students’ struggles with reading comprehension and differing home and academic Discourses (Gee, 2012), influenced him to implement the activities surrounding the Ender’s Game project in the most beneficial way for his students. Consequently, in regard to his experience with utilizing the novel and the situated reality of his classroom of learners, he developed a plan that allowed for reading, writing, and discussion time within the classroom instead of assigning large amounts of reading or other assignments to be done at home. Even before utilizing the novel, Mr. Silas was already conscious of the issues of his students with reading comprehension, thus employing
strategies such as the chapter preview form. Accordingly, Mr. Silas’ situated cognition was affected by many factors including the pressure to successfully address the CCRS content literacy standards, promote scientific literacy, prepare students to do well on the ACT, successfully coach softball and cross country, and incorporate a variety of teaching methods; yet, the unique characteristics of his students also became an important influential factor. All of those other factors had to be addressed in a way that his students could be successful, thus validating how Mr. Silas’ students were so very important to his experience and his story.

Non-Threatening Literacy Activities Revisited

While discussing the results of the final Ender’s Game survey, Mr. Silas once again brought up what I refer to as non-threatening literacy activities (NTLAs). As mentioned previously, NTLAs are those literacy activities that require reading and writing, but are more familiar to students because they are common in their everyday lives and/or are more informal than other literacy activities. NTLAs also reduce the stress and anxiety that some students feel when faced with traditional school writing and reading assignments. Mr. Silas pointed out (lines 1-11, p. 192) that many of the students wrote more on the tweet sheets than they did on the survey questions. He attributed this to the fact that “tweets” were seen as informal and something students related to better than the open-ended survey questions. Throughout the novel implementation, Mr. Silas advocated for the use of these NTLAs because they were authentic modes of communication for his students, and they did not have the formal academic Discourse (Gee, 2012) attached to them like other, more formal assignments. Although formal reading and writing experiences seemed to be valued by Mr. Silas, the NTLAs provided a way to discover students’ thoughts, feelings, and questions related to the novel without the added pressure and judgment.
1. If you give them that, you know, a tweet is a 140 characters, they know if I don’t have to write as much, they usually write more. If I’d just say “ok, you can’t go over this amount of words,” it’s almost like they’ll go to that point. It’s like, you know, “don’t chew gum in class,” you’re going to want to chew gum. “Don’t go over this,” they’re going to go over this, it’s weird. But if you say “write me two sentences,” they ain’t going to write you two sentences, they ain’t going to write two sentences. Just by putting quotations around “tweet,” you know, that’s not “essay,” that’s not “multiple choice.” It’s something that they’re relating to. You know as well as I do, they’re going to text before they’re going to make a phone call because that’s their mode of communication. And I think doing like that, they can express what they want to say more.

As previously discussed, the use of information and communication technologies such as Twitter in the classroom is supported by much research (King-Sears et al., 2011; Sweeney, 2010; Wendt, 2013). Many of these ICTs are also considered to be NTLAs because of their authentic and informal nature. In addition, these NTLAs allow students to practice with informal science language (Hand et al., 2003) within the context of their real life (Baker et al., 2009; Gee, 2004), both of which are significant to science learning and scientific literacy. Once the understanding of the concept has occurred, the science teacher can facilitate the progress toward more formal use of science language.

Mr. Silas also incorporated other NTLAs not related to the Ender’s Game novel implementation into his lessons. One such example was the previously discussed chapter preview form (see Figure 3) that he utilized with each textbook chapter. This activity was considered an NTLA because the students were not required to strictly read the textbook sections, but instead concentrate on the chapter titles, headings, and subheadings as well as the chapter summaries and illustrations. With so many problems related to textbooks cited in the research (Holliday, 2004; Llewellyn, 2013; Olson & Mokhtari, 2010; Rutherford, 2005; Shanahan, 2004; Wellington & Osborne; Yager, 2004b), breaking down the information and eliminating the more formal element of “read chapter 1, 2, 3, etc.” by using the chapter preview form seemed to be a helpful strategy for Mr. Silas’s students.
The incorporation of NTLAs into the *Ender’s Game* project was an important discovery in Mr. Silas’ experience with utilizing the science fiction novel. As discussed in earlier sections, the physical science students that Mr. Silas taught faced a multitude of obstacles such as language barriers, cultural and socio-economic factors, and learning disabilities before they ever entered his classroom. Consequently, Mr. Silas felt that creating assignments that were less formal academically and more in tune with their home Discourses and “real” life would support his students in overcoming some of those obstacles and provide them with a rich experience exploring literacy and science simultaneously. As illustrated in the narrative above, NTLAs seemed to work, at least for some of his students. According to Mr. Silas, simply calling a writing activity a tweet instead of an essay (lines 7-11, p. 192) allowed the students to express their thoughts more fully through writing because it was the type of communication they used outside of the classroom. This is yet another example of how Mr. Silas made pedagogical decisions based on his student population. His situated cognition as a teacher utilizing a science fiction novel in his classroom positioned him as both the teacher of science and literacy and also the learner of how to best incorporate the novel into his curriculum to address both science and literacy. After delving into Mr. Silas’ experience through this process, I would argue that he was also a learner in regard to his students. He had to consider their unique needs and abilities throughout this process, which ultimately affected his pedagogical decisions, his beliefs, and his overall personal Discourse.

**Novel Implementation Preparation Time**

Throughout Mr. Silas’ story, the whirlwind of issues he handled on a daily basis is well documented. Although the different concerns that create the swirling winds in each teacher’s situation are unique, there is a commonality in that all teachers have to experience them.
Because of this, I felt it was important to learn how much additional time was spent on implementing the full *Ender’s Game* project into his classroom. Much research attributes time limitations as the major factor for why teachers inadequately incorporate literacy into their curriculum (Fang & Wei, 2010; Llewellyn, 2013; Turk et al., 2007). These time constraints can be caused by the large amount of content that must be covered, having to prepare students for standardized testing, or increased planning time to add reading and writing activities. In addition, teachers must address the state or national standards, in this case the CCRS content literacy standards, when planning their lessons (Jetton & Lee, 2012a). As illustrated in his response (lines 1-13, p. 194), Mr. Silas shared that most of his issues involved the planning and preparation time with adding new literacy activities to his curriculum and the documentation required on the school’s lesson plans related to the CCRS content literacy standards, referring to the process as “hell.” However, as Mr. Silas mentioned, the second semester was more manageable because many of the lesson plans could be transferred and reused, reducing the amount of planning time.

1. I was probably reading these and doing the bookmarks, not counting reading the novel, it’s probably an hour a week. I would say just spending on this. As far as reading the novel, I mean, I can read a book over a weekend. I read it three times actually. I read it three different times. I mean whenever they would read it in class, I would read it in class with them. You know, because I was reading it for three classes, 15 minutes so I got it done quick. Then actually whenever I went to tournaments and stuff, I would take it and read too because I wanted to be able to discuss it and stuff with them. As far as extra time, it wasn’t nothing…I mean, I could handle it coaching softball. It wasn’t anything hard to handle. This stuff is great and this semester was a lot better. Now last semester was hell.

2. This semester I just took a lot of the lesson plans that I did last year and transferred them over here, didn’t have to type as much. I could just transfer and do the same thing, just tweak it a little bit. I mean last semester was awful.

In this narrative, Mr. Silas affirmed the viability of the *Ender’s Game* project from a planning perspective. This finding is significant to his overall experience because most teachers will be searching for activities and strategies that easily fit into their existing curriculum,
especially when there is a lack of support or professional development for these new approaches as in the case of Mr. Silas. Throughout his story, we have seen the many vortices that come together to create the whirlwind that Mr. Silas had to navigate daily in order to do his job and be the most effective teacher possible. Therefore, adding a major project that required extensive planning and reorganization of his curriculum would not have been a feasible undertaking even though addressing the literacy standards was a directive he had to follow in order to keep his job and comply with state mandates. Mr. Silas admitted to struggling with the implementation of the CCRS content literacy standards, but through his learner identity and willingness to try out new methods and strategies, he became more comfortable with addressing literacy each semester.

**Pedagogical Influences of the CCRS Discourse**

There is a vast amount of commentary about both the negative and positive aspects of the CCRS as well as the Common Core Standards, much of which focuses on how they influence the education of students (Conley, 2011; Haycock, 2010; Ivey, 2011; Porter et al., 2011; *Raising Expectations*, 2011; Robelen, 2012; Rothman, 2012; Tienken, 2012). There are also many issues related to these standards that directly affect the classroom teacher and influence his or her pedagogical practices. Mr. Silas and I were able to explore a few of these issues during our conversations. As described in lines 1-37 on pages 196-197, when I inquired about how Mr. Silas felt teaching had changed with the adoption of the CCRS, he stated that the science content did not change with the new standards, it was still facts and laws, but the goal now is to present the content more authentically and relate it to students’ real lives (lines 1-3, p. 196-197). In addition, he affirmed that he would have focused his teaching more on the facts and content of science with less integration of reading and writing if the content literacy standards were not implemented.
As previously discussed, another influence of CCRS on pedagogy was the increased planning time caused by the additional documentation of the literacy standards, along with the Alabama Course of Study Standards (ACOS) in science. Before Mr. Silas fully implemented the *Ender’s Game* project, he described his frustration with the additional documentation on daily lesson plans. As seen below, this continued to be a source of frustration for Mr. Silas even after the project was concluded. Furthermore, Mr. Silas lamented about the tediousness of documenting three different standards on one daily lesson plans and considered it “covering yourself” instead of something necessary for quality lessons (lines 13-21, p. 196-197). Since Mr. Silas had the added duties of coaching, it made daily lesson planning even more stressful and overwhelming.

1. Well, I mean science, there’s no real interpretation to it, it is facts. It’s this causes
2. this causes this, I mean it’s laws. You know, you can still do a lot of the same
3. material but you’ve got to present it a lot different way. You know, there’s a
4. whole lot of, I’m going to get myself in trouble, but there’s a lot of wasted time
5. writing these standards down. Putting them in my lesson plans and finding what
6. standard goes where and how do I incorporate this reading into that standard.
7. There’s a lot less time spent on content. You know, 80% of my lesson planning
8. now is planning for those standards. Twenty percent of my time is teaching them
9. about gravity or teaching them about atoms, and it’s just tough. And then
10. whenever I get my lessons, 80% is on content and 20% is on…. It’s what I plan
11. for with all these standards, I don’t end up doing that much in class. I hate to say
12. that but, it’s just hard for me to go from preparing them for knowing the content
13. and putting it on a test to having all these standards now. It’s added a lot more,
14. it’s a lot more planning time. Golly, I don’t want to say useless stuff, a lot of it I
15. see as useless. It’s CYA is what it is, that’s what I call it-CYA. Just what they
16. want us to put in our lesson plans here, I mean, you’ve got your writing
17. standards, you’ve got to put 1-C; your reading standards-this is number 7. Then
18. on top of that, I’ve got to put my Alabama Course of Study, so that’s 3 different
19. things I have to have in every lesson plan. I mean, what writing standard do I
20. have? What reading standard? And I am supposed to be doing that every single
21. day, every single lesson I have, it’s incorporating reading into science. I mean,
22. this [Ender’s Game project] has obviously helped me with that. Then I have to
23. teach the Alabama course of study, you know there’s 15 of those in physical
24. science, so I’ve got to try to get those in somewhere. Now this stuff, I’ve learned
25. is really good. It’s just me because I coach, I don’t have that planning period. So
26. some part of my day has to prepare for all these standards and putting them in a
Mr. Silas’ shared experiences and feelings of adjusting to these additional standards are reminiscent of what I felt as a new teacher trying to survive the first year. Even though Mr. Silas was a seasoned teacher, he was struggling with addressing these new standards on a daily basis as if he was new to the profession. The pedagogical adjustments caused by the CCRS added more complexity to the whirlwind already being navigated by Mr. Silas, creating a situation where he felt completing paperwork was more important than actually teaching the students. Thus, Mr. Silas had to not only manage the time constraints caused by the addition of daily literacy standards with his science standards, but also the extra time requirement for lesson planning. Although he felt that it was unnecessary busy work, the educational directive to address the CCRS content literacy standards was a major influence on his lesson planning (Jetton & Lee, 2012a). Furthermore, implementing a variety of disciplinary literacy strategies, a variety of texts, and opportunities for social interaction also had to be considered during planning lessons (Jetton & Lee, 2012a). As mentioned previously, as well as in the account above, the *Ender’s Game* project fulfilled those aspects, but it only lasted for a few weeks within the semester. Consequently, Mr. Silas had to seek out other ways to address literacy on his own during the remainder of the school year.
Another facet of Mr. Silas’ experience with utilizing *Ender’s Game* is implied within this narrative in lines 7-13 on page 196. Mr. Silas subtly revealed his two identities as he prepared lessons in that his science teacher persona was being challenged to address literacy now. The disconnect between Mr. Silas’ science teacher identity and English teacher identity has already been discussed and was something that I noticed during my classroom observations. Yet, here in these few words, Mr. Silas is acknowledging this for himself, even though he may not even be aware. In his situated cognition, he has had to leave his comfort zone as a science teacher teaching hard science facts for standardized tests to incorporating more literacy strategies and activities, which caused him anxiety and frustration. Additionally, Mr. Silas must contend with his coaching identity as well, which eliminates much of his planning and reflection time. Even though Mr. Silas, along with many other Alabama teachers, was suddenly inundated with the CCRS content literacy standards, he felt more confident and comfortable with incorporating literacy into science once this project and this first year of the literacy standards was complete. He even expressed that he would continue to incorporate more reading and writing into his lessons, even if the standards were one day renounced.

**Reflections of the Multiple Vortices**

I previously discussed the multiple whirlwind vortices that rival the focus of the classroom teacher from his primary responsibility of teaching the students in his class. In my observations, the vortex with the “strongest wind” appeared to be the coaching duties of Mr. Silas. In the following conversation (lines 1-6, p. 199), I asked Mr. Silas to reflect on how his coaching duties as well as the other previously identified vortices affected the *Ender’s Game* project. From his account, not only were the students’ routines interrupted, but Mr. Silas’
routine was affected as well. Since he was inundated with coaching duties during the Fridays he missed school, he had to find time to catch up with his responsibilities.

1. I think me having the Regional tournament on Friday, changing it to the next Tuesday or to the next Wednesday, it threw them out of their…. I mean, the tweets weren’t turned in as much. The bookmarks weren’t turned in as much toward the end of the year. I left it with my sub. Then what they’d do was stack it right there and I would come in, and I would take my stack. Oh gosh, I spent a good two solid days trying to catch up.

Another issue related to Mr. Silas’ coaching duties was revealed during our conversation.

He expressed difficulty in finding time to plan and prepare lesson plans with the required additional documentation and incorporation of the CCRS content literacy standards along with the ACOS science standards. This added documentation was previously discussed as a pedagogical influence caused by the CCRS. In this situation, it also became one of the multiple vortices that removed the focal point from the learning environment. Mr. Silas admitted that occasionally he must work on lesson plans instead of teaching students. He rationalized this diversion from his mission of teaching because he does not have a true planning period or time after school due to his coaching duties. Mr. Silas shared, “When schools out, I’ve got to go to practice and after that, I mean, I would like to see may family some.” After my observations and Mr. Silas’ own reflections, it was apparent that his coaching duties were a very strong whirlwind in their own respect.

In response to the multiple vortices of the whirlwind of Mr. Silas’ situated reality, he seemed to portray three differing identities (Gee, 2005, 2012): science teacher, English/literacy teacher, and coach. Depending on the context of the situation and the impending responsibilities, he would adjust his “social language” and his Discourse (Gee, 2004, 2005, 2012), thus changing from one identity to another, with some melding at times. The transitions among these various representations of Mr. Silas are important to his experience with implementing *Ender’s Game*
into his secondary classroom because most secondary teachers must take on a variety of different identities throughout the day as well. More often than not, secondary teachers will be involved with some type of extracurricular activity that will take at least some of their focus away from teaching duties. Furthermore, as in Mr. Silas’ case, incorporating new strategies and activities may require even seasoned teachers to become both the master and the apprentice (Lave & Wenger, 1991) within the classroom. The previous narrative described how his coaching identity many times dominated over his teaching identities out of necessity of the situation: he had to go to the state tournament, he had no planning time due to practice, etc. In the previous discussion about his multiple vortices, the issue focused more on the interruption of instructional time due to coaching duties. In this final reflection, Mr. Silas affirmed that missing the instructional days due to coaching affected the students’ participation and experience with the *Ender’s Game* project.

**Revisions for Subsequent Novel Implementations**

In order to provide the best possible learning experience for students, every teacher should be a reflective practitioner willing to amend each method, lesson, activity or strategy when needed. Thus, I felt it meaningful to Mr. Silas’ experience with implementing the *Ender’s Game* project as well as his situated cognition in the classroom to explore his feelings of what could or should be revised with the project to make it more successful with future endeavors. Mr. Silas discussed several possible revisions in lines 1-30 on pages 200-201 that he would like to enact with the project. These included providing access to the novel via technology, adjusting the in-class reading time, shortening the length of time for the project, changing the time of the semester for the project, and adding more formal assessments.

1. It’s hard to take a book in your hand and compare it to a computer or phone they can read. I think it would be a good idea to have it on an electronic device. I
think a better way that I would do it for me is making it an assignment when your
classwork is over. Instead of doing it at the first, because I had some of them
that would be upset when I did have to stop them. They would try to keep
reading while I was teaching. I think if we did my lesson, I’d say just after my
lesson-50 minutes or whatever it is-then once their work’s done, fill in the rest of
the period with a reading time. Like I said, they’d have their laptops, but you
don’t have to keep up with the book. It’s right there-click, click-and they can
read. Now say that week, I give them 3 chapters whenever they have time to do
it, those 3 chapters are due then. So it’s not 15 chapters over 8, 9 weeks or
whatever it was, it’s 15 chapters over half the time. It was too extended.

I definitely think it needs to be done before spring break. After spring break, the
weather starts getting warmer, they start slacking off. If you look at a lot of these
[referring to tweet sheets], several of them start…. I mean look at that guy. He
did the first two and then after that didn’t want to do anymore. I think something
else, if I were to keep doing this or keep using this, is throw some kind of testing
in there to reinforce that they are reading it. Because with this here [tweets &
bookmarks], you know, it was graded but, like I said, they could take that and just
write something on it just to get a grade. I think the biggest thing is that the
timing of the year that I do. I think I did it at the wrong time. It shouldn’t have
been toward the end of school. I mean, in physical science, they like us doing
the chemistry first, physics second. I wish I could flip it to where I could do the
physics first and chemistry second. Do this at the start of the year when they’re
fresh, you know they’re all about doing what they are supposed to do because
they slack off. Some teachers slack off toward the end and everybody slacks off.
You get tired. I mean that’s the way it is. That’s something that I would do
differently is the time of year that I would do it. Like I said before, I think it took
too long, took too long to do. I would find some way to shorten it up and some
way to assess it a little more.

The revisions that Mr. Silas suggested above considered the characteristics of his unique
student population as well as his personal Discourse (Gee, 2005, 2012) in regard to teaching
science and literacy. For instance, he discussed having the book available digitally instead of as
a hard copy (lines 1-2, 8-9, p. 200-201). This reinforced how Mr. Silas sought to incorporate
non-threatening literacy activities (NTLAs) into this project. Today’s students are more used to
and familiar with reading text on computers, iPads, or phones so Mr. Silas implied that the hard
copy novel that was provided to students to read seemed antiquated and obsolete to them, and
that more students would have possibly read the novel if it were on a digital device (Hinchmann
et al., 2003; Wendt, 2013). Even modern interpretations of scientific literacy consider the
technologically-advanced world in which students reside (Achieve, 2010; Holbrook & Rannikmae, 2007; Kim, 2005). Fortunately for the students of Eagle High School, this could be a real possibility as they will all be receiving Mac books during the next school year.

Another procedural revision that Mr. Silas admitted he would like to make was to add some type of formal assessment to the project that would reinforce that the students are actually reading the novel (lines 16-20, p. 201). Through our conversations and reflections on the project, Mr. Silas realized that students could just quickly write down tweets and something on the bookmarks without necessarily reading the assigned chapters. Although he valued the non-threatening aspect of the project, he felt he needed to add some type of formal assessment to emphasize full student participation. I shared with Mr. Silas the comprehension quizzes and essay test that I used with my classes when I implemented Ender’s Game in case he wanted to use something similar next time.

Other revisions Mr. Silas discussed involved the procedures he had established for incorporating the reading time into the daily lesson (lines 3-8, p. 201), the length from start to end of the project (lines 10-12, 28-29, p. 201), and when the project would actually take place (lines 13-28, p. 201). Again, Mr. Silas recognized some of the issues that could be adjusted in order to provide an improved learning experience for his students as well as a more efficient and rich teaching experience for him. Although most of these revisions could easily be made, one issue that Mr. Silas shared with the timing of the novel implementation involved how the physical science course itself was arranged. According to Mr. Silas, the novel would be more effective if it were read during the same time that the corresponding physical science concepts were being taught in class, and these were covered the second half of the semester. This timing issue was characteristic of problems that can occur with implementing student-centered, literacy
activities such as the *Ender’s Game* project in secondary classrooms where school curriculum and school culture dictate many of the pedagogical decisions (O’Brien et al., 1995). He also shared that requiring the novel for a summer reading list would allow him to implement the novel during the appropriate section of physical science and help keep the project from being so drawn out. With *Ender’s Game* added to a summer reading list, there would be an expectation that the students would have already read it so regular reading time in class could be reduced or eliminated. The summer reading requirement, however, might be problematic for some of the marginalized students that Mr. Silas taught because they would possibly not have the parental support, academic Discourse (Gee, 2012), or motivation to complete the reading.

**The Calm After the Storm: Mr. Silas’ Feelings After Implementation of *Ender’s Game***

After the *Ender’s Game* project had been fully implemented, completed, and student surveys analyzed—once the calm after the storm arrived, I once again inquired about how Mr. Silas felt about utilizing this science fiction novel in his physical science classes. Overall, he felt that using *Ender’s Game* did fulfill the requirements of the CCRS content literacy standards by allowing him an avenue to incorporate new and different reading and writing opportunities into his classes. Mr. Silas also believed that implementing the project helped his students understand the physical science concepts contained within the plot of *Ender’s Game*, which is a beneficial characteristic of science fiction novels (Raham, 2004; Singh, 2014; Smolkin & Donovan, 2004). He did not formally assess students on these objectives (lines 1-10, p. 204), but through informal assessments such as the survey and class discussions, felt they had improved their content knowledge. Mr. Silas stated that he would like to continue using novels in his physical science classes and would even like to incorporate one that covered other physical science concepts such as chemistry. Furthermore, in addition to addressing the CCRS content literacy standards and
promoting scientific literacy, implementing the *Ender’s Game* project revealed the students’ feelings and attitudes toward reading. He continued that some students really enjoyed reading the book from day one and some did not, but generally his students struggled with “learning from reading” because they have been so accustomed to learning facts for standardized tests.

1. If I found a really good book that would go along with chemistry, I would definitely use it. I mean, this has helped me learn a lot about the kids. It’s helped me learn a lot about how they see reading. You know some of them from day one, “I do not want to read this, I don’t like reading, I hate this.” Then some of them are opposite and that’s every kid, everybody learns a different way. That’s the thing is that I didn’t test them, but you can see from the material right here, even if they were writing it straight out of the book at least they got something from it. Just that they could say during a lesson, “hey, that’s what happened in the book.”
2. Just that they could remember that and refer that to the book shows you that they’ve learned something.

Before implementing the *Ender’s Game* project, Mr. Silas admitted that he was somewhat apprehensive about incorporating the reading of a novel and the corresponding literacy strategies into his class. After the implementation, I brought this topic back up. Mr. Silas shared he felt that he took on the role of what an English teacher would normally do in the classroom. He also shared in lines 1-8 on page 205 that he did not feel prepared or trained to address literacy in science to the extent required by the CCRS content literacy standards, nor did he fully comprehend the terminology and language used within the CCRS content literacy standards. I shared with Mr. Silas that I felt the same way when I incorporated *Ender’s Game* into my physical science class and did seek out the assistance of an English teacher colleague.

The Alabama State Department of Education now offers a three-day workshop on the Alabama Reading Initiative (ARI) that provides guidance and strategies on incorporating literacy into secondary content classes. However, as previously mentioned, Mr. Silas stated that he had not had this training. Furthermore, is three days enough time to prepare teachers trained in teaching a specific content (science, math, history, etc.) how to address literacy issues that even seasoned
English teachers struggle? Also, if Mr. Silas did not really understand what he was supposed to address from the content literacy standards because of the unfamiliar terminology, would providing a variety of literacy strategies be sufficient?

1. I use those [strategies] in science, but with the reading I need to know how to do that. I mean, I’m illiterate in knowing how to put literacy strategies into science. I said illiterate, but I need to learn a lot more about that. I don’t understand the English terminology, and I do not know how to grade according to the English terminology. Myself and other science teachers are confused on what we are supposed to be assessing. There are too many headings to these standards and sub-headings under them. Everything is so clumped together that it is hard to make sense of these standards.

Mr. Silas’ feelings about addressing literacy in his science class revealed his situated cognition of both teacher and learner. Due to the state mandate to implement the CCRS content literacy standards, Mr. Silas had to quickly figure out the best way to do this, creating a new identity (Gee, 2005, 2012) than that of just a teacher of science content. In the essence of legitimate peripheral participation (Lave & Wenger, 1991), Mr. Silas was an apprentice English teacher actively participating in this role when implementing the Ender’s Game project.

Accordingly, through participation in this project, Mr. Silas developed his conceptual case knowledge of literacy strategies and reading in science so that he could demonstrate his strategic knowledge by incorporating other literacy activities and strategies into the science classroom in the future (Kim & Hannafin, 2008). Even though he learned through this process and stated in a later conversation that he felt more comfortable in trying to incorporate literacy in science now, this strategic knowledge was not gained through formal training or professional development.

Not only did Mr. Silas have to navigate the whirlwind of “normal” issues common to a classroom teacher (paperwork, lesson planning, classroom management, meetings, etc.), but he also had to learn within the context of his classroom, developing new behaviors of an
English/literacy teacher while also representing the identity of a science teacher (Brickhouse, 2001; Lave & Wenger, 1991; Núñez et al., 1999).

**Successful Motivation of ALL Students?**

As discussed previously, Mr. Silas was interested in exploring ways to increase the motivation of all of his students to learn and participate in the class activities, but he was especially interested in how to inspire and encourage those students that did not seem to be motivated by grades or anything else. When I questioned Mr. Silas about whether he felt that implementing the *Ender’s Game* project and providing a different teaching style from lecturing, taking notes, and repeating facts on a test had increased the motivation of these students, unfortunately, he did not feel it had. In lines 1-12 on page 206, Mr. Silas became very apologetic and seemed even a little ashamed that he had to share this story with me. I attempted to put him at ease by explaining that was why educators do research so we can hopefully find things that can help all students learn and be successful. He did mention that all of the students, even those unmotivated five, enjoyed and watched the movie. Mr. Silas continued that he felt the project extending so close to the end of the year also affected student motivation.

1. You’re going to have, like I said, about five out of every class that just do not want to do anything. They’ve got a thirty in the class, they’re just waiting until they’re seventeen so they can drop out of school. Trying to get them to interact by commenting on each other’s bookmarks and commenting on each other’s tweets, they just didn’t want to do it. All they want to do is stay on their phone, try to put their head phones in, and they don’t want any part of it. They just don’t want to interact with other kids, period. I mean, I can think in my head of the ones. I mean, I wish I could tell you that I found a way to do it but I don’t know. I’m sorry, I don’t know how… [nervous laughter]. I’ve got to find some way to motivate them to read it, but how else can you read a novel but just to sit down and read it. You can’t break it up, you just got to have the discipline just to sit and read it.

As relayed throughout Mr. Silas’ story, he expressed his eagerness to implement quality activities and strategies to address the CCRS content literacy standards, teach the required
science content, and encourage all of his students to participate and do their best in his class. Mr. Silas was by no means the stereotypical coach/teacher who was only concerned with his team and not his students. The fact that he wanted to even participate in this study and get out of his teaching comfort zone to try out this unique tool demonstrated his enthusiasm for teaching and motivating ALL students. Before I introduced *Ender’s Game* to Mr. Silas, he was already incorporating many pedagogical strategies and activities considered best practices for teaching science such as cooperative learning and group work (Hand et al., 1999; Llewellyn, 2005, 2013; Pratt & Pratt, 2004; Wellington & Osborne, 2001; Yore et al., 2003), technology based assignments (Alvermann, 2006; Holbrook & Rannikmae, 2007; King-Sears et al., 2011; Sweeny, 2010; Wendt, 2013), and inquiry labs (Llewellyn, 2005, 2013). As mentioned previously, this project allowed him to incorporate even more of these best practices by promoting a more constructivist classroom (Llewellyn, 2005, 2013; Yore et al., 2003), authentic connections (Hand et al., 1999; Hurd, 2000; Lemke, 2001; Yager, 2004b; Yore et al., 2003), and 21st century skills (King-Sears et al., 2011; Sweeny, 2010; Wendt, 2013). However, Mr. Silas was caught up in the dominant educational discourse as described by Sammel (2008). He was doing all the right things for the status quo: addressing the CCRS content literacy standards, creating an interactive, constructivist classroom, promoting scientific literacy and teaching science content so that all students would do well in his class and on standardized tests; yet, ALL students did not do well or participate. In the end, Mr. Silas was at a loss of how to motivate these last few students, other than they just had to be forced to do it. Nevertheless, it is my final summation that Mr. Silas did care for his students and this was an integral part of his teaching philosophy, Discourse, and identity of a teacher (Llewellyn, 2013; O’Connor, 2008).
The motivation of his students was a significant theme in Mr. Silas’ experience with utilizing *Ender’s Game* in his class. Throughout his story, we explored various facets and issues of what Mr. Silas went through, struggled with, and felt as he took this journey. However, in the end, no matter how awesome an activity, strategy, or method looks on paper or fits seamlessly into the already established curriculum, if the students are not learning, then it is of no use. Since Mr. Silas valued the participation of his students in the project and utilized activities and strategies to maximize this participation, his classroom became a community of practice within the context of legitimate peripheral participation (Lave & Wenger, 1991). I feel Mr. Silas genuinely attempted to create a learning curriculum as described by Lave and Wenger (1991) where the learners are considered an important part of the situated cognition of Mr. Silas as he apprenticed as an English/literacy teacher. Furthermore, even though Mr. Silas was disappointed that he could not motivate those “unmotivated five,” his stories throughout the project were mostly positive and demonstrated an overall successful experience for him and his students.

**Suggestions for Pre-Service Content Teachers in the Era of Common Core**

Throughout Mr. Silas’ experience with utilizing *Ender’s Game* in his physical science classes, it has been continuously noted of how he developed a new identity of an English/literacy teacher as he tried out this new approach. Since this unique experience provided him with a variety of insights into addressing the CCRS content literacy standards as a content teacher, I asked Mr. Silas if he had any thoughts or suggestions on how content teachers, specifically science teachers, could be trained or taught more effectively in the era of the Common Core Standards. Since the Alabama CCRS are basically the *Common Core State Standards* (see Chapter II), the same issues surrounding the CCRS are generalizable to teachers in other states. Mr. Silas suggested in lines 1-16 on pages 209-210 offering more and “different strategies to
incorporate reading” (line 1, page 209). Mr. Silas felt he was prepared to employ various strategies to teach science content, but was lacking in strategies to teach literacy. He also mentioned wanting to know more about literacy strategies to be used with groups (lines 2-3, p. 209). I shared with Mr. Silas a few of the strategies that I used in my class and obtained in some of my graduate work such as the literature circles (Daniels, 1994) and Hotseat. The incorporation of fiction novels and literature circles into the science curriculum is supported by Jewett (2013) as feasible English/language arts strategies that can easily be adjusted by science teachers. Mr. Silas expressed that obtaining more of these type strategies would be helpful in preparing literacy lessons.

1. They need to be taught different strategies to incorporate reading. You know, like those papers you gave me, the Hotseat. What I would like to have more training, and this is just me, is more of a group work strategy. I use those in science, but with the reading I need to know how to do that. I mean, I’m illiterate in knowing how to put literacy strategies into science. I said illiterate, but I need to learn a lot more about that. I’m not trained in this so I think if you took…you know how professional development is done now, it’s science, social studies. Make a science-English combo. Get English teachers and science teachers together and let an English teacher show science teachers, “Hey, this is the strategy that I use.” You know, just teach me something. Teach me how to do it. Don’t give me a folder with strategies in it. When I go to the AMSTI training over here, I mean, we had ten labs and we did the labs. You think I learned it better? Heck yeah, I learned it better. Give me an English teacher, you know, put me in a group and show me how to do these strategies. Don’t give me a notebook and say read this and use this. Show me how to use it. Like in class, don’t stand up and give a bunch of notes. Show me how to use it. Show me how this works.

Another suggestion Mr. Silas offered involved the way that these strategies should be taught through professional development. As seen above, Mr. Silas was not in favor of simply being given some generic strategies without further explanation or support. Mr. Silas also expressed training teachers through professional development sessions segregated by subject area (science, history, math, etc.) should be replaced with pairing a content area teacher and an English teacher mentor to help better understand how to use the literacy strategies (lines 6-11, p. 209).
209). Mr. Silas continued that teachers needed more than the strategies simply given to them, but needed the strategies modeled. The approach of content area teachers collaborating with literacy/English teachers in order to examine literacy strategies is also supported by research as a valid and superior procedure than just handing generic literacy strategies to content teachers to figure out on their own (Brozo et al., 2013; Fang, 2012b). If content teachers have literacy strategies modeled for them and are given opportunities to discuss the best use of the literacy strategies with other teachers of the same content, they should be able, as discussed by Adams and Pegg (2012), to modify the literacy strategies to work best in their specific classroom, with their specific students, and with their specific content to optimize learning. However, Shanahan (2012) cautioned about the literacy strategies being demonstrated by literacy teachers with insufficient science content knowledge.

Mr. Silas offered some very valid suggestions, some of which have been partially addressed through the provision of ARI training. Yet, the question continues to be is three days of training on literacy strategies adequate enough to prepare non-English content area teachers to address literacy in their classes to the extent required by the CCRS content literacy standards? Furthermore, Mr. Silas was in the same situation as many teachers across Alabama as well as other states that had never had the opportunity to attend ARI training and whose teacher certification program offered very few disciplinary literacy courses; science content was taught separately from pedagogy (Conley, 2012). As can be seen from Mr. Silas’ suggestions, in order for science teachers as well as other content area teachers to truly embrace the CCRS content literacy standards and develop the knowledge base to incorporate a variety of reading and writing activities and the appropriate literacy strategies, there will have to be a major re-evaluation and
Final Reflection

The experience of Mr. Silas as he utilized Ender’s Game within his physical science classroom was shaped by a variety of feelings, uncertainties, successes, and even failures as revealed through his story. The whirlwind that he had to navigate daily presented itself as even more turbulent at times than originally anticipated. Throughout this process, Mr. Silas developed three significant identities that became crucial characters in the story of his experience: the science teacher, the English/literacy teacher, and the coach. In his situated cognition, Mr. Silas was a science teacher that was responsible for promoting scientific literacy through his lessons in order to help students achieve high scores on standardized tests as dictated by the educational discourses at the school, state, and national level. Other educational discourses, however, mandated that he also address literacy through the CCRS content literacy standards. This required him to apprentice as an English/literacy teacher because he had little training, professional development, or support in actually how to successfully teach literacy. As he implemented the Ender’s Game project, he relied somewhat on trial and error, depending on his preconceived notions of how an English/literacy teacher might utilize a novel. This situated him as both learner and teacher simultaneously within the classroom, but also caused a disconnect between the “teaching of science lessons” and the “teaching of literacy lessons.” The final identity Mr. Silas exhibited was that of a coach. He had a very successful softball team that was in the state play-offs and tournament during the time of this project. His coaching duties, however, created an additional vortex in the whirlwind, focusing his attention away from his
students and teaching during certain times. This caused additional stress for Mr. Silas and caused the students to slack off from their participation in the project.

Although Mr. Silas discussed several revisions he would like to make and the failure to motivate the “unmotivated five,” we did agree that overall the *Ender’s Game* project was a success and fulfilled its purpose. Not only were literacy standards addressed through the novel, but using the story in the novel to illustrate abstract physical science concepts such as inertia improved students’ scientific literacy. Mr. Silas knew his students very well and developed his implementation plan based on their needs. Hence, his students became part of the socially-mediated community of learners that influenced his pedagogical decisions and his Discourse as he went through this experience. In the short narrative below (lines 1-5, p. 212), Mr. Silas once again expressed his belief that teachers must respond to the needs of the students, even though that becomes more difficult each year.

1. The standards are constantly changing, but more importantly, the students are changing. Teachers are going to have to evolve with the children, and that is the hard thing to change. Students are less motivated than ever to do what they are supposed to do, regardless of what strategies you try. That is not a cop out, it is just a sign of the times.

As a science teacher myself, Mr. Silas’ experience with utilizing *Ender’s Game* is interesting simply for the story that he told. Yet, there are also many facets of his experience that are generalizable to other content area teachers faced with incorporating literacy standards into their courses with limited to no training on how to do so. His final thoughts about the project shared above illustrate his understanding of the ever-changing nature of education, students, and the world in which we all reside. If teachers are going to successfully navigate the whirlwind of issues that exist on a daily basis and provide rich learning experiences for students, they have to be willing to step out of their comfort zones and try new things. This is exactly what Mr. Silas did in this story. In the above accounts, one can see that at times things did not go as planned,
Mr. Silas felt unsure and overwhelmed sometimes, and students had mixed opinions on the project, but utilizing a science fiction novel to address literacy and promote scientific literacy was definitely a unique approach that served its purpose in his classroom. In Chapter V, I will summarize Mr. Silas’ story with respect to the research questions and highlight the major insights deemed relevant for teachers. In addition, I will discuss conclusions and implications that I drew from Mr. Silas’ re-storying as well as several recommendations for further research.
CHAPTER V:
DISCUSSION OF FINDINGS, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

As I stood before the room of new students about to enter into the teacher education program at the university where I taught, I saw many confused, stressed, and excited facial expressions as I quickly attempted to cram everything they needed to know for the next two to three years into a thirty-minute advising session. The students consisted of future secondary teachers from several content areas such as English, math, social studies, and science. As I was reviewing the courses they would be required to take, one of which was Teaching Reading and Writing in the Content Areas, a science education student raised her hand to ask a question. She asked, “Since I am going to be a science teacher, do I have to take the teaching reading and writing course?” Needless to say, I very emphatically explained about the CCRS content literacy standards, and that this one literacy course was nowhere near sufficient to prepare teachers to address reading, writing, disciplinary, and content literacy in the secondary classroom.

The story above solidified and characterized the context and situation of this study—content area teachers are required to address literacy in the secondary classroom, but are not sufficiently prepared to do so, especially as they must also attend to all other responsibilities of running the classroom, teaching their discipline, and attending to extracurricular activities. Accordingly, the primary purpose of this research study was to explore and relay the experience of an Alabama science teacher as he utilized a science fiction novel in his physical science classroom. His story is significant because content area teachers in Alabama are now required to
address literacy standards along with teaching their discipline as mandated by the Alabama College and Career Ready Standards (CCRS) (Alabama State Department of Education [ALSDE], 2010a, 2010b). Many times teachers are expected to take on this daunting task with little to no preparation in how to address literacy, especially with struggling readers that many English/language arts teachers have difficulty helping. In the case of Mr. Silas, he not only had to address content literacy, but also promote scientific literacy. The situated reality of these tasks and his personal Discourse (Gee, 2005, 2012) situated him as both a teacher and learner simultaneously. In addition, three distinct identities were present during the time of the implementation of the novel: science teacher, English/literacy teacher, and coach.

Evidence of this teacher’s experience was gathered through conversational interviews, classroom observations, and review of work documents as he implemented the science fiction novel, *Ender's Game*, into his curriculum. In Chapter IV, I re-storied his experience through a grand narrative account that covered a wide array of anecdotes and episodes connected to the theoretical framework. I will now summarize Mr. Silas’ experience through various significant facets and insights gathered from his grand narrative that are central to answering my research questions. Furthermore, this chapter will present a discussion of conclusions gained from the research questions as well as implications and recommendations for further research.

**Research Question One**

*What is the experience of a science teacher as he utilizes a science fiction novel in the secondary science classroom?*

Mr. Silas, the science teacher in this story, shared many rich and honest conversations with me during our time working on this study. As an external researcher to Mr. Silas’ personal experience, I had to depend on his honesty and candidness when describing all that he perceived,
felt, believed, and encountered over the course of the *Ender’s Game* project. Of course, I did observe Mr. Silas in his classroom and inspect his work documents in order to formulate my own inferences. However, since experience is shaped by much more than the events that occur, my own biases must be considered in the final analysis. Accordingly, the answer to my first research question is summarized below as a combination of Mr. Silas’ own stories and my understanding and interpretation of these stories and observations. The following discussion frames Mr. Silas’ complex experience within the theoretical framework where as a science educator he had to daily navigate a whirlwind of issues and duties as he facilitated the pursuit of scientific literacy, addressed the various educational and science discourses that influenced his pedagogical practices, and became both a teacher and learner simultaneously within his situated reality of the science classroom all while he implemented a unique tool for the science curriculum, a science fiction novel.

As I began to examine Mr. Silas’ stories, I discovered his grand narrative was rich with depictions of a teacher navigating a whirlwind of complex issues, some that I, as a seasoned teacher, had not anticipated. My first surprise was the difficulty I initially and continually had with getting in touch with him and subsequently finding time in his busy schedule to meet. I discovered he had no true planning period due to his coaching duties and rarely had time to check email. Consequently, our interactions took place mainly through text messages and meetings after softball practice or between classes while I was observing. Before Mr. Silas even added the *Ender’s Game* project to his curriculum, he was extremely busy with the duties of his job as a teacher and coach. There was no doubt that he already had a hectic and demanding schedule which would ultimately affect his pedagogical practices and procedures and shape his overall experience.
Professional Development with Content Literacy

Mr. Silas wanted to try out using a science fiction novel in his physical science classes to address the CCRS content literacy standards. He took on this unique approach with little to no training, support, or professional development in how to actually teach literacy or address the content literacy standards. Even though national and state educational discourses mandate to teach content literacy, during Mr. Silas’ college preparation to become a science teacher, the focus was on content. The professional discourses at Eagle High school also mandated the incorporation of literacy activities and strategies to address the CCRS content literacy standards, but the true focus was on technology, athletics, closing the gap, and eliciting high test scores and thus, provided little professional development or guidance in regard to the literacy standards. A final difficulty that affected Mr. Silas’ success with addressing the literacy standards was that he never attended the Alabama Reading Initiative (ARI) training.

Due to his lack of preparation to successfully address literacy in the science classroom, Mr. Silas was thrust into a situated reality where he taught the novel basically through trial and error. Even though he had an implementation plan with planned activities to enhance the reading of the novel such as Friday group discussions, completion of discussion bookmarks and tweets, and an outline of the CCRS content literacy standards that would be addressed through the project, how he went about it was modeled based on the pedagogical practices of an English teacher. Mr. Silas essentially became an English teacher apprentice where he learned the behaviors and developed this new identity in the spirit of legitimate peripheral participation (Lave & Wenger, 1991). This was an important construct of Mr. Silas’ experience because as he developed this new “English teacher identity,” there was a slight disconnect during his lessons where merging the teaching of science and the teaching of literacy did not occur. Conceivably,
utilizing Ender’s Game in the physical science classroom would allow science and literacy to unite in order to demonstrate that literacy is truly important in every content area.

**Classroom Literacy Insights and Motivation of Students**

Before he began the Ender’s Game project, Mr. Silas was already incorporating various reading and writing activities into his science curriculum, but felt his students struggled with the more formal academic reading and writing activities such as essay questions. In addition, Mr. Silas felt the emphasis on standardized testing affected student writing skills; the competition with technology impeded their ability to read a novel; and their literacy knowledge was affected by differing home and academic Discourses (Gee, 2012), learning challenges, and English as a second language barriers. Since Mr. Silas taught the non-advanced students, many of which struggled academically and/or received collaborative services, the motivation of all of his students to participate in the project and improve their skills in both reading and writing literacy and science literacy was a major influence on why he took on this project and planned the various activities and strategies that he did. Mr. Silas wanted to utilize the novel to motivate the students more, especially the unmotivated five, and allow them to express their ideas openly and use science language in a less formal setting which is essential for marginalized students as they learn science (Brown et al., 2005; Gee, 2012; Lee & Fradd, 1998). Additionally, although I am not sure if Mr. Silas was fully aware of the theory of constructivism, his literacy activities, both before incorporating Ender’s Game and after, encouraged a constructivist environment where students were encouraged to interact with one another, authentic examples of science were provided, and a variety of resources both technological and print were utilized (Llewellyn, 2005, 2013; Yager, 2004b; Yore et al., 2003).
The classroom literacy insights that Mr. Silas possessed as well as his desire to provide lessons and activities that would motivate all of his students were significant to his overall experience with the project because they revealed his impetus in regard to the pedagogical decisions that he made before, during, and after the implementation of the novel into his curriculum. Mr. Silas chose to utilize this uncommon tool for a science classroom and became both a teacher and a learner as he negotiated the best process to incorporate the novel and corresponding activities in order to provide the most engaging lessons for his population of students while still teaching science and literacy. As he experienced this process, his situated cognition of being a science teacher apprenticing as an English teacher was influenced by his students, creating a socially-mediated community of learners that influenced his pedagogical decisions, personal Discourse (Gee, 2005, 2012), and identity related to what it means to be a science teacher using a tool commonly only found in an English classroom. Within the context of legitimate peripheral participation (Lave & Wenger, 1991), as Mr. Silas was both learner and teacher simultaneously and as his community of practice (classroom) was influenced by his students, the hierarchical nature of the teacher-student relationship became more balanced. Mr. Silas genuinely attempted to create a learning curriculum as described by Lave and Wenger (1991) where the learners, in this case the students, were considered an important part of his situated cognition and necessary to develop his ideal of a successful teacher. The motivation of ALL of his students was a significant theme in Mr. Silas’ experience. Although utilizing Ender’s Game in his physical science classroom was an overall positive and beneficial experience for Mr. Silas and his students, unfortunately, he did not feel that the project successfully motivated the “unmotivated five” that he so desperately wanted to inspire.
Implementation Plan

During Mr. Silas’ experience with implementing the *Ender’s Game* project, he developed an implementation plan that he closely followed with a few minor adjustments toward the end of the semester. The literacy activities that were utilized with *Ender’s Game* were originally developed by another science teacher that had formerly been a secondary reading coach for the Alabama State Department of Education; thus, she had more experience and training with literacy pedagogy than Mr. Silas. During the project, Mr. Silas used her activities and strategies but implemented them based on his own unique classroom culture and curriculum.

The literacy strategies that he utilized, such as the Discussion Bookmark (see Figure 5), were categorized as instructional strategies which elicited deeper reading strategies such as questioning and clarifying (Jetton & Lee, 2012b). Because Mr. Silas was not fully trained or experienced in teaching literacy, he did not explicitly teach the reading strategies as advocated by Jetton and Lee (2012b). Through our conversations and my observations, I surmised that Mr. Silas was not even aware of the difference in instructional literacy strategies and reading strategies. Again, in regard to Mr. Silas’ situated cognition of a teacher and learner within the classroom, he was using a trial and error technique, searching for what best worked with his students and hopefully improved their reading and writing skills without a true understanding of literacy pedagogy. As a content teacher with little training, professional development, and support in literacy, Mr. Silas tended to utilize more instructional strategies into his lessons without the awareness of what they actually did in regard to improving literacy skills. I feel he was more aware of how incorporating current information and communication technologies (ICTs) (Sweeney, 2010) and non-threatening literacy activities (NTLAs) into the project would be more beneficial to his students than how to best utilize the literacy strategies.
Scientific Literacy

The overarching goal of science education is the pursuit and promotion of scientific literacy (Bybee, 1997; Laugksch, 2000; Llewellyn, 2013; Pratt & Pratt, 2004; van Eijck & Roth, 2010). Therefore, in addition to addressing the CCRS content literacy standards, the major purpose of utilizing *Ender’s Game* in the physical science classroom was to hopefully improve students’ scientific literacy. Although teaching science and pursuing scientific literacy through a science fiction novel normally aligns more with a *Vision II* perspective where the socio-scientific aspects are considered (Roberts, 2007), due to the school culture and pressure for high ACT scores, Mr. Silas felt the *Vision I* (Roberts, 2007) approach would be more beneficial. Even though there were differing perspectives of scientific literacy displayed through the project, Mr. Silas affirmed that he felt reading the novel had improved his students’ scientific literacy. He mentioned that they were able to connect physical science concepts illustrated in the plot of *Ender’s Game* to what was taught during the formal science lessons. These included concepts such as Newton’s Laws of Motion, inertia, speed, gravity, and free fall. Mr. Silas changed his perspective of how to best pursue scientific literacy somewhat when he saw how it was improved through the use of the novel. He affirmed that true science learning can only be achieved through interaction with varied formats such as through novels, movies, and other technological applications. Thus, Mr. Silas was pleased with the results of utilizing the novel because it incorporated reading and writing literacy into the science classroom (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010) as well as promoted scientific literacy (Czerneda, 1999; Fang & Wei, 2010; Norman, 1998; Wellington & Osborne, 2001).
Student Stories/Student Surveys

The analysis of Mr. Silas’ experience with implementing a science fiction novel into his physical science curriculum is not complete without some discussion of how the student characters within his story influenced his teaching Discourse (Gee, 2005, 2012) and pedagogical practices. Although not the focus of the study, the students became an influential socially-mediated community of learners as Mr. Silas experienced this process. Their reactions as seen through the eyes of Mr. Silas shaped his situated cognition and provided clear pathways through the whirlwind because without students, there is no need for a teacher. Mr. Silas’ implementation plan included various constructivist type activities that moved away from the traditionalist way of teaching. He planned for student interaction, authentic connections to science, and the incorporation of ICTs such as Twitter. Of course a plan is nothing if not carried out. According to Mr. Silas’ stories of how his students participated in the project, it was a successful and viable tool for addressing science and literacy. Even though many of Mr. Silas’ students performed inadequately in regard to academics and were marginalized based on their socio-economic status, ethnicity, and/or disabilities, learning or physical, many of the students were motivated to read the novel and participated in the discussions. There were still problems with motivating the “unmotivated five” and, according to Mr. Silas, this became worse as the school year came to a close. However, Mr. Silas was genuinely excited about the “light bulb moments” he witnessed in the students when they connected a science concept to the story or realized a certain theme within the plot. Overall, he felt the students’ knowledge of science and vocabulary was improved through the use of Ender’s Game.

Due to the student population that is usually enrolled in non-advanced physical science classes, Mr. Silas had to contend with very different home and academic Discourses (Gee, 2005,
2012) of his students where some had never even read an entire book. This project allowed all
the students to read the novel, interact, and discuss it with one another. The project gave the
students opportunities to practice using science language, provided authentic and socio-scientific
examples, motivated students by providing a respite from more traditional practices of teaching,
and facilitated the development of their secondary academic Discourse (Gee, 2005, 2012).

Keeping with the constructivist and non-threatening ideal of the project, Mr. Silas chose
to solicit feedback from his students about utilizing a science fiction novel in science class. The
survey revealed that students were able to connect some physical science concepts, such as
inertia and gravity, in the plot of the *Ender’s Game* story to what they were studying in class.
Unfortunately, the students still felt that it was strange to be reading a science fiction novel in
science, and it was something that should be done in English instead. This was surprising to Mr.
Silas because of the emphasis on reading across the curriculum at Eagle High School.
Regardless of the Eagle High professional discourses which emphasized cross-curricular reading,
these students still adhered to the traditional subject compartmentalization of secondary schools
(O’Brien et al., 1995).

**Non-Threatening Literacy Activities**

From the beginning of the project, Mr. Silas shared his desire for the activities he
incorporated to be non-threatening and familiar to the students. I referred to these activities as
non-threatening literacy activities (NTLAs) because they involved reading and writing but were
less formal and more authentic to life outside school than other more formal literacy
assignments. Mr. Silas was aware of the academic struggles of his students and wanted to find
out what they knew in a non-threatening way. In previous activities, he had seen his students
shut down many times and refuse to answer formal essay questions, thus he chose to have them
interact through tweets and short response notes without the added pressure of formal writing. In today’s technological and fast-paced world, students are familiar with communicating through ICTs (King-Sears et al., 2011; Sweeney, 2010; Wendt, 2013) and other less formal means of communication. Allowing them to utilize this non-threatening approach took the stress of formal academic writing away and permitted students to communicate their thoughts in a more comfortable and authentic way. Mr. Silas affirmed that many of the students wrote more on the tweets than they did when answering the more formal survey questions. Mr. Silas was even aware of the terminology that was used in his work documents opting to use “tweet” and “thoughts to share” instead of “summarize.” An additional benefit of the NTLAs was that they allowed the students to authentically practice using science language and improve scientific literacy before the added pressure of more formal assessments were required (Gee, 2004; Hand et al., 2003).

Mr. Silas’ Feelings and Disconnections of Identity

Throughout the story of his experience, Mr. Silas’ Discourse (Gee, 2005, 2012) of a practicing science teacher influenced every aspect of the implementation of the *Ender’s Game* project. He was out of his comfort zone in many ways: using a novel to teach literacy and science, struggling with the terminology of the CCRS content literacy standards, struggling with planning for all the new standards, changing from a more traditionalist classroom to a more constructivist one, and apprenticing as an English/literacy teacher. Although very apprehensive before implementation of the novel, once he had a few lessons under his belt, he began to feel more comfortable with the project. He affirmed that implementing the *Ender’s Game* project was a successful way to address the CCRS content literacy standards by allowing him an avenue to incorporate new and different reading and writing opportunities. Mr. Silas also felt that
utilizing *Ender’s Game* in his curriculum helped his students understand the physical science concepts more fully, thus improving their scientific literacy. Furthermore, Mr. Silas felt he better understood his students’ feelings and attitudes toward reading after the project was completed.

Because Mr. Silas had minimum training or professional development in regard to literacy before the CCRS content literacy standards were implemented and before he took on this unique project, he felt very unsure and unprepared on how to best go about addressing these new standards. Consequently, he handled it the best way he could by taking on the role of an English/literacy teacher while participating in the behaviors, using the social language, and embracing the Discourse of that identity (Gee, 2004, 2005, 2012). His situated cognition then positioned him as a science teacher apprenticing as an English/literacy teacher (Lave & Wenger, 1991). Through this apprenticeship three identities—science teacher, English/literacy teacher, and coach—were developed out of necessity as he navigated the complex whirlwind of his reality. As these identities shifted among one another throughout the day, I witnessed a disconnect at times between the “science” lessons and the “literacy” lessons. This disconnect most likely occurred because Mr. Silas felt that a science teacher would display different behaviors and Discourses than an English/literacy teacher. Because utilizing a science fiction novel to teach science was foreign even to Mr. Silas, he approached the science fiction novel from the perspective of the English/literacy teacher identity. Accordingly, Mr. Silas’ feelings throughout the implementation of the novel project contributed to the development of his identities, especially the English/literacy teacher identity, as it was the “new” identity that joined the other two within his classroom whirlwind.
Multiple Vortices

The whirlwind already swirling while Mr. Silas’ implemented the *Ender’s Game* project into his physical science classroom was complicated by various other issues or “vortices” throughout his experience. Mr. Silas had the added responsibility of being the softball coach and the cross country coach. During the implementation of the *Ender’s Game* project, the softball season was in full swing and Mr. Silas’ team had made the state play-offs. Although a wonderful and exciting opportunity for him, the students, and the school, the emphasis on taking care of his coaching responsibilities overshadowed his job of teaching at times. Mr. Silas’ coaching duties were a major vortex within his whirlwind of teaching responsibilities. As relayed in Mr. Silas’ story, he had to miss several days of school due to the softball tournament which thwarted his established procedure for the project. This caused him, as well as his students, to be less prepared for the discussions which in turn resulted in less quality learning. Then, once you added the constant distractions from phone calls while he was present in class, very little rich and focused learning was achieved during this time. Although the professional discourses at Eagle High were supposedly focused on rigor, they also endorsed athletics and other extracurricular activities, many times at the expense of the students’ learning.

The increase in planning time due to the documentation of the CCRS content literacy standards as well as the planning of new and different activities that addressed these standards were also major vortices within the whirlwind. Like many other teachers across the state and even nation, Mr. Silas had to plan lessons, teach students, complete paperwork, and sponsor an extracurricular activity or coach one to multiple sports. In his experience, he had to do all of this without a true planning period so the increase in planning time due to the literacy standards was a major source of frustration and stress. At times he felt so much pressure to complete the lesson
plans that he neglected the actual teaching of the students. Moments of desperation such as these are why research into planning and preparation for literacy instruction within content subjects by content teachers should be increased (Jetton & Lee, 2012a). Again, his feelings and, thus, his identities affected his pedagogical practices and decisions as he attended to the multiple vortices that created his situated reality of the classroom.

**Novel Implementation Preparation Time**

Since every successful classroom teacher must be an expert at time management, the preparation time required for planning for and then carrying out the *Ender’s Game* project was significant to Mr. Silas experience. Mr. Silas struggled mostly with the planning and preparation of adding new content literacy activities to his existing curriculum and then documenting the CCRS content literacy standards daily on his lesson plans. He likened this process as “hell” at first, but then felt it became more manageable the second semester once he had time to become more familiar with implementing the literacy standards. However, the actual implementation of the *Ender’s Game* project was not that daunting to Mr. Silas as he affirmed the project as something he could handle even with coaching softball. This confirmed the viability of the *Ender’s Game* project from a planning perspective in addition to a feasible activity to address scientific literacy and the CCRS content literacy standards.

**Pedagogical Influences of the CCRS Discourse**

The pedagogical practices of Mr. Silas were definitely influenced through this overall experience of novel implementation. His pedagogical practices were affected by both the directive to address the CCRS content literacy standards as well as the incorporation of a science fiction novel, a somewhat uncommon tool for the science classroom (Bunn, 2012; Ruiz et al., 2011). Mr. Silas now presented the science content more authentically and incorporated more
reading and writing into his curriculum. Yet, his planning time was also increased by the additional documentation of the literacy standards, creating even more frustration since he had no planning period and limited planning time due to coaching activities. Implementing the *Ender’s Game* project into his curriculum provided him with a way to address the CCRS content literacy standards, but before and after the project, he was responsible for incorporating various literacy strategies and activities on his own. The adoption of the CCRS content literacy standards caused Mr. Silas to step out of his comfort zone of being a somewhat traditional science teacher into a more constructivist teacher. He also developed another identity of an English/literacy teacher as he “taught” *Ender’s Game* based on the behaviors, Discourses, and social languages he associated with that identity from previous experience (Gee, 2004, 2005, 2012; Lave & Wenger, 1991).

**Revisions for Subsequent Novel Implementations**

Effective teachers are naturally reflective about their lessons and pedagogical practices, thus inquiring about the thoughts Mr. Silas had about revisions he would like to make next time were significant to his experience with implementing the *Ender’s Game* project. The main revisions he offered were providing access to the novel via technology, adjusting the in-class reading time, shortening the length of time for the project, changing the time of the semester for the project, and adding more formal assessments. These revisions exemplified Mr. Silas’ awareness of the nature and characteristics of his students as well as his personal Discourse (Gee, 2005, 2012) in regard to teaching science and literacy. Because of his students, he valued the non-threatening literacy activities (NTLAs) that were part of the project, but felt he needed more formal assessments to make the students more accountable. In addition, Eagle High School students were getting Mac Books during the next school year, so providing the novel via
technology would be a somewhat easy transition. The other revisions involved the implementation plan and procedures of when and how to logistically carry out the project. Although, some of these adjustments could be made, rearranging when the physical science topics were to be covered during the school year in order to change the time when the project could be completed would be difficult as higher administration dictates the pacing guide of secondary courses at Eagle High School.

**Suggestions for Pre-service Teachers**

The culminating experience of Mr. Silas with utilizing a science fiction novel in his secondary science classroom resulted in unique insights into how to best prepare future teachers to address both content and literacy in the age of Common Core. Suggestions offered by Mr. Silas are supported by research, but would require major adjustments to professional development as well as some courses offered in teacher certification programs. Mr. Silas shared his frustration when literacy strategies were just simply handed to him in meetings or through emails without explanation. He felt a better procedure would be to have the literacy strategies modeled by an English/literacy teacher so that content teachers with limited training in teaching literacy could be more prepared and comfortable when utilizing these uncommon strategies and merging them with their content (Bean & O’Brien, 2012; Brozo et al., 2013; Fang, 2012b; Shanahan, 2012). Another suggestion would be more emphasis on disciplinary and/or content literacy in education certification programs that normally only require very few of these courses (Conley, 2012; Jewett, 2013; Ruiz et al., 2011). The suggestions offered by Mr. Silas demonstrate how the personal experience of this one science teacher can provide significant and relevant insights and awareness of issues faced by many other classroom teachers in similar situations as they navigate their own personal whirlwinds.
Summary

The job of teaching is not an easy, cookie-cutter profession that can be successfully accomplished by any person that once sat in a desk in high school. Teachers must navigate a complex whirlwind with multiple vortices on a daily basis. The experience of Mr. Silas as he utilized a science fiction novel in his classroom exemplified this whirlwind. As a science teacher, he was responsible for teaching science content and promoting scientific literacy. He also had to contend with the other major educational and science discourses that influenced his classroom, pedagogical practices, and personal Discourse (Gee 2005, 2012). One of the most influential of these educational discourses was the directive of the CCRS standards to address content literacy in every content classroom. This was a major reason why Mr. Silas wanted to utilize a science fiction novel, but due to his lack of educational training, professional development, and support, his situated reality within the classroom positioned him as both a teacher and a learner simultaneously. The overarching goal to promote scientific literacy, the influence of various educational and science discourses, and the situated cognition of Mr. Silas as he implemented *Ender’s Game* into his physical science classes created his whirlwind and shaped his unique experience.

Research Question Two

*How does a secondary science teacher meaningfully address scientific literacy through the use of a science fiction novel in a physical science classroom?*

The pursuit and promotion of scientific literacy is an overarching goal of science education as well as a greatly debated educational and science discourse as discussed in Chapter II. National documents such as the *National Science Education Standards* (NRC, 1996) and the *Next Generation Science Standards* (NGSS Lead States, 2013), along with state-wide directives,
uphold the pursuit of scientific literacy for all students. I found through my conversations and observations with Mr. Silas, however, that he was not as aware of the influences of these discourses as he was the Alabama College and Career Ready Standards. Mr. Silas knew he was to teach the science objectives from the Alabama course of study and the CCRS content literacy standards, but when we discussed scientific literacy, he seemed somewhat unfamiliar with that term. After a discussion about his ideas about scientific literacy and a brief overview of what the research says, he explained that he felt that scientific literacy would be determined by students learning scientific facts that could be remembered while taking standardized tests such as the ACT. This view aligned more with Roberts’ (2007) Vision I perspective. After learning of his view of scientific literacy, I was concerned that the use of a science fiction novel would not fit into his personal Discourse (Gee, 2005, 2012) in regard to teaching science as use of this tool would normally align more with the Vision II (Roberts, 2007) perspective.

To address the research question of how does a secondary science teacher meaningfully address scientific literacy through the use of a science fiction novel in physical science, I cannot escape my own personal experience as I also faced this situation when I utilized Ender’s Game in my class. Mr. Silas and I had different views of how to best approach scientific literacy from the beginning. I aligned more closely with the Vision II (Roberts, 2007) perspective of scientific literacy, and thus the use of an uncommon science resource such as a science fiction novel was not as inconceivable given my views of scientific literacy. The difference in mine and Mr. Silas’ views may have been the reason for the disconnect between the teaching of the novel and the teaching of the science lesson by Mr. Silas. I feel he did not see the novel as a tool to teach both science and literacy, but more of a means to just address the CCRS content literacy standards. I utilized the novel to explicitly teach science and improve students’ understanding of the physical
science concepts through the authentic examples of science found in the story. The science connections made by the students while Mr. Silas taught the novel were more implied as he taught the novel more from an English/literacy perspective. This resulted in several instances where there were missed opportunities to go more in-depth with the science concepts. I surmised that one reason for these missed opportunities was because of the English/literacy teacher identity that Mr. Silas took on while teaching the novel. During the novel discussions, his focus was on the discussion bookmarks which centered on various vocabulary words found in the novel, the plot, and character interactions more so than the science. When science concepts such as inertia and gravity were brought up or occurred in the plot of the novel, Mr. Silas would elaborate on these somewhat, but I do not feel that he viewed the novel as an actual tool to teach science. The science concepts gleaned from the novel seemed to be only a positive benefit of the tool Mr. Silas was using to address the CCRS content literacy standards. However, once the project was concluded, Mr. Silas had a different view and discourse about how to best address scientific literacy. He affirmed that a more constructivist approach, although he was not aware of that terminology, was much more effective than the more traditionalist approach of lecture and talking to students about science.

During our first conversations about scientific literacy, Mr. Silas was very focused on how to best prepare his students to do well on the ACT, which is the current sanctioned standardized test to determine student success in Alabama. He felt the pressure from this state directive and from the Eagle High School administration to prepare his students to receive high scores on this assessment. Consequently, Mr. Silas was concerned with his students learning science facts and vocabulary that could be repeated on this objective standardized test. As discussed previously, this view of what it means to be scientifically literate did not seem to
correspond very well with addressing scientific literacy through a science fiction novel. However, once Mr. Silas witnessed his students using science vocabulary in relation to the novel and connecting science concepts to situations in the *Ender’s Game* story, he began to see the novel as a tool to not only address the CCRS content literacy standards but also as a useful tool to strengthen scientific literacy. The change in his personal Discourse (Gee, 2005, 2012) about how to teach science and promote scientific literacy came from witnessing his students learn the science vocabulary words, discuss the concepts in class using science language, and connect the science to real world examples. The use of *Ender’s Game* also illustrated many of the reasons cited for utilizing science fiction in the science classroom such as a prompt for ethical discussions (Gallo, 2007; Groenke & Scherff, 2010; Zigo & Moore, 2004); a way to imagine future scientific and technological advances (Czerneda, 1999; Gallo, 2007; Raham, 2004); connections to other content areas and disciplines of science (Bixler, 2007; Kilby-Goodwin, 2010; Raham, 2004); incorporation of science concepts without the confusing technical vocabulary (Smolkin & Donovan, 2004); and authentic examples of science and technology (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010; Singh, 2014). Yet, probably the most important and beneficial reasons to this study were that utilizing *Ender’s Game* incorporated literacy into the science classroom (Clemmons & Sheehy, 2011; Kilby-Goodwin, 2010) and promoted scientific literacy (Czerneda, 1999; Fang & Wei, 2010; Norman, 1998; Wellington & Osborne, 2001).

Similar to the rest of Mr. Silas’ experience with implementing the *Ender’s Game* project, determining how he as a science teacher meaningfully addressed scientific literacy through the use of a science fiction novel is complex. Mr. Silas’ pedagogical practices and personal Discourse in regard to addressing scientific literacy were influenced by the educational and
science discourses that stressed standardized testing as well as the incorporation of more reading and writing activities to satisfy the literacy standards. Even though Mr. Silas felt the need to focus on strict science content from the more traditionalist approach, he did not necessarily want to it to be that way. Once he began to implement the *Ender’s Game* project, however, his teaching took on a more constructivist approach as he utilized the novel to provided authentic examples of science, connections to real-life experiences, and classroom interactions, all of which are motivating factors for students that promote scientific literacy and science learning (Hand et al., 1999; Lemke, 2001; Pratt & Pratt, 2004; Wellington & Osborne, 2001; Yager, 2004b; Yore et al., 2003). Even though these connections to science were implied at times due to the English teacher identity Mr. Silas developed when teaching the novel, they still occurred.

Based on the accounts from this study, a science fiction novel is a viable and useful option for other secondary science teachers looking for a resource that can address scientific literacy. Yet, secondary science teachers that choose to utilize a science fiction novel for this purpose should reflect on their own ideas and beliefs about what it means to be scientifically literate and how to best promote that in their students. As seen in Mr. Silas’ story, many times the national, state, or local educational and science discourses influenced his personal Discourse and teaching practices in a way that would prove using a unique resource such as a science fiction novel difficult. In addition, I surmised that many secondary teachers are not aware of the numerous benefits to improving scientific literacy that a science fiction novel provides. As in the case of Mr. Silas, many secondary teachers will adhere so closely to the traditional compartmentalization of secondary subjects (O’Brien et al., 1995) that utilizing a science fiction novel would only be something to be done in an English classroom, thus not an option as a science activity. The conclusions drawn from this study, however, can be shared with other
secondary science teachers so that informed decisions about using a science fiction novel within the secondary science classroom are possible.

Conclusions

Based on the story of Mr. Silas’ experience with implementing a somewhat unique tool, *Ender’s Game*, into his physical science classroom and the insights gained during this study, several conclusions were discovered. These conclusions are significant and transferable to other content area teachers as they address literacy standards in their classrooms and/or scientific literacy all while navigating the complex whirlwind of teaching.

**Differing Identities Were Represented Throughout the Project**

Teacher “identity” can be used to describe a variety of conceptual approaches to teaching as well as examining the classroom teacher through different theoretical lenses. For instance, Kelly-Jackson and Jackson (2011) investigated a teacher’s pedagogical stance as culturally relevant pedagogy was engaged, and O’Conner (2008) examined how emotions affected teacher identity. For this study, identity is based on Gee’s (2005, 2012) concept where the “who” and “what” of an identity are shaped by the social language and meaningful activities demonstrated within a specific context as well as the personal Discourse. In accordance with Gee (2005, 2012), Lave and Wenger (1991) also acknowledged the use of language (talk) within a specific identity. Thus, the three identities represented during Mr. Silas’ experience were identifiable based on these criteria. Based on Gee’s (2005, 2012) concept, representation of various identities among teachers is a common phenomenon within a secondary classroom, especially if the teacher has added duties of coaching or other extracurricular activities.

The multiple vortices which created the complex whirlwind of Mr. Silas’ situated cognition influenced the establishment of three differing identities (Gee, 2005, 2012)-science
teacher, English/literacy teacher, and coach. These identities presented themselves at certain times very distinctly and at other times, merged their personas based on the particular situation occurring in the classroom at that moment. What was happening at the moment in the classroom determined which identity would be dominant. For example, during the state play-offs when Mr. Silas was distracted by constant phone calls about softball and had to miss discussion days due to the softball tournament, his coaching identity took over. Another example occurred as Mr. Silas reviewed the discussion bookmarks and would highlight the literacy aspects of the novel such as the vocabulary, plot, and characters. Once the discussion of the novel was over, Mr. Silas would “begin his science lesson.” This illustrated that he was taking on the identity of an English/literacy teacher while discussing the novel, and his science lesson along with his science teacher identity, did not begin until the novel was put away and the science textbook was brought out.

At times, there was a brief consolidation of the identities when science concepts were brought up during the novel discussions, but according to Mr. Silas’ words and actions as well as my observations, the science lessons were considered separate from the literacy/novel lessons. Because Mr. Silas’ educational background had focused on learning science content, he was not as prepared, nor comfortable in how to teach literacy through a novel. While discussing the novel and addressing the CCRS content literacy standards through the novel, his situated cognition positioned him as an apprentice English/literacy teacher carrying out the pedagogical methods he felt would correspond with that identity (Lave & Wenger, 1991). Once the novel discussion was over, he would shift back to his comfort zone as a science teacher and begin his science lessons. Mr. Silas never made the final step to unite the two identities and utilize the science fiction novel as a tool to simultaneously teach literacy and science.
Science vocabulary is extremely difficult for students to comprehend even though they can technically read the words (Fang, 2012b; Wellington & Osborne, 2001). Based on Mr. Silas experience, I surmised that one issue he had with using *Ender’s Game* to teach science was based on the differing text structures found in a novel and a science textbook. He had already disclosed that he felt scientific literacy was measured through the regurgitation of science facts on a standardized test so using a resource with text structured around a story with a plot, characters, and themes was not seen as technical enough. Because of this belief, as well as his lack of training with alternative resources such as science fiction, he was never able to fully embrace *Ender’s Game* as a legitimate resource to teach science. However, at the conclusion of the project, Mr. Silas agreed that students’ science vocabulary and concept knowledge had increased as well as their scientific literacy.

Mr. Silas’ experience with utilizing a science fiction novel in the secondary physical science classroom is intricate, yet not unusual to many practicing secondary teachers. In the age of *Common Core* and the incorporation of content literacy standards into every content curriculum, many secondary science teachers trained primarily in content may be overwhelmed with how to best approach “teaching” these literacy standards. Even other content area teachers such as math and history may also experience similar struggles within their classrooms. As teachers, we are forced on a daily basis to handle multiple tasks with flexibility and authority, which can result in teachers taking on various identities to manage the most important task at the moment. Although the “coach” identity or the “club sponsor” identity may always appear out of necessity, the “science teacher” (or math, history, etc.) and “English/literacy teacher” identities could consolidate with more training and support in content and/or disciplinary literacy. Teachers already have a full curriculum that now must include content literacy standards;
however, there should be less disconnected lessons when secondary teachers have a better understanding of how to address literacy while teaching their content. Therefore, *Ender’s Game* or other science fiction novels could be a useful tool to address both science and literacy harmoniously reducing the stress of the teacher and the confusion of students who question why they are “doing” English in science.

**Use of a Science Fiction Novel within a Secondary Science Classroom is a Viable Curricular Option to Address Content Literacy and Scientific Literacy**

As previously discussed, Mr. Silas was searching for some additional resources, strategies, and activities to incorporate into his physical science curriculum to address the CCRS content literacy standards. Although the use of a science fiction novel was somewhat strange even to Mr. Silas at the beginning, he agreed to try it out in hopes that it would fulfill this requirement. Throughout Mr. Silas’s experience, he faced many uncertainties, especially since he had very little training in disciplinary literacy and/or professional development in regard to the content literacy standards. However, final analysis determined that overall, the use of *Ender’s Game* in his classroom was a viable option to address both the CCRS content literacy standards and scientific literacy.

There are various examples discussed within the story of Mr. Silas’ experience to support the use of a science fiction novel as a viable curricular option. The implementation plan and activities created a more constructivist classroom where students were reading a non-textbook resource, interacting with one another, using science language both through informal writing and discussions, using technology, and connecting authentic examples of science from the story to science concepts being discussed in class. When the CCRS content literacy standards specifically addressed through this project were examined (Standards 1, 2, 3, 4, 9, and 10), there were also examples of how they were met during the project. For example, Standard 1 states:
Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text (ALSDE, 2010b). This standard was satisfied in several ways. First, Mr. Silas used the discussion bookmarks along with reading each chapter. In order for students to accurately complete the bookmarks, they had to closely read the novel and write their thoughts and questions related to the specific chapter. Second, these thoughts were enhanced through interactive responses to the bookmarks on post-it notes as well as “tweets.” These interactions among students not only addressed the above mentioned standard, but they also embraced the Web 2.0 ideology and 21st century skills by students sharing and supporting their thoughts about the novel (Hinchmann et al., 2003; King-Sears et al., 2011). Furthermore, these activities are considered non-threatening literacy activities (NTLAs) because they allow students to concentrate on their thoughts instead of formal writing rules. A final way that Mr. Silas addressed Standard 1 was through his weekly discussions. During this time, students had opportunities to verbally examine the novel, citing specific information to support their ideas.

Another instance of how the CCRS content literacy standards were satisfied through the Ender’s Game project is with Standard 4. Standard 4 states: Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone (ALSDE, 2010b). As part of the project, students were to determine at least three words from each chapter that they did not know (see discussion bookmark), and Mr. Silas would then review these words during the book discussions; thus, addressing this literacy standard. Even in regard to planning and preparation, the incorporation of a science fiction novel was not overwhelming to Mr. Silas while he was coaching multiple sports with no true planning period.
The conclusion that utilizing a science fiction novel within a secondary science classroom is a viable curricular option is significant because many science teachers will be searching for unique, motivating, and easily implemented resources in order to address the content literacy standards. Even though this study specifically took place in Alabama and focused on the CCRS content literacy standards, the Common Core State Standards (NGA Center & CCSSO, 2010a) have been adopted by many states and mandate the same content literacy standards be addressed within all subject areas. Therefore, secondary science teachers searching for a viable curricular option to address content literacy, promote scientific literacy, and increase science learning can embrace the use of a science fiction novel. Since there are so many quality science fiction novels available at low cost or even digitally, they can be utilized within any subject area. In addition, many of these novels are considered Young Adult (YA) literature and are encouraged by research to be utilized within secondary classrooms (Clemmons & Sheehy, 2011; Ruiz et al., 2011). Finally, although this study specifically examined science fiction as a curricular option, both fiction and non-fiction books could also be feasible curricular options for other content areas. For instance, the use of a quality historical fiction novel within a history class could offer some of the same benefits as science fiction such as prompts for ethical discussions and connecting historical events to authentic and real life situations.

**Knowing Student Learners is Essential for Strategically Teaching a Science Fiction Novel**

As stated previously, this study was focused on Mr. Silas’ experience as a science teacher implementing a science fiction novel into his classroom; however, the intention of every lesson, activity, and strategy should benefit student learning. Every secondary classroom, even from period to period, will be made up of diverse students from various backgrounds, cultures, ethnicities, learning abilities, and learning styles. Teachers must gather and acknowledge the
unique characteristics of their students in order to develop and plan lessons differentiated to the students’ needs. Mr. Silas did just this during the implementation of the *Ender’s Game* project. Since Mr. Silas taught the non-advanced physical science course, his student population was marginalized in various ways so he developed an implementation plan that took into account these issues and characteristics. For example, Mr. Silas was aware that many of his students had home lives that were not conducive to completing assignments for homework so he planned for reading time at the beginning of his class each day. In addition, Mr. Silas knew the struggles that many of his students had with formal reading and writing activities; thus, he chose to make the project less threatening to the students by incorporating NTLAs such as tweets, “thoughts to share,” and a survey as opposed to essay questions and formal assessments. His rationale behind these plans was to hopefully motivate all students to actively participate in the project.

One of the major educational and science discourses for best practices in the science classroom is the recommendation for moving away from more traditionalist teaching to a more constructivist approach (Eisenhart et al., 1996; Llewellyn, 2005, 2013; Yore, 2004). Constructivism embraces the prior experiences and knowledge of students and encourages social interaction and engagement (Llewellyn, 2005, 2013). Although I am not sure that Mr. Silas was familiar with constructivism as a best practice of teaching science, he still implemented many constructivist activities into the *Ender’s Game* project. Again, this exemplified how Mr. Silas focused on what was best for his students, even if it took him out of his teaching comfort zone. He was cognizant of the nature of his students and knew that traditionalist teaching methods would not motivate or engage the students to participate in a literacy project that involved reading a novel, especially since many of his students struggled with reading comprehension and had never read an entire book before. Furthermore, as Mr. Silas apprenticed as an
English/literacy teacher while implementing the novel, his students created a socially-mediated community of learners which shaped his situated cognition throughout his experience.

Much research supports acknowledging student diversity when teaching science to marginalized students (Brown et al., 2005; Gee, 2012; Lee & Fradd, 1998; Norman, 1998) such as made up Mr. Silas’ student population. However, teachers should recognize the unique student characteristics within their classroom and the situated context of diversity of their local community in order to strategically implement and teach a science fiction novel. Of course this is important when utilizing a science fiction novel in the science curriculum as can be verified through Mr. Silas’ experience; however, other content area teachers wanting to try out a novel need to recognize student diversity as well. Even the particular novel a teacher chooses could be influenced by the student population and/or local community culture. For instance, a teacher may choose a novel with characters and setting similar to the particular student population and greater school community.

Knowing student learners is an essential step in planning effective lessons. Many strategic lesson plans as well as the 5E Learning Cycle lesson plan commonly used in science classrooms (Llewellyn, 2013) recognize student differences in regard to learning styles, prior knowledge, and experience. For example, the strategic lesson plan adapted and utilized within the teacher certification program at the university at which I currently teach has “gather facts about the learners” as the first step to the plan. Furthermore, the standards used to assess teachers for EDUCATEAlabama (ALSDE, 2009), the teacher evaluation system in Alabama, acknowledge such things as activating prior knowledge, engaging learning styles, implementing a culturally responsive curriculum, and providing modification and accommodations for
students. Lastly, EdTPA, a new educational discourse on the horizon to be implemented for teacher certification in Alabama, also considers the context of student population.

New and changing educational mandates and directives will never cease in the profession of teaching. Just as in the case with the implementation of the CCRS content literacy standards in Alabama and the Common Core literacy standards in other states, teachers will be searching for new activities, methods, strategies, etc. to meet the directives of these educational discourses. This study has provided evidence that when utilizing a science fiction novel, it is essential to consider the unique needs of the students during this endeavor. I also deduced that regardless of the specific activity or strategy being implemented, the needs of the student learners must be acknowledged and embraced in order to create the most conducive environment for learning and the richest learning experiences.

Content Teachers Addressing the CCRS Content Literacy Standards Require Support and Professional Development

From the very beginning of Mr. Silas’ story, he shared his apprehension with how to best address the CCRS content literacy standards. Much of this apprehension was the result of his lack of both educational training and professional development in regard to literacy. The unfamiliarity of how to implement literacy into non-English content classrooms (Fang & Wei, 2010; Greenleaf et al., 2011) as well as the lack of professional support in doing so (Bean & O’Brien, 2012; Brozo et al., 2013; Shanahan, 2012) are unfortunately common problems among teachers. When I first met Mr. Silas, he was incorporating a variety of reading and writing activities into his science curriculum such as physical science in the news and chapter preview form, but these focused more on the science content and textbook reading than the literacy strategies and activities he utilized with *Ender’s Game*. Because use of a science fiction novel in the science classroom is a somewhat uncommon practice, Mr. Silas did not use the same
teaching approach with the novel that he did with his other science-related literacy activities. Since he was lacking in knowledge of how to address content and/or disciplinary literacy, he viewed *Ender’s Game* as a tool to address literacy more so than science. This resulted in him developing the identity of an English/literacy teacher and detaching his “literacy” lessons from his “science” lessons as he utilized a trial and error process. Relevant and useful educational courses in content and/or disciplinary literacy as well as beneficial professional development and support could have reduced his frustration and apprehension and allowed him to utilize *Ender’s Game* to merge science and literacy within the curriculum.

The administrative directive at Eagle High School required that CCRS content literacy standards be addressed within every lesson and documented on every lesson plan. This was also very overwhelming to Mr. Silas for various reasons in addition to his lack of training and professional development in literacy. First, due to his coaching duties, he had no planning period which made finding time to develop quality lessons difficult. Second, he had never had the opportunity to attend Alabama Reading Initiative (ARI) training to at least receive a crash course in literacy. Third, he struggled with understanding the terminology and organization of the content literacy standards. Finally, he was unsure of how to assess students in regard to the content literacy standards. Again, professional development and support from his school system would have improved most of these issues. It is not likely that Mr. Silas’ coaching duties would have been removed so that he would have more planning time, but if he had a strong support and plenty of quality professional development in literacy, he would not struggle as much with the terminology and assessments; thus reducing his planning time. Furthermore, the Eagle High administration could have allowed any teachers that had never had ARI training to attend.
At the conclusion of the study, Mr. Silas offered some insightful suggestions on how to improve the training and support for content teachers in the age of the Common Core content literacy standards. He suggested that a variety of literacy strategies be shared with teachers but not by just handing them out at a meeting or through an email. He recommended having the literacy strategies modeled by an English/literacy teacher so that teachers trained primarily in content could benefit from their expertise. The approach of content area teachers collaborating with literacy/English teachers in order to examine literacy strategies is also supported by research as a valid and superior procedure than just handing generic literacy strategies to content teachers to figure out on their own (Brozo et al., 2013; Fang, 2012). Furthermore, if content teachers of the same subject were grouped together as the strategies were modeled, they could discuss ways to modify the literacy strategies to work best in their specific classroom, with their specific students, and with their specific content to optimize learning (Adams & Pegg, 2012).

ARI training, which is conducted by Alabama State Department of Education personnel, does utilize reading and literacy coaches to model the literacy strategies for secondary teachers and pre-service teachers; however, all content areas are grouped together and literacy strategies covered are general in nature and not specific to any one discipline (J. Slaton, personal communication, August 27, 2015). Although ARI training is a good start to providing support to content teachers as they address the content literacy standards, not all Alabama teachers receive this training. In addition, the training is an intensive three-day course in literacy strategies. Content teachers are then expected to take all of this information back to their classroom and utilize it within their curriculum, a very overwhelming task in itself.

The insights generated from this study of Mr. Silas’ experience revealed that content area teachers need much support and opportunities for professional development in regard to literacy
in order to reduce their frustration and apprehension when addressing the content literacy standards. Accordingly, there is research into the restructuring of teacher certification courses in order to focus more on the incorporation of content and/or disciplinary literacy (Conley, 2012; Jewett, 2013; Ruiz et al., 2011). Even at the university at which I currently teach, we are discussing changes to our current course offerings in order to provide more training in literacy. As illustrated in the story of the science student in the introduction of this chapter, pre-service teachers are many times not fully aware of what they will be required to do or what they will face in regard to teaching literacy in the content classroom. Although professional development and support in content literacy is imperative to practicing classroom teachers, restructuring teacher certification courses could prepare teachers before they must navigate the whirlwind of daily classroom.

**Implications and Recommendations for Future Research**

This narrative study examined the experience of one science teacher as he utilized a science fiction novel, *Ender’s Game*, with his secondary physical science classroom. The study also investigated how to meaningfully address scientific literacy through the use of a science fiction novel. The insights generated during the study provided a glimpse into the world of a secondary science teacher in Alabama as he sought to navigate the whirlwind created by the overarching goal of promoting scientific literacy, the educational and science discourses that mandated pedagogical best practices and adherence to certain standards such as the CCRS content literacy standards, and the situated cognition of the reality of the classroom. Although the insights gained are hopefully transferable to other secondary content teachers and significant to administrators as well as other educators, the following are recommendations for future researchers:
1. Follow-up studies should be conducted with additional science teachers in Alabama or other states currently mandated to address content literacy within the curriculum as they utilize unique literacy approaches such as a science fiction novel. In addition, other content area teachers, such as history and math, should be examined as they incorporate fiction or non-fiction into their curriculum. I chose to begin this investigation with one science teacher as he utilized the *Ender’s Game* novel with his physical science students. This study gave me a “first look” at another teacher’s experience and established a framework for studying other teachers as they implemented fiction or non-fiction books into their curriculum. Thus, the next step in this investigation would be to expand the research with other science teachers in Alabama or other states that have adopted the *Common Core State Standards*.

2. Studies should be conducted with secondary students as a science fiction novel is utilized within their classroom. For this study, students were not the focus, yet their stories, interactions, and characteristics created the socially mediated community of learners within Mr. Silas’ situated reality throughout his experience. Studies conducted with students could focus on their general experience with a science fiction novel or more specifically center on one of the insights gathered from Mr. Silas’ experience. For example, further studies could focus on student motivation when reading a science fiction novel, use of non-threatening literacy activities (NTLAs) with science fiction, or student attitudes toward reading fiction novels in a non-English classroom.

3. Based on Mr. Silas’ inclination to incorporate non-threatening activities into the *Ender’s Game* project so that his students would be more motivated to participate, I introduced the concept of non-threatening literacy activities (NTLAs). Although much research discussed literacy activities that would be considered NTLAs (Alvermann, 2006; Alvermann & Heron,
specific studies with both students and teachers in regard to NTLAs is needed. Mr. Silas’ story revealed how he utilized NTLAs with his students, but investigations into how beneficial these activities are in other classrooms with other teachers, especially when compared to more formal literacy activities, is necessary. Furthermore, studies about how students feel about NTLAs as well as how they participate in these activities compared to more formal literacy activities would be noteworthy.

4. According to Jetton and Lee (2012a), there is a lack of research in how content area teachers prepare and plan for literacy instruction. Therefore, investigations which examine this planning process are necessary. This would be significant not only for science teachers in Alabama but all content teachers that are now required to implement content literacy standards into their curriculum. Mr. Silas struggled with several issues in regard to planning for literacy instruction which included lack of time, understanding the content literacy terminology, and assessment of literacy standards; therefore, specifically addressing these issues in further studies would be beneficial.

5. Many secondary teachers are responsible for other duties such as coaching or sponsoring extracurricular activities in addition to their teaching responsibilities. As was seen in Mr. Silas’ story, many times this plethora of duties contributes to the creation of identities that take over in order to attend to these extracurricular responsibilities at the sacrifice of teaching the students. This is especially problematic when school culture, professional discourses, and the community voice promote strong performance in athletics as in the case of Eagle High School. Consequently, studies should be conducted with secondary teachers who coach or sponsor extracurricular activities as well as administrators regarding the protection of instructional time within the classroom. This is especially significant for teachers who teach marginalized students.
as did Mr. Silas. These students must already contend with differing academic and home Discourses (Gee, 2012) and negative attitudes toward science (Kanter & Konstantopoulos, 2010) so the absence of the primary teacher for school-related functions or constant classroom interruptions such as occurred during the state softball tournament in Mr. Silas’ story can further impede their academic success.

6. Currently there is research into the restructuring of teacher certification courses to encourage the integration of more content and/or disciplinary literacy practices (Conley, 2012; Jewett, 2013). With the continuing directive to address literacy within content classes, follow-up studies with teachers who have taken courses similar to these are necessary. Once these pre-service teachers enter the classroom, investigations into matters such as how or to what extent they implement the literacy practices taken from these courses; what aspects of the courses were most beneficial to student learning; and, what is their comfort level or feeling of preparedness in regard to teaching literacy would offer useful insights for college instructors.

**Final Reflection**

As previously relayed, this narrative dissertation was a re-storying of one teacher’s experience with utilizing a science fiction novel in his secondary physical science classroom. When I was a classroom science teacher, I also utilized the science fiction novel, *Ender’s Game*, with my physical science students. This was before the CCRS content literacy standards were mandated, but incorporating reading and writing across the curriculum was considered a best practice. The conception for this narrative dissertation came from my own experiences and struggles with how to best implement a science fiction novel with limited training, no professional development, and very little support from colleagues and students. Just like Mr. Silas, I had not attended ARI training and had content classes taught separately from pedagogy
classes. However, because I enjoyed reading science fiction, I became the weird science teacher that made her students read a novel.

Once the CCRS content literacy standards were authorized, I wondered what the experience would be of another science teacher as he utilized a novel in his physical science classroom. Would there be more support, training, or professional development for content teachers now that it was a state directive? Would the attitudes of the students be different and more accepting of reading a novel? Would his experience be similar to my own? How would he take an uncommon tool to teach science and utilize it to pursue scientific literacy and enhance science learning? From exploring Mr. Silas’ experience, I recognized both similarities and differences in his experience and my own. I went through this investigation as the researcher but still a science teacher trying to grapple with how to best address the CCRS content literacy standards myself. At the conclusion of this investigation, there are no concrete answers to my queries as every teacher’s classroom and experience is unique. Yet, through Mr. Silas’ unique experience, I am able to merge his insights with my own in order to help encourage my pre-service students to embrace unique and “out-of-the box” ideas when teaching because that unique lesson or tool may be the one to inspire their students like never before.
REFERENCES


Sweeney, S. M. (2010). Writing for the instant messaging and text messaging generation: Using new literacies to support writing instruction. *Journal of Adolescent & Adult Literacy, 54*(2), 121-130. doi: 10.1598/JAAL.54.2.4


APPENDIX A

IRB Approval and Consent Forms

April 3, 2014

Leigh Hester
Dept of Curriculum & Instruction
College of Education
Box 87002

Re: IRB #: 14-OR-106 “Navigating the Whirlwind: One Science Teacher’s Experience Utilizing a Science Fiction Novel in the Secondary Classroom”

Dear Ms. Hester:

The University of Alabama Institutional Review Board has granted approval for your proposed research.

Your application has been given expedited approval according to 45 CFR part 46. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies

Your application will expire on April 2, 2015. If your research will continue beyond this date, complete the relevant portions of the IRB Renewal Application. If you wish to modify the application, complete the Modification of an Approved Protocol Form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, complete the appropriate portions of the IRB Request for Study Closure Form.

Please use reproductions of the IRB approved stamped consent forms to obtain consent from your participants.

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research.

Shawn Oches, Ph.D.
Chair, Non-Medical Institutional Review Board
The University of Alabama
March 26, 2015

Leigh Hester, Ed.S.
Department of Curriculum & Instruction
College of Education
The University of Alabama
Box 870302

Re: IRB # 14-OR-106-R1 “Navigating the Whirlwind: One Science Teacher’s Experience Utilizing a Science Fiction Novel in the Secondary Classroom”

Dear Ms. Hester:

The University of Alabama Institutional Review Board has granted approval for your renewal application.

Your renewal application has been given expedited approval according to 45 CFR part 46. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your application will expire on March 25, 2016. If your research will continue beyond this date, complete the relevant portions of Continuing Review and Closure Form. If you wish to modify the application, complete the Modification of an Approved Protocol Form. When the study closes, complete the appropriate portions of FORM: Continuing Review and Closure.

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research.

Sincerely,

[signature]

Director, Research Compliance Officer
Office for Research Compliance
UNIVERSITY OF ALABAMA
INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS
REQUEST FOR APPROVAL OF RESEARCH INVOLVING HUMAN SUBJECTS

I. Identifying Information

Principal Investigator: Leigh Hester
Second Investigator: Sharon E. Nichols
Third Investigator: 

Department: Curriculum & Instruction
Curriculum & Instruction Education

College: Education
University of Alabama

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Fax: E-mail: leigh.hesten@athens.edu
snichols@bamaed.ua.edu

Title of Research Project: Navigating the Whirlwind: One Science Teacher’s Experience Utilizing a Science Fiction Novel in the Secondary Classroom

Date Submitted: N/A
Funding Source: 

Type of Proposal: √ New  □ Revision  □ Renewal  □ Completed  □ Exempt

Please attach a continuing review of studies form.

Please enter the original IRB # at the top of the page.

UA faculty or staff member signature:  

II. NOTIFICATION OF IRB ACTION (to be completed by IRB):

Type of Review: □ Full board  √ Expedited

IRB Action:

Rejected

Tabled Pending Revisions

Approved Pending Revisions

Approved—this proposal complies with University and federal regulations for the protection of human subjects.

Approval is effective until the following date: 4/2/2015

Items approved:

- X Research protocol (dated )
- X Informed consent (dated )
- X Recruitment materials (dated )
- X Other (dated )

Approval signature:  

Date: 4-2-14

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UNIVERSITY OF ALABAMA
Informed Consent for a Research Study

You are being asked to take part in a research study. This study is called: Navigating the Whirlwind: One Science Teacher’s Experience Utilizing a Science Fiction Novel in the Secondary Classroom. The study is being done by Leigh Hester who is a doctoral student at the University of Alabama. Dr. Sharon Nichols is the dissertation committee chair.

What is the study about?
This study will tell the story of the experience of a science teacher as a science fiction novel is used in the classroom.

Why is this study important? What good will the results do?
This study is important because it will be transferable to other educators in other classrooms seeking innovative and unique ways to incorporate content literacy into the science classroom. This study is extremely timely and beneficial for Alabama educators with the implementation of the content literacy standards of the Alabama College and Career Readiness (CCRS) Standards.

Why have you been asked to take part in this study?
You have been asked to take part in this study because you are an Alabama physical science teacher willing to try a new approach to content literacy and teaching science.

How many people besides you will be in the study?
Since this is the story of one teacher’s unique experience, you are the only participant in this study.

What will I be asked to do in this study?
If you decide to participate in this study, you will be asked to do these things:
1. Use the novel, Ender’s Game, with your physical science classes. Novels will be provided by the researcher.
2. Participate in up to five interviews (possibly audio-recorded) lasting approximately an hour for each interview. Audio- recorded interviews are optional (see below).
3. Allow researcher to observe you in your classroom while using books. Observations may be audio recorded. Up to five classroom observations will take place during the entirety of a class (period or block). Audio-recorded observations are optional (see below).
4. Share other documents related to the study with researcher. These may include notes, lesson plans, work samples, and emails.
5. Openly share and collaborate with researcher to relay your true experience of using the science fiction novels.

What if I choose not to participate in this study?
If you choose not to participate in this study, you will not be allowed to use the novels provided by the researcher. You will also not be required to take part in any of the study activities (observations, interviews, etc.). Refusal to participate will in no way affect your relationship with your school or the University of Alabama.

How much time will you spend in this study?
Classroom observations will be conducted during your normal class time. Interviews will take place at a time agreed upon by participant and researcher, possibly during planning time, after school, or weekends. Interviews will last approximately an hour each time.

What are the possible risks for being in the study?
Risks for participating in this study are minimal, however, possible risks will involve the time you spend with researcher during interviews and any inconvenience associated with researcher conducting participant observations in your classroom.

Will you be paid for being in this study?
You will not be paid for being in this study.

Will being in this study cost me anything?
There will be no cost to you for participation.

Can the researcher take you out of the study?
The researcher can take you out of the study if she feels that the study could cause you harm, even though risk for this study is minimal.

If you have questions, please feel free to contact Leigh Hester at 256-627-6623 (leigh.hestera@athens.edu) or Dr. Sharon Nichols at snichols@bamaed.ua.edu. If you have questions about your rights as a person taking part in a research study, or if you would like to make suggestions or file complaints and concerns, you may call Ms. Tanta Myles, the Research Compliance Officer of the University at (205)-348-8661 or toll-free at 1-877-820-3066. You may also ask questions, make suggestions, or file complaints and concerns through the IRB Outreach Website at http://osp.ua.edu/site/PRCO_Welcome.html. You may email us at participantoutreach@bama.ua.edu. Signing below constitutes your agreement to participate. You will be provided a copy of this form.

☐ Checking this box indicates that you agree to audio-recorded interviews.
☐ Checking this box indicates that you agree to audio-recorded observations.

Printed Name

Signature

Date 4/11/14

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 4/13/14
EXPIRATION DATE: 4/12/2015
UNIVERSITY OF ALABAMA
INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS
REQUEST FOR APPROVAL OF RESEARCH INVOLVING HUMAN SUBJECTS

I. Identifying information

Principal Investigator
Names: Leigh Hester
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Title of Research Project: Navigating the Whirlwind: One Science Teacher's Experience Utilizing a Science Fiction Novel in the Secondary Classroom

Date Submitted: 3/12/15
Funding Source: N/A

Type of Proposal □ New □ Revision □ Renewal □ Completed □ Exempt
Please attach a renewal application
Please attach a continuing review of studies form
Please enter the original IRB # at the top of the page

II. NOTIFICATION OF IRB ACTION (to be completed by IRB):
Type of Review: _______ Full board □ Expedited

IRB Action:
□ Rejected
□ Tabled Pending Revisions
□ Approved Pending Revisions
☑ Approved - this proposal complies with University and federal regulations for the protection of human subjects.
Approval is effective until the following date: 3-25-16 4:50
Items approved: Research protocol (dated 3-25-16)
Informed consent (dated 3-25-16)
Recruitment materials (dated 3-25-16)
Other (dated 3-25-16)

Approval signature (redacted) Date 3-26-16
UNIVERSITY OF ALABAMA
Principal/Superintendent Permission for Research

I am asking permission to conduct a research study in your school. This study is called: Navigating the Whirlwind: One Science Teacher’s Experience Utilizing a Science Fiction Novel in the Secondary Classroom. The study is being conducted by Leigh Hester, a doctoral student at the University of Alabama. Dr. Sharon Nichols is the dissertation committee chair.

What is the study about?
This study will tell the story of the experience of a science teacher as a science fiction novel is used in the classroom.

Why is this study important? What good will the results do?
This study is important because it will be transferrable to other educators in other classrooms seeking innovative and unique ways to incorporate content literacy into the science classroom. This study is extremely timely and beneficial for Alabama educators with the implementation of the content literacy standards of the Alabama College and Career Readiness (CCRS) Standards.

Why has a teacher in this school been asked to take part in this study?
A teacher in this school has been asked to take part in this study because he/she is an Alabama physical science teacher willing to try a new approach to content literacy and teaching science by using a science fiction novel in the classroom.

How many teachers will be participating in this study?
Since this is the story of one teacher’s unique experience, only one teacher will be participating in this study.

What will the teacher be asked to do in this study?
After permission is obtained from teacher, he/she will be asked to do these things:

1. Use the novel, *Ender's Game*, with his/her physical science classes. Novels will be provided by the researcher.
2. Participate in up to five interviews (possibly audio-recorded) lasting approximately an hour for each interview. Audio-recorded interviews are optional for the teacher.
3. Allow researcher to observe him/her in the classroom while using books. Observations may be audio recorded. Up to five classroom observations will take place during the entirety of a class (period or block). Audio-recorded observations are optional for the teacher.
4. Share other documents related to the study with researcher. These may include notes, lesson plans, work samples, and emails.
5. Openly share and collaborate with researcher to relay the true experience of using the science fiction novels.

What if the teacher chooses not to participate in this study?
If the teacher chooses not to participate in this study, he/she will not be allowed to use the novels provided by the researcher. He/she will also not be required to take part in any of the study activities (observations, interviews, etc.). Refusal by the teacher to participate will in no way affect his/her relationship with the school or the University of Alabama.

How much time will the teacher spend in this study?
Classroom observations will be conducted during normal class time. Interviews will take place at a time agreed upon by participant and researcher, possibly during planning time, after school, or weekends. Interviews will last approximately an hour each time.

What are the possible risks for the teacher participating in this study?
Risks for participating in this study are minimal, however, possible risks will involve the time the teacher spends with researcher during interviews and any inconvenience associated with researcher conducting participant observations in the teacher’s classroom.

Will the teacher be paid for being in this study?
The teacher will not be paid for being in this study.

Will being in this study cost anything?
There will be no cost to teacher or school.

Can the researcher take the teacher out of the study?
The researcher can take the teacher out of the study if he feels that the study could cause him or her harm, even though risk for this study is minimal.

If you have questions, please feel free to contact Leigh Hester at 256-627-6623 (leigh.hesterc@uab.edu) or Dr. Sharon Nichols at snichols@bama.ua.edu. If you have questions about your rights as a person taking part in a research study, or if you would like to make suggestions or file complaints and concerns, you may call Ms. Tanta Myles, the Research Compliance Officer of the University at (205)-348-8461 or toll-free at 1-877-820-3066. You may also ask questions, make suggestions, or file complaints and concerns through the IRB Outreach Website at http://osp.ua.edu/site/prco_welcome.html. You may email us at participate@osp.ua.edu. Signing below constitutes your agreement to participate. You will be provided a copy of this form.

Printed Name _______________________________ Title ______________
Signature _______________________________ Date ____________

UNIVERSITY OF ALABAMA
CONSENT FORM APPROVED: 4/3/14
EXPIRATION DATE: 4/3/2015
APPENDIX B

Theoretical Framework

Science Teacher
Utilizing Science Fiction Novel
**Scientific Literacy:** The pursuit and promotion of scientific literacy is the overarching goal of science educators. Facilitating scientific literacy represents the job that a science teacher is responsible for doing in the classroom. It is positioned higher than the other components because it is what guides the science teacher as they teach content. It is also intertwined with the other components because they all work together to create the classroom environment in which a teacher exists. To facilitate scientific literacy in the classroom and with students, the science teacher must navigate the many standards, reforms, mandates, and best practices that guide and influence what happens in the classroom.

**Educational & Science Discourses:** These discourses both directly and indirectly influence the teaching practices of the science teacher. They represent the various reforms and standards as well as the recommended best practices for teaching science. These educational and science discourses must be navigated while the science teacher continues to facilitate scientific literacy. They create the complex reality of the science teacher, yet how he conceives and addresses these discourses is part of his identity; thus, his personal Discourse (note capital D) and belief system factor into his decisions. Again this is intertwined with the other two components because each affects the other.

**Situated Cognition:** The situated cognition of the teacher represents the essence of what takes place in and outside of the classroom, and situates it in the living reality of the science teacher. The situated cognition of the science teacher is located at the base of the whirlwind funnel because the other two swirling components influence and create this reality, regardless of whether the teacher is totally aware of these influences or not. The science teacher’s situated cognition places him as both learner and teacher simultaneously as he employs a novice approach in the classroom.

**Science Fiction Novel:** The science fiction novel is the tool that this science teacher will use in the classroom to address content literacy and reading in science. It is a tangible object that can assist in successfully actualizing the other whirlwind components within the classroom.