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Science Based Education for Students Who Are Deaf and/or Hard of Hearing

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“Science Based Education for Students Who Are Deaf and/or Hard of Hearing”

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Abstract

Research studies have shown that if science is taught through inquiry using both hands-on and minds-on instruction, the theory of science-based learning would be the best method to teach students with disabilities (Luckner & Carter, 2001).

In the field of Deaf education, it is well known that for a majority of students who are Deaf and/or Hard of Hearing (D/HH), American Sign Language (ASL) is their primary language with its own syntax and grammar. The English language is, in actuality, a Deaf student's second language. With this in mind, students who are Deaf are functionally English-language learners (ELLs) or limited English proficient learners. Looking at students who are D/HH as actual ELLs, it would seem logical to research what has been used as best practices in teaching Hearing ELL students. Sutman (1993), Barrera, Shyyan, & Liu (2008), Echevarria (2005), and McCargo (1999) all came to the conclusion that exposure to hands-on, inquiry based science helped facilitate the acquisition of language and the development of cognitive skills to hearing English-language learners. If ELLs are successful in learning English through a science-based curriculum, can students who are D/HH do the same? This mixed methods research study gathered data to validate the need to use a science-centered curriculum to support reading comprehension with 4th and 5th grade students at a school for the Deaf in a northeastern, urban region of the United States.

Findings from this action based phenomenological research study included an increase in vocabulary retention in science, as well as an increased trend line of correct responses during English Language Arts (ELA) classes. Along with this quantitative data, qualitative data was collected supporting the perspectives of both teachers and students in this mixed methods study. Six teachers and four students were interviewed that met the criteria of this study and concluded that motivation and experiential learning through the lens of science increased students' ability to retain information, as well as word identification, compared to an English-centered curriculum.

Key Words: Deaf, Hard of Hearing, Deaf Education, ELL, Science, Reading, Constructivism, Reading Comprehension, Mixed Methods, Inquiry, Experiential Learning.

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Chapter One

Introduction

A majority of students who are Deaf and/or Hard of Hearing (D/HH) continue to fall below grade level in reading and comprehension of language skills (Marschark, Sapere, & Convertino, 2009). The purpose of this mixed methods research was to determine if changing the lens of learning for students who are D/HH from English-centered learning to Science-centered learning would increase reading comprehension skills compared to the levels that are currently being achieved.

This chapter begins with an overview of the background of the study that includes the laws, research, proficiencies and discrepancies within the context of students who are D/HH. Research problems will be addressed following this background study and will include how it will be addressed within the dissertation along with the researcher's approach to the problem, assumptions, and researcher's perspectives. Next will be the research questions to support and clarify the process of this study. This will lead to the context of the study to show how the study was approached. The rationale for and significance of the study will follow, allowing for the reader to understand the rationale and significance of the study.

Background of the Study

With the Individuals with Disabilities Act of 1990 (IDEA PL 94-142), the No Child Left Behind Act of 2001 (NCLB PL 107-110), and the Individuals with Disabilities Education Improvement Act of 2004 (IDEIA), teachers are required to use evidence-based practices, provide services to students with disabilities in the least restrictive environment and achieve grade level content areas for student learning (Andrews, 2004, as cited in Easterbrooks, 2008).

No Child Left Behind Act (NCLB) of 2001 suggests that education policies and practices should be based on scientific evidence (Luckner, 2006).

> According to the U.S. Department of Education, Office of Special Education Programs (2002), hearing impairment comprises of 0.11% of the estimated school-age population and 1.23% of all children with disabilities. Hence, hearing loss is a low-incidence disability. The low–incidence nature of the impairment and its wide geographic dispersion leads to difficulties in conducting studies that meet the U.S. Department of Education's 'gold standard' which includes a relatively large sample size and random assignment to form treatment and control groups (Luckner, 2006, p. 50).

This causes a discrepancy with the ability to show evidence-based practices within the D/HH student population. "Educational practices have most often been based on opinion rather than any form of investigation" (Luckner, 2006, p.50).

Students who are Deaf and/or Hard of Hearing (D/HH) have faced many challenges with their ability to learn English. English is often not the first language of a person who is Deaf. Their first language is visual, be it American Sign Language, home signs and gestures, cued speech or visual communication. Researchers through the years, such as Boyd and George (1971), Lang & Albertini (2001), Marschark, Sapere, & Convertino (2009), and Scruggs, Mastropieri, & Okolo (2008) have found minimal improvement with increasing student knowledge of English compared to their hearing peers. Students who are D/HH are reading and comprehending grade level language skills significantly lower than their hearing peers. Research by Marschark, Sapere, & Convertino (2009) found the median reading achievement of deaf 18-year-old students in the United States has increased only from that typical of a hearing 8-year-old (grade level 2.7; 1986) to that typical of a 9-year-old (grade level 4.0, 2000). Deficiencies in writing ability, together with limitations imposed by lack of reading ability, are major contributors to deaf children's generally poor academic performance (Lang & Albertini, 2001).

There is a difference in the background knowledge and learning strategies of hearing and Deaf children that need to be addressed. A variety of approaches to literacy has continued to show little progress for students who are D/HH and in turn, students are completing high school with a greater disadvantage and lagging behind their hearing peers in their competencies in reading and writing (Marschark,1997). In 2013, little has changed and the pressures of state mandates continue to build without finding evidence based solutions on how to close the gap of reading comprehension for students who are D/HH.

Research Problem

In the field of Deaf education, it is well known that for students who are Deaf, American Sign Language (ASL) is most often their primary language with its own syntax and grammar. The English language is, in actuality, a Deaf student's second language. With this in mind, students who are Deaf are functionally English-language learners or limited English proficient learners. These students are learning the English language through the process of second language acquisition similar to, though not identical to hearing students who have a home language other than English. Viewing students who are D/HH as ELLs, it would seem logical to research what has been used as best practices in teaching hearing ELL students. Has science-based learning helped typical hearing ELL students with learning and increasing their reading comprehension of the English language?

Research Approach

"Since limited English proficient (LEP) students learn English skills most effectively when they are taught across the curriculum, it is especially productive to integrate science and English teaching” (Sutman, 1993, p.2).

To support this researcher’s ontology of science-centered learning for students who are D/HH, data was collected from research based on hearing English Language Learners (ELLs) and evidence-based practices showing an increase in reading and comprehension. In 2005, Lee gathered studies that were published from 1982 through 2004 focusing on science education at the elementary and secondary levels, K–12. The selected research used “empirical studies from different methodological traditions, that included (a) experimental and quasi-experimental studies; (b) correlational studies; (c) surveys; (d) descriptive studies; (e) interpretative, ethnographic, qualitative, or case studies; (f) impact studies of large-scale intervention projects; and (g) demographics or large-scale achievement data” (Lee, 2005, p.495). Lee’s research synthesis concluded that through science inquiry-based instruction, both science and English proficiency increased. Sutman (1993), Barrera, Shyyan, & Liu (2008), Echevarria (2005), and McCargo (1999) also concluded that exposure to hands-on, inquiry-based science facilitates the acquisition of language and the development of cognitive skills of hearing English-language learners. Based on this information, can students who are D/HH also increase their reading and comprehension through the lens of inquiry-based science?

To emphasize the possibility for students who are D/HH to increase their learning of English through the lens of a science-centered program, a phenomenological, mixed methods action research case study was developed and conducted by this researcher. By examining the effects of science-centered learning, evidence was gained through the use of test scores and the perspectives of the practice of using science as the tool for learning English by both the teachers and the students. Phenomenology entails the “investigation of lived experiences of people to identify the core essence of human experience as described by research participants" (Bloomberg & Volpe, 2008). The phenomenon identified with students who are Deaf is not only the delay in learning the English language, but the lack of retention at all grade levels. Interviews to understand the teacher's perspective of this phenomenon was critical. An action research strategy was also crucial to this study. The goal of action research is to improve a practice, and in this instance, in education (Marshall & Rossman, 2011). Marshall and Rossman stated, "participatory action research is full collaboration between researcher and participants in posing the questions to be pursued and in gathering data to respond to them" (p. 23). As an educator of the Deaf, professional experiences and perspectives can be addressed with other teachers of the Deaf that experience the same phenomena. The objective of this research was to examine, with the potential to change the focus of teaching from language-centered, to science-centered. An action research strategy to support this theory was the most appropriate choice. "Action research is the study of action, often with the intent to lead to better action, but it is special in that it is carried out by the people directly responsible for the action"(Stake, 2010, p. 159). Having one's own personal actions, through change, to improve the abilities of students who are D/HH will possibly have a greater impact on educators in the field of Deafness (compared to researchers or consultants that are not in this specific field).

It was the goal of this phenomenological action research study to determine any potential benefits of a science-centered curriculum compared to an English language-based curriculum, in relation to student learning.

Research Assumptions

Science has not been a high priority nor has it been looked upon as a base for teaching language (Lee, 2005). Until recently, science test results did not factor into state accountability measures for student learning (high stakes tests focused on English and math). This factor might suggest why research focused on assessment accommodations in science for ELLs was sparse (Lee, 2005). This also applies to D/HH students. Students who are D/HH continue to lag behind their hearing peers. Little research has been done to make a connection between ELLs and how they learn compared to D/HH. If science-based learning can support ELA for ELLs, is it possible for D/HH to have similar outcomes?

Discrepancies comparing students who are D/HH to students who are hearing ELLs have been found within professional literary reviews. Marschark (1997) suggested, since ASL vocabulary and syntax do not parallel printed English, students who are D/HH remain at a greater disadvantage than their ELL peers (Marschark, 1997). The study by Singleton et al. (2004) suggested that educators use caution when considering using the same English teaching strategies to students who are D/HH as with ELLs. However, if the focus were on teaching science to support the learning of English, would both populations benefit?

Research Perceptions

This researcher has a Bachelor of Science in Elementary Education, a Master of Science in Deaf Education and a Master of Arts in Education in Environmental Science and is currently completing a doctorate in Special Education.

As an educator and a lead teacher at a school for the Deaf for the past nineteen years, this researcher has been exposed to an array of strategies to try to improve the English language skills of the students. There seems to be a continued struggle with what would show the most success for our population of students. One strategy that had not been attempted school wide was to change the focus from English-centered learning, to science-centered learning. Science-centered learning was taught in the late 1990’s when this researcher had the opportunity to teach a year-long, hands-on Watershed project with the middle school students. With support from both the Math and Social Studies teachers, there was full collaboration for the students to learn with the main focus on science. All of the English Language Arts (ELA) focused on the Watershed, be it poetry, reflections, informative information, historical information, narratives and so on. At the time, there were no mandated state testing scores or other high-stakes tests to see if the students improved their reading skills. The Watershed continues to be a part of the 6th grade curriculum today, but it is not approached in the same manner as it was, with full cooperation or collaboration from other staff. Is it possible for a science-centered curriculum to be effective (to be able to increase comprehension scores in reading) on all the elementary grade levels? Using a mixed method action research study helped focus on the researcher's professional knowledge of students who are D/HH and to work collaboratively, to question current practices, make changes, and assess the effects of those possible changes.

With the literary research that was collected to support science-centered learning with English language learners, the following research questions were applied to this dissertation.

Research Questions

1. **Qualitative.** (1) What are teacher's perspectives of using a science-based curriculum to teach reading to students who are D/HH?

   (2) What are student's perspectives of using a science-based curriculum to learn English and reading?

2. **Quantitative**. Is there a significant difference in learning outcomes when using passages to test for comprehension with both text-based and inferential questions when using a science-based curriculum to support reading compared to using an English-based curriculum?

3**. Mixed Methods**. How do teacher and student perspectives of science-based learning support possible increased test scores in reading compared to English-based test scores?

Contexts of the Study

The setting for this study was at a school for the Deaf in an urban, northeast region of the United States. Each student at this school has an Individualized Education Program (IEP). Regardless of the students' disability, disabilities, or severity of the disability, all students are mandated to participate in state accountability testing in accordance to their grade level. Students are to achieve at a level of "proficiency or above" in accordance to NCLB for the home school district to report on Adequate Yearly Progress (AYP) and for the student to receive a high school diploma. Testing begins at the third grade level.

Participants

Participants in this study included voluntary students (through consent from both parent and student) in the fourth and fifth grade (during this study) that did not have comorbid disabilities. Students were tested throughout the course of this study to document and compare achievement levels in their reading comprehension skills using the school's Running Record assessment tool that was applied to all elementary level students (at this school). Observation of student progress was documented by the researcher, teachers, and certified reading specialist at the school for the Deaf during this study.

Teachers of these students were invited to participate in the study with a signed consent form, in accordance with IRB. Teachers were interviewed via videotape individually and as a focus group to document the perspectives of student learning through an English-centered and science-centered curriculum.

Method

Data collection of this phenomenological, mixed methods action research case study began with categorizing where the participating students were performing within the context of reading and comprehension using the school developed assessment tools. Simultaneously, individual interviews with participating teachers were implemented. The next step was working collaboratively with the participating teachers to help with both the ELA lessons and the science-centered intervention. After the six to eight week intervention was complete, two participating students from each class were randomly interviewed by the researcher. Data was collected at the end of the intervention to document outcomes using the same school developed assessment tool. This mixed method of data collection and perspectives of those who participated were integrated in the results and analysis section of this research.

Rationale for and Significance of the Study

The lack of data that has been researched on evidence-based practices to increase the language skills for Deaf learners continues. The significance of this research study was to apply the strategy of a science-based approach to increase the language skills of students who are D/HH. Research has shown science-based approaches to learning the context of English has been effective within the population of hearing English language learners (ELLs) (Barrera, Shyyan & Liu, 2008, Echevarria, 2005, McCargo, 1999, Lee, 2005, and Sutman, 1993). Although there has been some research comparing ELLs with students who are Deaf, in the context of learning English, the comparison of the science-based strategy had yet to be researched.

Findings from this study has informed and extended current best practice instructions by teachers of the Deaf, in the context of teaching English Language Arts (ELA) through a science-based curriculum. If using a science-based curriculum to support ELA is effective (effective, meaning, overall, significant improvements in mandated test scores and other forms of reading comprehension assessments in one school for the Deaf), it may become established as a best practices option in classrooms and schools for the Deaf around the country. The significance of using an action research approach was to provide examples of ways to change, monitor, and brainstorm thinking, in real classroom contexts, to move into a science-based mode/perspective of teaching students.

Conclusion

Overall, students who are Deaf and/or Hard of Hearing continue to struggle with reading and comprehending the English language. This struggle has been on the front line of Deaf Education for decades with questions of "How can we help our students achieve?" with still few answers. Finding evidence-based practices for teaching students who are Deaf remain limited due to this low incidence population.

Making connections between hearing English language learners (ELLs) and the means to learn through the lens of a science-based curriculum may lead to the answer to support the needs of students who are D/HH. Very little research has been done or tested to make the comparisons with the science connection and how students can retain the English language that is being taught until now, with the research presented in this dissertation.

In the following chapters of this dissertation, past and current literary research focused on educating students who are Deaf, educating students who are ELLs and the cross connections to science has been presented. The methodologies of how to address the issues of creating a science-based curriculum, and to test the theory that learning English through the context of science will be described in detail in chapter three.

Can students who are D/HH increase their reading comprehension skills through the lens of science? This dissertation research, with the use of qualitative and quantitative methods has helped to determine if this achievement was possible.

Chapter 2

Literature Review

Science Based Education for Students Who Are Deaf and/or Hard of Hearing

The primary purpose of this research was to review literature documenting best practices in teaching students who are Deaf and/or Hard of Hearing. To understand the complexity of teaching students who are Deaf and/or Hard of Hearing, this review consisted of the history of teaching students who are Deaf and/or Hard of Hearing (D/HH); best practices that have been and are currently being used for students who are disabled, but who are not necessarily Deaf; best practices for students who are English-language learners (ELLs) or have limited English proficiency (LEP); and lastly, best practices for students who are D/HH with a focus on science-based learning. With the Individuals with Disabilities Act of 1990 (IDEA PL 94-142), the No Child Left Behind Act of 2001 (NCLB PL 107-110) and the Individuals with Disabilities Education Improvement Act of 2004 (IDEIA), teachers are required to use evidence-based practices, provide services to students with disabilities in the least restrictive environment and grade level content areas for student learning (Andrews, as cited in Easterbrooks, 2008). The IDEA law was developed to eliminate discrimination in education by implementing appropriate accommodations for children with disabilities in the school systems and for these students to be able to be on the same competitive field as their nondisabled peers (Marschark, 1997). Marschark (1997) concluded that this law was not only lacking details, but funding has led to local and state level conflicts as to how and who was to support these accommodations.

Due to the lack of details and funding, the question of what are evidence-based best practices for students who are D/HH are still being determined today.

History and Background of Educating Students who are Deaf and/or Hard of Hearing

To understand the current status of children who are Deaf and/or Hard of Hearing in education, one must understand the history of how these children were educated. This begins with defining what it means to be Deaf and/or Hard of Hearing. According to the IDEA of 1990, the federal definitions are as follows:

Deaf: A hearing loss which adversely affects educational performance and which is so severe that the child is impaired in processing linguistic (communication) information through hearing, with or without amplification (Individuals with Disabilities Education Act, 1990).

Hard of hearing: A hearing loss, whether permanent or fluctuating, that adversely affects a child's educational performance but which allows the child access to some degree of communication with or without amplification (Individuals with Disabilities Education Act, 1990).

> When a child has a hearing loss during the developmental years, all areas of development can be affected significantly. A hearing loss limits ease of acquisition of a communication system, which further influences development of interactions with others, the ability to make sense out of the world, and ease of acquiring academic skills. (Easterbrooks, 1997, p. 1)

Schildroth and Hotto (1996) reported that 48,300 children have been identified as having a hearing loss in the United States. In addition, 25% to 33% of this school-age population has comorbid, significant disabilities (Holden-Pitt & Diaz, 1998; Karchmer & Allen, 1999; Schildroth & Hotto, 1996).

Students who are Deaf and/or Hard of Hearing (D/HH) are typically delayed in language. McAnally, Rose, and Quigley (1987) stated, "The acquisition of language requires fluent communicative interaction between children and mature language users as well as intact sensory mechanisms to transmit linguistic information to the brain" (p.29). Singleton, Morgan, & DiGello, (2004) emphasized that children who are profoundly deaf have great difficulty acquiring English vocabulary in the same manner as hearing children do, through the incidental learning process. Not being able to overhear conversations and the limit of an early literacy experience, children who are Deaf struggle to develop age-appropriate English as their hearing peers (2004). Language delay often begins in the home where the child who is Deaf does not necessarily have access to their parent's English (Marschark, 1997). The parents are typically not proficient in sign language (1997). "The lag in language skills tends to increase during the school years, as deaf children of hearing parents show slower growth in language development relative to hearing children, even if both show the same general pattern of development" (p. 135). To add to the lack of communication and delay of language, American Sign Language (ASL) has no written form. The ability to transfer from the first language of ASL to the second language of English continues to be a struggle for students who are Deaf (Singleton, Morgan, & DiGello, 2004).

With the factors of language delay beginning in the home and the conflict between ASL and English communication, the ability to meet a child's needs coming into a school system can be daunting. Standards for students who are Deaf have been ongoing to support these issues.

History of Standards in Deaf Education

The Council on the Education of the Deaf (CED) began in 1930. Educators of the Deaf and Hard of Hearing developed mutually agreed-on standards for educating their students (CED, 2003). The "CED's Executive Board approved a revised process of accreditation of teacher preparation programs in deaf education on June 26, 1977" (CED, 2003, p. 6).

The National Council for Accreditation of Teacher Education (NCATE) formed a partnership with CEC and in “March 1992, the first set of *common core* standards became available. *The Red Book*- the common core was a set of 107 specific statements across eight categories that all teachers of exceptional children, regardless of discipline, were to learn” (Easterbrooks & Putney, 2008, p. 6). The eight categories included standards for:

- philosophical, historical, and legal foundations of special education
- characteristics of the learner
- assessment, diagnosis and evaluations
- instructional content and practice
- planning and managing student behavior and social interaction skills
- communication and collaborative partnership
- professionalism and ethical practice.

According to Spencer, Marschark and Swanwick (2010), examples of “best practices” to meet the expectations of these standards are abundant in both the classroom and laboratory in educating students who are D/HH. However, the majority of this information is either unevaluated or underutilized. (One example of this lack of information is the efforts used to teach students who are D/HH literature using the same techniques and best practices used for students who are hearing (Marschark, 1997). There is a difference in the background knowledge and learning strategies of hearing and Deaf children that need to be addressed. This approach to literacy has continued to show little progress for students who are D/HH and in turn, students are completing high school with a greater disadvantage and lagging behind their hearing peers in their competencies in reading and writing (1997).

While these reforms continued to develop, nationwide mandates for all students were introduced with the No Child Left Behind Act of 2001.

The Introduction of the No Child Left Behind Act of 2001

On January 8, 2002, the NCLB Act of 2001 was signed into law and made sweeping reforms in general education (Steffan, 2004). The law's stated purpose was to close the achievement gap with accountability, flexibility, and choice so that "no child is left behind". The specific goal of the law was to ensure that all students were 100% proficient in reading, mathematics and science by 2014 (2004). These goals also included the participation and proficiency of goals being met by students with disabilities (Cawthon, 2004).

The NCLB six priorities includes; (1) higher accountability for results; (2) more choices for parents; (3) teachers who are highly qualified; (4) the encouragement of proven educational methods; (5) greater freedom for states and communities; and (6) flexibility in funding (U.S. Department of Education, 2002).

The law included several goals which stated the following: All students in the US will attain proficiency or better in reading and mathematics by the 2013-2014 school year. All students with limited English proficiency (not necessarily Deaf) will become proficient in English. All students will be taught by highly qualified teachers by 2005-2006. All students will learn in safe, drug-free schools conducive to learning. All students will graduate from high school (U.S. Department of Education, 2002). This seemingly daunting task has become more difficult due to shrinking local, state, and federal dollars and unfunded mandates like ADA and IDEA that offer educational opportunities but no realistic way of achieving them (Marschark, 1997).

Standards developed by IDEIA and NCLB. According to Easterbrooks (2008b), "Current mandates from the No Child Left Behind Act (NCLB) and the Individuals with Disabilities Education Improvement Act (IDEIA) require teachers to use evidence-based practices" (p.12).

Swanwick and Marschark (2010) emphasize that “due to the heterogeneity of deaf children and the low incidence of significant hearing losses, the large-scale randomized design studies considered the ‘gold standard’ for certitude simply are not going to happen” (p.225).

These standards are the “initial set of standards” for beginning teachers and “advanced set of standards” for teachers who are on the advanced level for teaching students who are D/HH. Within the standards; “DH” represents “deaf and hard of hearing”, “K” means “knowledge” statement, and “S” represents a “skills” statement. Following the standards, clarification and needs of Deaf students in education will be reviewed. Each of the standards will be addressed when reviewing best practices for students who are D/HH using research-based references, literature- and theory-based references and/or practice-based references.

Steffan (2004) stated that “the law has great and lofty goals” (p.47). Some will be difficult to attain for many children with disabilities including those children who are Deaf. However, in the opinion of Mauk (1993), the ultimate goal for educators is to help each child push the limits of his or her capabilities, and to achieve as much as possible in the school setting.

Initial Set of Standards for Deaf and Hard of Hearing Students. The first standard provided by The National Council for Accreditation of Teacher Education (NCATE) (Easterbrooks & Putney, 2008) to be addressed in this review was standard two. Standard two focused on the development and characteristics of the learners (Cognitive and language development of individuals who are deaf or hard of hearing: DH2K1)**.** Knowing the cognitive function of students can help teachers match strategies to the needs of the students. Boyd and George (1971) stated that Piaget’s cognitive theory posts the roots of intellectual development in the direct manipulation of the environment, not in the verbal symbol (1955). “The basic cognitive structures are derived from actions with the observations that young children classify manually before they can classify linguistically"(p.3).

Lang and Albertini (2001) stated that "reading and writing form an essential link to the worlds of social and cognitive interaction, and the consequences of illiteracy have an increasing impact on all realms of functioning as deaf children grow up" (p. 260). Deficiencies in writing ability, together with limitations imposed by lack of reading ability, have been major contributors to Deaf children's generally poor academic performance. The term "functional literacy" is linked to basic reading and writing skills. Students who are functionally literate have only minimal reading and writing abilities necessary to function in society through access of written communication (Marschark, 1997). The emphasis within the research of Marschark, et.al (2011) conclude D/HH students generally begin their education with less developed academic and world knowledge and language competence compared to their hearing peers. Their experience of the world is through vision and direct experiences of what is taught to them at home or in school (2011). To increase academic performance, with the knowledge of an incoming deficit, specifically in the realm of literacy, several research-based models have been shown to be effective.

Testing students cognitive abilities, Boyd and George (1971) divided students who were Deaf into experimental and control groups. Both a pretest and a posttest were provided. The control group used formal (text book) instruction in science and the experimental group used inquiry-based science. The emphasis was on the production of new concepts through hands-on/ minds-on science [activities focus on core concepts, allowing students to develop thinking processes and encouraging them to question and seek answers that enhance their knowledge and thereby acquire an understanding of the physical universe in which they live (North Central

Regional Educational Laboratory, 1995)], rather than focusing on new vocabulary from the text (English-based learning) (1971). The results of the analysis demonstrated a significant change in the level of categorization used by the Deaf children in the experimental group. This indicated that physical experience, rather than language attainment, was the critical factor in the development of categorization within the context of teaching science. The researcher noted that "deaf children can benefit from participation in inquiry based on physical manipulation of objects" (p.12).

Visual tools and organizers that support content mastery and retention by individuals who are D/HH (DH4K1) was another criterion for the initial set of standards. Many students with hearing loss are visual learners. According to Easterbrooks and Stephenson (2006), one of the ten best practices in science is the practice of visual organizers. This information was gathered by field-supported practices, highlighted from nearly 500 articles. "Visual organizers are a favorite field –promoted practice in fostering content-area acquisition with students who are deaf or hard of hearing" (p. 392). However, there has been little research to compare outcomes of the uses of visual to the nonuse of visual tools for those who are Deaf or Hard of Hearing (2006). As of 2011, Marschark, et al. researched two strategies that supported the learning for student who are D/HH. The first was the use of concept maps and other diagrams that provide a visual relationship among categories within and among themselves. The second was the use of games or activities that focus on similarities and differences among concepts at different levels (2011).

Developing proficiency in the languages used to teach individuals who are D/HH (DH4S1) is another skill set from NCATE used for the initial set of standards. "Regardless of choices made for students and issues that surround the appropriateness of interventions for individualized programming and instruction, other literature strongly supports the need for teachers to be competent in what they teach"(Easterbrooks, 2008b, p. 17). However, the focus of how to approach language instruction and support for students who are D/HH have hindered the use of how students can be supported through their diverse range of communication experiences (Swanwick & Marschark, 2010) and therefore the question of how to best communicate with a range of communication modes within one classroom continues. This concern should not only apply to the core courses that one teaches but the fluency and proficiency of the language that is used to teach the courses to those who are D/HH.

Proficiency with the courses being taught. The NCLB Act states that all educators should be 'highly qualified' to teach in their field. According to a survey given by Lang and Propp (1982), half of the science teachers of the Deaf who were currently teaching science indicated they had not taken even one science education course. This percentage surveyed in 1982, had minimal change when reading Easterbrooks, Stephenson and Mertens survey in their published journal in 2006. The article stated that for "possessing specific training, experience, and certification in content-area knowledge, 54% indicated that they felt that the practice was clearly beneficial. Interviewers were quoted stating; 'I am a skilled learner/teacher and I have the ability to teach any content well and learn it on my own in order to teach it,' summing up the opinions of those who did not feel the need for additional credentials in content area" (p.406). Although it is not clearly evident that certification in content areas improves achievement of students who are D/HH, there are studies that have supported the importance of content expertise (Easterbrooks, 2006).

Proficiency in the language of the learner. The teacher as a skilled communicator has been a recurring concern for educators who teach students who are D/HH. "It is essential to acknowledge that most deaf students come to school without the language fluencies necessary to benefit optimally from instruction"(Swanwick, Marschark, 2011, p.219). The language skills of the learner directly affect the ability to achieve academically and continue to lag, falling farther behind as the academic years increase (2011).

> Teacher's ability to communicate is a crucial component of effective instruction. For teachers of the deaf, this means striving for native like skills in ASL, quality replication of English structure when using English based sign systems, and a solid repertoire of techniques for making language comprehensible when using spoken language with orally communicating students (Easterbrooks, 2006, p.391). .

In the survey that was conducted by Easterbrooks, Stephenson and Mertens, 92% of the master teachers in Deaf education stated that being a skilled communicator was most beneficial (2006).

Through the realm of science, Easterbrooks and Stephenson's examination of best practices used in educating students who are D/HH (2006) appeared as one approach to increase the language of the learner. A study of Norwegian teachers who were Deaf reflected on their own experiences when asked about factors that contributed to their success, stated that learning the science concepts through their own visual language helped them understand and express their own thoughts 'through the air' (Roald, 2002).

Providing activities to promote print literacy and content area reading and writing through instruction via spoken language and/or signed language indigenous to the Deaf community (DH4S2) was another skill based initial set of standards from the NCATE. The language that is provided in the home of children who are D/HH before school age, depends greatly on the family (Deaf family member or hearing family members and their ability to communicate 'through the air'), and how it will impact the child's ability to read and write (Swanwick &Marschark, 2010). Students who are D/HH need to construct meaning with their writing by understanding what is being stated via sign language (Easterbrooks & Stephenson, 2006; Lang & Albertini, 2001; Lang, Hupper, & Monte et al. 2007; Marschark, Sapere, & Convertino, 2009).

Social Constructivist Theory. Lang and Albertini (2001) used a social constructivist theory to study how students receive meaning through written activities. “The emphasis in social constructivism is on the primary role of communication and social life in meaning formation and cognition”(p.259). Social constructivist theory places the teacher in the strategic role of organizer and facilitator of social and cultural activity (Lang, 2001).

Lang and Albetini (2001) analyzed 228 writing samples from Deaf students in grades 6-11 as well as the explanatory and reflective comments of teachers. The four major strategies that were used to connect a social construct included: 1.*Creative piece* (fictitious situation connected to their learning); 2. *Guided free writing* (specific instructions to follow in steps); 3.*Double entry* (copy of one paragraph, or part of one and then respond to it); and 4. *End-of-class reflection* (list two or three of the most important things you learned).

The results of this study concluded that students were able to use such processes as the scientific method (predicting, observing) through guided free writing and were able to construct meaning of the principles of science by using the creative piece. Teachers were able to assess both the comprehension and interpretations of the students through the double entry and the end-of-class reflections (2001).

Challenges in the theory of reading via sign language. Marschark, Sapere, and Convertino et al.’s (2009) research found “educators and researchers do not know as much about deaf students’ literacy as they think they do” (p.358). “One reason we have made so little progress in improving D/HH students' reading over the past 50 years is that their alleged reading challenges are not really about reading" (Borgna, et al. as cited by Marschark, 2009, p. 94).

> Taken together, such findings suggest that efforts to improve reading—and learning more broadly—need to focus more on the cognitive and metacognitive skills supporting language comprehension whether or not presented as text. Such skills largely are acquired incidentally by hearing children; for deaf children, it appears that we need to teach them more explicitly. (Borgna, Convertino & Marschark, 2011, p.5)

Students were tested on their knowledge of a topic by: (1) having a passage signed to them by a certified interpreter and, (2) reading a passage independently and writing about that passage. (2009). The results concluded that "although the present two experiments used different measures of learning, scores in both indicated that deaf students learned no more from signed instruction than they did from reading the corresponding texts" (p.367).

In support of the above information, Lang, Hupper, and Monte et al. (2007), conducted a study on technical signs in science. In Deaf education, specifically to the subject of science, there are few definite signs for scientific words. Educators may use a 'home-made' sign to match the work. To determine if this was a factor in learning outcomes, Lang, Hupper, and Monte et al. studied; "does sign selection by teachers (and interpreters) influence cognitive engagement and the construction of meaning in deaf students during a learning experience?" (p. 65). Through this study, the researchers found the importance of collecting multiple perspectives on a sign for a lexical database being used for instructional purposes. "The open-ended format again provided qualitative data that allowed us to use inductive analysis to identify factors which influence teachers' thinking in selecting and using signs in the classroom" (p.74). Dependent on the educational background of content being taught by the teacher, misconceptions of sign lexicons was evident" (p.77).

Additional research. To hold true to the standards that have been mandated by NCLB Act and IDEIA, there needs to be consistency with how students who are D/HH are being taught the appropriate signs for the content they are learning. Lang et al. (2007) state, "Imagery has been shown to be a predictor of long-term memory; we also need to investigate how teachers may best promote the development of imagery skills" (p. 78). Appropriate lexicons to match the meaning of vocabulary will support the imagery that allows for students who are D/HH to retain information learned. Marschark et al.,(2009) also conclude that "not only does lack of full access to communication impede formal and informal teaching and learning, but a related lack of language fluency can leave deaf students relatively unaware of how much they are missing" (p.366). Full access to communication included teachers understanding the context of the science topics being presented.

Providing balance among explicit instruction, guided instruction, peer learning, and reflection (DH4S4) was another skill set in the framework of the initial set of standards for D/HH students. It has been stated by Marschark, Spencer and Adams (2011) that "parents and teachers frequently demonstrate over-directedness and over-control of DHH children, appearing to believe that they are in constant need of assistance or protection" (p. 21). Dependency on teachers for reading and other academic opportunities has become a hindrance for students to discern meaning independently (2011). It is suggested that students should become better self-monitors and "engage in their own correction and remediation strategies" (2011, p. 21). Students who are D/HH use fewer strategies, are less accurate in metacognitive judgments and self-monitoring compared to their hearing peers (Borgna, Convertino, & Marschark, 2011).

Barman (1991) used an investigative and experimental design to study the use of the *learning cycle approach*. The main purpose of this project was to help educators develop specific teaching strategies in the content area of science. Few of the teacher participants ranked science as ‘very important” among the subjects they taught. However, there was recognition that students who are D/HH held an interest in science related to the activity-oriented approach to the subject (1991).

The response to the learning cycle program from the teachers’ perspective was that the students (a) became responsible for their own learning, (b) were more apt to try new things, (c) were more motivated, (d) became more confident, (e) retained more information and (f) were more observant (1991). The learning cycle approach was consistent with the skill set (DH4S4) stated above. However, more research needs to be provided for educators to teach at this level in science.

Instructional Planning (Standard 7) focused on integrating language instruction into academic areas (DH7S3) in the final initial set of standards for D/HH students. “Emphasis on reading sub-skills, memorizing vocabulary words, and answering teacher questions takes away from the reading of authentic texts for meaning and may lead students to adopt relatively superficial comprehension criteria while failing to acquire the metacognitive strategies necessary for fluent reading”(Borgna, Convertino, & Marschark, 2011, p.80). McIntosh, Suzen, Reeder and Holt (1994), stated that “active learning encourages students to choose from among various paths and allows the students to move from one path to another, depending upon self-initiated lead” (p. 481). In teaching science, the process-oriented approach advocated cooperative learning due to the natural curiosity of the student. This helped with language and communication skills, and gave students opportunity to develop more rapidly and naturally dependent on self-initiation of the student. This process integrated reading, writing, communication and problem solving (1994).

Although teachers were responsible for teaching all subjects in elementary school, of the four areas (language arts, social studies, mathematics and science) science had gotten the least attention (Mangrubang, 2004). The Full Option Science System (FOSS) was developed to help integrate science into the elementary school curriculum. FOSS had made science more applicable to contexts common to everyday experiences, along with teaching hands-on/minds-on learning (2004).

More research needs to be applied to such systems as FOSS in teaching students who are D/HH. Yore (2000) stated that students need to "do first and read and write later" (p.105). There is limited research on the value of print-based language in science learning; hence more needs to be investigated for the future (2000).

Along with the initial set of standards that were mandated by the NCLB Act and IDEIA, there was an advanced set of standards for teachers who are at an advanced level in the field of Deaf education (Easterbrooks, 2008a). Two of these standards will be addressed next.

Advanced Set of Standards for Deaf and Hard of Hearing Students. The first advanced standard was leadership and policy focused on standards for teachers of individuals who are D/HH who have comorbid disabilities (DHH1K4). "There is a shortage of curriculum methods and materials specifically designed for students who are deaf and hard or hearing with additional disabilities" (Luckner & Carter, 2001, p. 8). Comorbid disabilities range from 25% to 33% with students who are D/HH (Luckner & Carter, 2001; Mauk & Mauk, 1993). Luckner and Carter conducted a nationwide study to identify the essential competencies needed for working with this group (2001).

The study consisted of a survey that was sent to 428 program supervisors (57% of survey's sent out were returned), and a focus group of seven teachers of students who were D/HH examined the surveys (2001). Results identified the importance of multisensory active learning with real-life experiences and teaching strategies centered on teaching students to think and problem-solve, along with developing effective behavior-support plans (2001).

Mauk and Mauk (1993) were quoted stating; "The primary advantage to accepting the concept of learning disability is that it forces educators to confront the ineffectiveness of conventional instruction for many deaf and hard of hearing children who have good potential for learning" (p.14). This statement concisely summarized the need for more research and study in the field of Deaf education for students with additional disabilities.

The second advanced standard addressed in this review was standard three: Research and Inquiry; Disseminate new advances and evidence-based practices (DHH3S1). "Evidence-based practices are intended to emerge from verifiable, scientific evidence for effectiveness" (Schirmer & Williams, 2008, p.167). "Like their counterparts in general education, teachers of deaf and hard-of-hearing students must base their teaching on research-based instructional practices" (Easterbrooks, 2008a, p.44). Easterbrooks, Stephenson, and Mertens (2006) reviewed three definitions through the National Center for Education and Evaluation and Regional Assistance, (2003) to support and analyze their research. The definitions were as follows: *Content best practices*: practices that have been proven effective for teaching the various aspects of a curriculum that have been deemed critical for all students to learn. *Strong evidence*: randomized controlled trials showing effectiveness in two or more typical school settings and including a setting similar to the one in which the interventions being implemented. *Possible evidence*: randomized controlled trials or comparison group studies showing pre- and post- evidence,

evidence from mismatched comparison groups or meta-analyses (2003). With this information, the objective of Easterbrook's (2006) study was (a) to identify the content to be taught and methods for teaching that content and (b) to propose enhancements to teacher preparation based on data and field evidence.

The results from Easterbrook's study showed a lack of guidance from the states as to how to make modifications to the general education curriculum to students who are D/HH. Best practices were determined by progress shown on an individual basis and what was decided through the Individualized Education Program (IEP). "All interviewees indicated that their states required teachers of students who are deaf or hard of hearing to differentiate materials, instructional strategies, and methods, but none indicated how to accomplish this"(Easterbrooks, 2006, p.151). Two main themes did arise to support best practices from the interview data, including enhancing content mastery through the use of minds-on activities and materials, and teaching science concepts by incorporating a collaborative, case-based, problem-solving approach (2006).

Challenges with finding advanced and evidence-based practices. Schirmer and Williams (2008) stated, and Luckner (2006) agreed, that "evidence-based practices are best practices; best practices are not evidence-based practices unless identified through evaluation of research with criteria agreed on by the research community" (Schirmer & Williams, 2008, p. 166). "Rigorous educational standards, more accountability requirements, and current reform legislation (e.g., the No Child Left Behind Act (NCLB) of 2001) all suggest that education policies and practices should be based on scientific evidence. " In fact, NCBL used the term 'scientifically based research' 111 times" (Luckner, 2006, p. 49).

> According to the U.S. Department of Education, Office of Special Education Programs (2002), hearing impairment comprises of 0.11% of the estimated school-age population and 1.23% of all children with disabilities. Hence, hearing loss is a low-incidence disability. The low–incidence nature of the impairment and its wide geographic dispersion leads to difficulties in conducting studies that meet the U.S. Department of Education's 'gold standard' which includes a relatively large sample size and random assignment to form treatment and control groups (p. 50).

With the information from the above statement, The U.S. Department of Education or private foundations have not supported research in the area of deafness and other low-incidence disabilities at the same level that they have researched in general education or high-incidence disabilities. This caused a discrepancy with the ability to show evidence-based practices within the D/HH student population. "Educational practices have most often been based on opinion rather than any form of investigation" (Luckner, 2006, p.50).

Best Practices for Students with Disabilities

Students who are Deaf and Hard of Hearing have been placed under the same umbrella as students with disabilities in accordance with the NCLB Act of 2001. For this review, it was important to develop an understanding of best practices for students with disabilities, in general and in the realm of science to apply to the learning of students who are D/HH. "Evidence-based teaching practices ensure that students receive quality instruction, and the research is clear that children taught via efficient, quality instruction achieve better educational outcomes" (Easterbrooks, 2008a, p37). According to Cawthon (2004), "Both participation and proficiency goals must be met by significant subcategories of students, including students with disabilities" (p.315). Borgna, Converntino and Marschark (2011) stated that "for students who are D/HH, the differences in learning are not simply a matter of the relative availability of a framework for comprehension, and that simply providing support in the form of a scaffold of the main ideas or vocabulary is not the answer" (p.90).

In this section, the focus was on studies conducted on successful approaches to teaching students with disabilities using several methods including interview studies, observational studies, documented analysis and data analysis. These approaches were linked to the needs of students who are D/HH and how these students may benefit from these studies.

Traditional Instruction versus Differentiated Learning Activities

According to the findings of Matropieri, Scruggs, and Norland (2006), "Those with disabilities- increased demands on content area learning can lead to frustration, academic failure, loss of access to the general education curriculum, and loss of future opportunities in society" (p.130).

> Using a data set from the National Education Longitudinal Study that included 1,946 eighth-grade students from 78 schools, Anderman (1998), reported that students with learning disabilities scored nearly one standard deviation (SD) lower on science achievement tests than students without learning disabilities did. They also scored nearly one SD lower than students without disabilities did at the 4th grade, 8th grade and 12th grade levels. Such data suggest that students with disabilities fall farther behind their peers as they progress from elementary to secondary schools. (Mastropieri et al.,2006, p.130)

One suggestion that comes from this study was how students' reading and comprehension skills impact the learning of core subjects such as science. There was a discrepancy between students with disabilities' ability to read, comprehend, and have the skills to decipher at the science textbooks levels compared to the reading levels represented in the textbooks (Kinder, Bursuck, & Epstein, 1992). Although students can learn concepts at their grade level in science, they are not able to read the text to support the concepts due to their reading comprehension. In addition, Gallaudet University (a university in Washington, D.C. for the Deaf and Hard of Hearing) reported the majority of incoming students did not read well enough to make effective use of first-year college textbooks (Marschark, 1997).

The objective of Mastropieri's et al, (2006) qualitative investigation was to determine whether differentiated curriculum enhancements relevant to the study of scientific methods could be developed for eighth grade inclusive science classes. Scruggs et al. also conducted an experimental-based method using the *crossover design* in 1993, focused on textbook-based compared to inquiry-oriented approaches (using the Full Option Science System (FOSS)) to learning in special education classrooms. Experimental-based methods apply to hands-on, minds-on (inquiry based) experiments used by the students to show proof of a scientific concept. Inquiry-oriented approaches give students the opportunity to do an experiment led by the teacher and afterwards students expand on that experiment to test the scientific theory further. Textbook-based learning is reading about a scientific concept and answering questions to show understanding. Additionally, Scruggs, Mastropieri and Okolo (2008), compared textbook knowledge with inquiry-based methods for prompting and questioning.

Curriculum enhancement in inclusive middle school science. In Mastropieri's et al., 2006 study, 13 eighth-grade science classes, with a total of 213 students, of whom 44 were classified with disabilities participated in a 12-week session using both a control and experimental condition. The control condition included traditional textbook instruction which consisted of teacher lecture, class notes, laboratory-like class activities, and supplementary textbook materials. The experimental condition consisted of scientific investigation (inquiry-based); instruction, covering charts and graphs, measurement, independent and dependent variables, and qualitative and quantitative research methods (Mastropiere et al., 2006).

The results of this study drew the conclusion that there was support in the effectiveness of using differentiated learning activities with peer partners in middle school inclusive science classes, not only on content posttests, but also on high-stakes end of year tests (Mastropiere et al., 2006).

Reading versus doing: the crossover design. In the 1993 study with Scruggs et al., 26 junior high school students who were labeled Learning Disabled (LD) were enrolled in four science classes taught by one of the school's special education teachers. This study took place in a lower socioeconomic status, Midwestern urban setting. The experimental design was based on the first two of four classes receiving an activity-based treatment (inquiry-based, hands-on experiments) for the first unit of instruction, and a textbook treatment (reading the text, teacher run experiments, and answering questions from the text) during the second unit of instruction. The other two classes received treatment in the opposite order. This was called a *crossover design* (1993). "Because each student receives both treatments and serves at his or her own control, preexisting differences between classrooms, such as ability of students, classroom atmosphere, or time-of-day effects, are not a particular concern" (1993, p.4).

The results indicated that on both immediate and one-week delayed recall tests, students scored higher when they were taught with activity/inquiry-oriented methods and materials compared to the traditional text-based learning (1993).

Data analysis of instructing students with disabilities. In a 2008 data analysis by Scruggs, Mastropieri and Okolo, two experiments were conducted to determine whether students with mild disabilities were able to construct scientific principles through prompting and questioning compared to their non-disabled peers.

The results suggested that normal achieving students drew the correct conclusions either immediately or after only a small number of prompts, and students with learning disabilities performed only slightly lower (Scruggs, 2008). “Although the performance of students with disabilities on inductive learning tasks was lower than that of normally achieving students, they may nonetheless benefit from highly structured inquiry learning” (2008, p.6).

Discussion on best practices for students with disabilities. Evaluations were conducted by the U.S. Department of Education, the National Science Foundation, the American Association for the Advancement of Science, the Eisenhower National Consortia, the National Diffusion Network, and the Northwest Regional Educational Laboratory (Ridgway, Titterington, & McCann, 1999) to support the studies that Scruggs, Mastrapieri and Okolo did collectively. These evaluations concluded that the following would be *best practices* in science education:

- student –centered instruction
- hands-on/minds-on learning
- authentic problem-based or issue-based learning
- emphasis on communication skills
- ongoing, embedded, authentic assessment.

To ensure these best practices in science education, Scruggs and Masterpieri (1994) recommended seven variables to promote inclusive education to support the evaluations that were conducted. These variables included: (1) an open, accepting classroom environment, (2) administrative support for inclusion, (3) general effective teaching skills on the part of the general education teacher, (4) special education support, in the form of consultation or direct assistance, (5) peer mediation, in the form of classroom assistance or cooperative learning, (6) an appropriate curriculum (supporting hands-on approach to science learning), and (7) teaching skills specific to a particular disability or needs areas (Scruggs & Mastropieri,1994).

In 2003, The Wisconsin State Department of Public Instruction also focused on using differentiated learning activities compared to traditional instruction. The rationale was based on the notion that too often the curriculum failed to challenge students to think about the connections and the implications for their own lives and their role as citizens. It was noted by Marschark et al. (2011) that "students who are D/HH may not readily make connections between what they are learning and what they already know or between one concept and another (p. 20). Studies also revealed that students who are D/HH "overestimate how much they are learning, suggesting that they either lack accurate language-related metacognitive skills or do not utilize them in situations where they would facilitate learning' (Swanwick & Marschark, 2010, p.220).

The standards that The Wisconsin State Department of Public Instruction created were called *crossover points*. These crossover points connected to citizenship education and the ability of individuals to make sound and informed decisions in science, social studies, mathematics, and language arts (2003). "Designing new science, technology and society (STS) curriculum invariably places teachers and their students in touch with a broad range of real-world problems" (2003, p.98). "What STS suggests is that we provide a meaningful context for student learning so that the content knowledge remains connected rather than isolated and unrelated" (2003, p. 100). In addition to this information, the method known as the *learning cycle* was another approach that supported the findings of using inquiry-based science to support student with disabilities.

The Learning Cycle. The learning cycle was developed in the 1960s by Karplus and Thier (1967) for the Science Curriculum Improvement Study (SCIS). This inquiry-based teaching approach was based on three distinct phases of instruction: (1) exploration, which provided students with firsthand experiences with science phenomena, (2) concept introduction, which allowed students to build understanding of science concepts through interaction with peers, texts, and teachers, and (3) concept application, which required students to apply their understanding to new situations or new problems (Hanuscin & Lee, 2008). This was also known as the 5E Model: Engagement, Exploration, Explanation, Elaboration, and Evaluation (Bybee, 1997, as cited in Hanuscin & Lee, 2008). However, according to Seaman (2008), there had been much debate about the use of the learning cycle method. Concerns and reflections wherein "researchers and practitioners have recognized a gap between the powerful learning often witnessed during experiential programs, and the ability of the most common conceptual models and research methods to explain how this learning occurs" (Kraft, 1990; Wichmann, 1980). Quay (as cited in Hanuscin & Lee, 2008) argued that 'mechanistics" stepwise models fail to capture the "holistic nature" of experiential learning (p. 108).

Overall, the studies that have been discussed in this paper thus far suggest that teaching strategies should be centered on teaching students to think and problem-solve, including a learning environment identifying the importance of multisensory active learning with real-life experiences (Luckner & Carter, 2001). To encourage students who are D/HH to become greater readers and provide guidance in their thinking, Yore (2000) recommended embedding structured writing activities within the teaching of science. Using hands-on activities and then writing about the experience supports the relationships between the written word and the content learned. Yore:

> emphasized the importance of cognitive and metacognitive skills for science learning, arguing that effective reading and writing in science require conceptual background; knowledge about science text and science reading; declarations, procedures, and

> conditions of reading strategies; and executive control to set purpose, monitor progress and adjust actions (2000, p.110).

Borgna et al. (2011) supported Yore's research by emphasizing the use of what the students are aware of and how to apply their knowledge and contexts by the use of writing strategies.

To increase comprehension for students who are D/HH, educational alternatives need to play a key role for optimizing student potential (Marschark, 1997). Marschark (1997) recognized the view of "deaf children as a linguistic minority with the right to receive their education via sign language" (p. 112). These rights are aligned with the Bilingual Education Act of 1988. This act "provided legal definitions for the terms native language and limited English proficiency that are frequently used in educational legislation, and it included deaf students and sign language under bilingual terminology for the first time"(Marschark, 1997, p. 112).

Introduction to English-Language Learners (ELL)

Learning about evidence-based and best-practices for students with disabilities helped bridge the learning for students who are D/HH. To continue bridging the gap, another type of population have been examined; the English-language learners (ELL) or, also known as limited English proficient (LEP) learners. For this paper, both titles were used. In the field of Deaf education, it is well known that for many students who are Deaf, American Sign Language (ASL) is their primary language with its own syntax and grammar. The English language is, in actuality, a Deaf student's second language. Students who are Deaf function like English-language learners or limited English proficient learners. These students are learning the English language as though they were coming from another country.

Marschark (1997) stated:

> Like Hispanic children who learned Spanish as their first language from Hispanic parents, these children are certainly literate in all senses of the word. They understand the building blocks of the language, they can use them in novel and creative ways, and they have access to much knowledge of the word as well as knowledge of both Deaf and hearing cultures. (134)

Fluency, be it in sign language or another minority language has not allowed for complete access to the larger culture at hand (1997). For students who are D/HH, fluency in either sign language and/or English has been a challenge. Students that were proficient in their native language were generally better readers of English due to the support of their Deaf parents, hence being bilingual. However, this proficiency in both languages only impacts ten percent of the population of children who are D/HH (1997).

Best Practices for English-Language Learners (ELL)

"Since limited English proficient (LEP) students learn English skills most effectively when they are taught across the curriculum, it is especially productive to integrate science and English teaching" (Sutman, 1993, p.2). In 2005, Lee gathered studies that were published from 1982 through 2004 focused on science education at the elementary and secondary levels, K–12. The selected research used "empirical studies from different methodological traditions, that included (a) experimental and quasi-experimental studies; (b) correlational studies; (c) surveys; (d) descriptive studies; (e) interpretative, ethnographic, qualitative, or case studies; (f) impact studies of large-scale intervention projects; and (g) demographics or large-scale achievement data" (Lee, 2005, p.495). Lee's research synthesis concluded that students' "level of English language proficiency and their scientific reasoning skills had significant effects, independently and in interaction with each other"(p.498). The results suggested that combined high levels of

English language proficiency and reasoning skills enhanced students' ability to learn scientific content knowledge in English. Through science inquiry-based instruction, both science and English proficiency increased. Barrera, Shyyan, & Liu (2008), Echevarria (2005), McCargo (1999), and Sutman (1993), all came to the conclusion that exposure to hands-on, inquiry based science helped facilitate the acquisition of language and the development of cognitive skills of hearing English-language learners.

Themes and Models. Sutman et al. (1993) stated "A quality science education is essential to the future success of all students, as is proficiency in the English language" (p.2). For ELLs, science instruction was most effective when the content was organized around common themes. These themes could be broad science concepts or they could be societal issues. Themes allowed for; organizing scientific knowledge, repetition for use of English vocabulary, leading naturally to the whole approach to second language instruction, and adding relevance to science in general (Sutman, 1992). "The degree to which science and other subjects are integrated in instruction is a direct measure of how effective the curriculum is in helping to improve learning"(p.22). For students who are D/HH, the cross connections of learning English through other core subjects such as science were typically not applied (Marschark, 1997). Inferential or spontaneous learning does not happen naturally among students who are D/HH. Although the reasons are not clear, and more research needs to be focused on this topic of transference of subjects, it is believed that both parents and teachers of children who are D/HH tend to focus on the concrete and familiar rather than exploration and discovery (Marschark, 1997).

One model that can be used for ELL students is drawn from the constructivist theory, also referred to as *science driven instruction*. It is believed that to achieve in school, ELLs must become involved in a rich variety of language and instruction so that the pace allows for great individual flexibility (Sutman, 1992). The constructivist model used an inquiry-based approach that included; looking for questions, using personal experiences, promoting collaboration in learning among other students, using open ended questions developed both by teachers and students, and included the availability of adequate time for reflection, analysis, general problem solving, and understanding through the use of both the first language and English (Sutman, 1992). For students who are D/HH, along with the constructivist model, there needs to be an emphasis on the social/emotional factors to help motivate and promote a desire to develop literacy and general academic success (Marschark, 1997).

Although the above information from Sutman was from 1992, if ELL teachers were able to teach in the manner that was presented above, one might see improvements in high-stakes testing that are currently mandatory, due to NCLB. However, there are reasons that impede this style of teaching to ELL students.

Conflicts with Teaching Science to ELLs. One argument that has arisen with teaching science was the lack of time in the daily student program to reach curriculum goals. According to Sutman & Guzman (1992), "many elementary school level teachers argue that they have little time for science instruction because subjects like language arts, of which ESL and foreign language are components, and math require most of the available classroom instructional time" (p.10).

Science has not been a high priority or has been looked upon as a base for teaching language. Until recently, science did not count toward accountability measures for student learning. Due to this factor, research on assessment accommodations in science for ELLs were sparse (Lee, 2005). This supported teachers' needs to focus much less on science and more on

English and math. To add to this conflict of not having the time to teach science, many educators did not have the educational background to teach inquiry-based science (Sutman, & Guzman, 1992). For teachers to effectively carry out an integrated science-English language approach to instruction required teachers be life-long learners in the field of science (Sutman, 1992).

Along with not having had the experience of teaching inquiry-based science, there had also been a lack of appropriate instructional materials that were essential for effective instruction. "High quality materials that meet current science education standards are difficult to find and are even less likely to be available in inner-city schools where nonmainstream students are concentrated" (Lee, 2005, p. 500).

Teaching ELL Students with Disabilities

Best practices with teaching ELL students is currently in question and research continues to focus on achievements for these students. A greater question is how to teach ELL students with disabilities. Comparing ELL students with those who are D/HH, there is a large percent of Deaf students with additional comorbid disabilities. According to the research analysis of Barrera, Shyyan and Liu, (2008), "in no case did educators seem to have access to methods specifically identified to address the needs of ELLs with disabilities" (p.1).

With lack of information in this area, the goals of the researchers were to; (a) identify teacher-initiated instructional strategies currently preferred by practitioners who daily work with ELLs with disabilities, (b) find new strategies specific to successful settings that could be identified, (c) find a way to examine congruities and incongruities between established research and the perception of successful practice by those who actually work with these students every day, and (d) provide a way to operationalize what researchers in this field are finding through their systematic examinations (p. 2).

The results in this study showed the five top strategies for teaching ELLs with disabilities. The top five included, hands-on participation (50%), graphic organizers (38%), student-made models (32%), vocabulary development (26%) and personal interest research (21%) (p.15). "All of the research participants unanimously weighted reading as the highest priority" (p.10). However, educators in this study considered all three content areas of reading, math, and science as "very important." The science education varied between states with small ELL population and among educators with over 10 years of experience (Barrera, 2008). Barrera et al., hypothesize that "the importance of science is more distant for educators who were trained in an era when students with special needs did not typically receive science instruction" (p.16).

With the NCLB Act of 1990, and the IDEIA, students will not only be accountable for being proficient in English and mathematics, but for science as well. Reviewing the importance for teaching science to ELLs helped shed some light on how to teach students that are D/HH.

Comparing students who are Deaf and ELLs.

Although there are few studies comparing the writing of students who are D/HH to that of hearing ELLs, Singleton, Morgan, and DiGello (2004) found similarities among the two populations with their performance patterns in the omission of function words and the difficulty of acquisition of syntactic structures. They emphasized the need to understand the performance of both ELL and D/HH students and how they acquired words and vocabulary usage (2004). Singleton et al (2004) stated; "with this understanding, we can improve our theorizing and interpretation of potential "transfer effects" from proficient ASL to English and explore the possible application of ESL pedagogical theory to ASL-based deaf-education context"(p. 90).

Concerns for comparing Deaf and ELL. "Many of the behaviors that deaf children exhibit in reading and writing are the same as those made by people learning English as a second language"(Marschark, 1997, p.139). In contrast, Singleton, Morgan and DiGello's (2004) research questioned the comparison of the two populations. They stated that although ELL children exhibited some weaknesses in their writing, their ability to use a high proportioned use of function words were demonstrated more often compared to their Deaf peers (2004). Since ASL vocabulary and syntax do not parallel printed English, students who are D/HH remain at a greater disadvantage than their ELL peers (Marschark, 1997). The study by Singleton et al. (2004) suggested that educators use caution when considering using the same English teaching strategies to students who are D/HH as with ELLs. However, if the focus were on teaching science to support the learning of English, would both populations benefit?

English-centered learning to science-centered learning

In their research, Lang and Albertini (2001) stated both writing and discussion about science experiences caused learners to generate verbal representations of their thinking, which, in turn, promoted the construction of understanding. They provided information connecting authentic science activities with writing (2001). New terms, facts, and unfamiliar usage of vocabulary through science enabled the student to build connections through the use of the "science" experience (2001). The National Science Education Standards, the American Association for the Advancement of Science, and the National Research Council emphasized the commitment to hands-on, minds-on science that provide richness and excitement of knowing about and understanding the natural world. Science is highly significant for diverse learners. (Mangrubang, 2004).

Additional Research Needed. "Science and social studies help students attain skills, information and dispositions that are important for success in school and everyday life" (Scruggs, Mastropieri & Okolo, (2008, p.1). Scruggs, Mastropieri, and Okolo (2008), strongly felt that "science is of particular importance to students with disabilities, which in fact provides important insights into our general understanding of science education" (p.2). Advanced studies and research focused on using inquiry-based science components as the base for teaching students who are D/HH could help determine evidence-based practices for the future of Deaf education. Additional research needs to be conducted to provide evidence-based practices to support the learning of English through the means of science with students who are D/HH.

Conclusion

"Schools are being asked to produce literate, self-determined, emotionally intelligent, and socially skilled life-long learners—undoubtedly, a formidable task" (Luckner, 2006,p.51). Addressing the mandates of the NCLB Act of 2001 and the IDEIA of 2004, research still needs to be obtained to help develop not only *best-practices* for students who are D/HH, but *evidence-based practices*. It has been clarified that due to the small percentage of students that make up the D/HH population, little support has been given to this area of disabilities.

The above quote from Luckner (2006) confirms the need for more research and study to justify evidence-based practices for students who are D/HH. Luckner suggested; increased funding for research, needs for research-comparison groups, correlations, descriptive, and ethnographic studies, and research built on previous studies (2006). "Reading and writing form as essential link to the worlds of social and intellectual interaction, and the consequences of literacy or illiteracy will have increasing impact on all realms of functioning as deaf children grow up" (Marschark, 1997, p.148). The goal is to increase literacy for students who are D/HH.

The question that remains unanswered is: “Have we been looking at literacy for students who are D/HH through the wrong lens? Can the lens change to focus on science-centered learning to improve literacy for students who are D/HH?”

Chapter 3

Research Design/Methodology

Introduction

The overall goal for this mixed methods research study was to determine if changing the lens of learning for students who are Deaf and/or Hard of Hearing (D/HH) from English-centered learning to science-centered learning would increase reading comprehension skills compared to the current levels being achieved. (A paradigm shift from English Language Arts (ELA) focused learning to science focused learning)

By fully examining the effects of science-centered learning, evidence was gained through the use of test scores and the admission of the practice of using science as the tool for learning English by both the teachers and the students. This required a sequential mixed method design. According to Teddlie and Tashakkori, a sequential mixed method design “occurs across chronological phases of the study, questions or procedures of one strand emerge from or depend on the previous strand, and research questions are related to one another and may evolve as the study unfolds” (2009, p. 151). The framework of this study was conducted through data conversion, or what is known as methodological triangulation. This refers to “the use of multiple methods to study a single problem” (Patton, 2002, p. 247).

Further triangulation in this study included the inclusion of multiple points of view: the perspectives of the teachers, the perspectives of the students, and analysis of data taken from the school’s assessment tool for reading comprehension as well as testing student retention of vocabulary. Teachers were interviewed by the researcher to gain an understanding of how teachers perceive students who are D/HH learn best in the classroom. The teachers answered questions that lead to an open discussion of how to best meet the needs of their students, and the population of students that attend this school. Students were also interviewed by the researcher to help understand the student's perspectives and perceptions of how they learn best. The researcher described learning best as students being able to retain information and produce work that shows understanding of the topics being taught through writing or signing. To support teacher and student discussions, reading and comprehension assessments were given to the students by the teacher and/or reading specialist, via the researcher's parameters to analyze if students increased their comprehension of text through the lens of science. The goal of this triangulation was to gain support with the researcher's theory that not only will science-based learning improve reading comprehension for students who are D/HH through assessments but to show support from the perceptions of the teachers and students.

In the field of Deaf education in this country, it is common knowledge that for students who are Deaf, American Sign Language (ASL) is most often their primary language; the structure of ASL is distinct from English, as it has its own syntax and grammar. The English language is, in actuality, a Deaf student's second language. With this in mind, students who are Deaf are functionally English-language learners (ELLs). These students are learning the English language through the process of second language acquisition similar to, though not identical to hearing students who have a home language other than English. Studies have shown that students who are ELLs, learn the English language best through hands-on, minds-on, inquiry-based science applications (Barrera, Shyyan & Liu, 2008, Echevarria, 2005, McCargo, 1999, Lee, 2005, and Sutman, 1993). Little research has been done to make a connection between hearing (non-deaf) ELLs and how they learn compared to D/HH students learning English as their second language. If science-based learning can support ELA for hearing (non-deaf) ELLs, is it possible for D/HH to have the same outcomes? This research study expanded on current research of how to best increase the English reading skills of students who are D/HH based on the teaching in the content area of science.

Research Questions

1. **Qualitative.** (1) What are teacher's perspectives of using a science-based curriculum to teach reading to students who are D/HH?

   (2) What are student's perspectives of using a science-based curriculum to learn English and reading?

2. **Quantitative**. Is there a significant difference in learning outcomes when using passages to test for comprehension with both text based and inferential questions when using a science-based curriculum to support reading compared to using an English-based curriculum?

3**. Mixed Methods**. How do teacher and student perspectives of science-based learning support possible increased test scores compared to English-based test scores?

Perspective of the Research

Due to the low incidence population of students who are D/HH, this was a phenomenological, mixed method, action research case study. Creswell, 1998 stated phenomenology refers to the study of the "meaning of experience for individuals"(p. 86). A phenomenological study incorporates common experiences with several individuals in which the researcher makes meaning of the phenomenon (Creswell, 1998). Research by Singleton, Morgan, & DiGello, (2004) emphasize that children who are profoundly deaf have great difficulty acquiring English vocabulary in the same manner as hearing children do, through the incidental learning process. Not being able to overhear conversations and the limit of an early literacy experience, children who are Deaf struggle to develop age-appropriate English as their hearing peers (2004). This supports the researcher's rationale to have used a phenomenological study.

This study also involved both narrative and numerical forms of information, rendering it a Mixed Methods investigation (2009). Action research was due to the researcher's involvement with developing and guiding staff through a six to eight week intervention (The baseline observations was an average of 11 weeks in length). Lastly, this involved a case study which explored a case "over time through detailed, in-depth data collection involving multiple sources of information rich in context" (Creswell, 1998, p. 61).

The researcher assessed the scores provided through the data collected from a Running Record assessment tool currently implemented in this school, pre and post vocabulary tests designed by the researcher, observations of correct student responses during ELA and science classes, along with having interviewed both teachers and students about their perspectives of student learning.

Context of the Study

This school for the Deaf is a state approved chartered day school (no residential component) for students who have a significant hearing loss (moderate to profound) who are best served through the Least Restrictive Environment based on the decision of their home school district and the parents in accordance with the Individuals with Disabilities Education Improvement Act (IDEIA, 2004). Students attending this school come from two different states and a total of 8 different counties. There are approximately 28 school districts that have enrolled their students at this school for the Deaf.

This school has an enrollment of students ranging from ages 3 to 21. At the time of this study, there were approximately 200 students, with about half male and female students. An estimated 40% of this enrollment had a secondary disability. The student ethnic backgrounds were approximately as follows: 40% Black (Non-Hispanic); 30% Hispanic; 20% White (Non-Hispanic); 5% Multi-Racial/Ethnic; and 5%, Asian (or Pacific Islander). An average of 80% of the students received free of reduced lunches due to their socio-economic levels.

Thirty-three percent of the teachers at the time of this study were D/HH. Four percent of the teaching staff were non-White. On the level of supervisory staff, two were non-White. The ratio of staff to students averaged 1:5. Due to the needs of the student and in accordance with their Individualized Education Program (IEP), this was an appropriate ratio. (Provisions of this § 14.105 adopted June 27, 2008, effective July 1, 2008, 38 [State of Residence] 3575 state that the maximum caseload for full-time Deaf and Hearing Impaired Support ratio is 8:1).

Each student at this school has an Individualized Education Program (IEP). Regardless of the students' disability, disabilities, or severity of disability, all students are mandated to participate in state accountability testing in accordance to their grade level. Students are to achieve at a level of "proficiency or above" in accordance to NCLB for the home school district to report on Adequate Yearly Progress (AYP) and for the student to receive a high school diploma. Testing begins at the third grade level. During the 2010-2011 school year, fifty-two students total, ranging from 3rd to 11th grade participated in the state exams, which included math and reading for grades three to eleven, and an additional science and writing exam for 4th, 8th, and 11th grade. Testing that year consisted of an alternate state assessment test that was developed by the state to support students with disabilities. Of these fifty-two students, three students achieved scores at the level of "proficient" on one subject of the state test. Two students taking the tests achieved "proficient" or "advanced" in two subject areas. This averaged less than 10% of this student population that attained proficient scores. In the 2012-2013 school year, the alternative assessment test was no longer being used by the state, hence students at this school received the standard state assessment test. This test was given to students ranging from 3rd to 8th grade. Thirty-eight students (with a total of 104 tests) were tested. The number of students that reached proficient or above was 0%. The goal of NCLB is for schools to obtain 100% proficiency by 2014. The state has recently begun to change the directive of the NCLB goal as 2014 comes to a close. New state testing is being applied at the high school level focusing on individual courses such as biology and algebra, the scores from which determine (by the year 2017) whether or not a student can receive a diploma (an indication of having learned the required state content and skill standards). It is being predicted that these high stakes tests within this school will place this population of students at a higher risk of not receiving a high school diploma from their home district. If looking at the data collected from the 2010-2011 and 2012-2013 state tests, it may be projected that less than 10% of the students will receive their high school diplomas allowing them to apply to a college. The other 90% and above would receive an IEP diploma which does not meet the requirements to apply for college.

Participants

A purposive sampling case study "addresses specific purposes related to research questions; therefore, the research selects from a few cases that are information rich in regard to those questions" (Teddie & Tashakkori, 2009, p.173). This was a case study because of the specific group of participants within the same occupation/school. Due to the low incidence population of students who are D/HH, this study was of a purposive nature (small selection), and not a probability sampling which selects a large number of cases within a population (2009).

A total of 14 students and 3 teachers from an urban school for the Deaf in the northeastern region of the United States were invited to participate in this research study. The criteria for invitation included students who are Deaf (a hearing loss of 70dB or more in both ears) that were enrolled in the fourth or fifth grade during the time of data collection. These students had a primary label of Deafness as their disability and had no intellectual disabilities, nor deficits with attention (ADD or ADHD) or any additional label that may impede their learning. The teachers that were asked to participate were certified in Deaf Education, and have worked in a school for the Deaf for a minimum of three years at the time of the study. One teacher per grade level was invited to participate (one fourth grade teacher and one fifth grade teacher) with students whose primary disability was Deafness with no comorbid disabilities. (Beginner reading skills are at the early developmental stages in first and second grades, and therefore did not make prime candidates for this study.) The third teacher invited to participate was the Elementary Science Teacher. This teacher was responsible for teaching the elementary students' entire science curriculum (1^{st}-5^{th} grade).

During the time of this study, there were a total of 75 students enrolled in grades one to six. Fifteen teachers were assigned to these students. Of the fifteen classes, five of these classes were students with co-morbid special needs (dual diagnosed), hence were deleted from this study. Of the teachers that did not work with students with special needs, six of the teachers had worked at this school for at least three years. All of the participating teachers were certified to teach students who are D/HH. The years of teaching experience ranged from three to 18 years during the time of the interviews. All six teachers were invited to participate in a one time, individual interview. A focus group interview at the end of the intervention was with the 4^{th} and 5^{th} grade teacher whose students participated in this research study.

Consent and Confidentiality Procedures

Consent was obtained within the school. Specific teachers meeting the outlined criteria were invited to participate in this study. There was first a verbal discussion between researcher and the invited participant. The invited participant was asked to read and if in agreement, to sign the consent form (See Appendix A). The signed consent form was returned before the start of the research study during the 2013-2014 school year. Interviews of the teachers took place in a location that was convenient for them in the school. Individual interviews ranged from 25-45 minutes in length and were videotaped and coded (videotape captured signing and ensured accuracy of transcription of participant responses). Teachers participating reviewed the transcription for accuracy and reliability. The videotaped focus group interview was approximately one hour in length, taking place on the school campus during a convenient time for all who participated.

Parents of the students who were asked to participate, as stated in the participation section of this chapter received letters at home explaining the study and asked for a signed consent to be returned before the research study began (See Appendix B). Four of six signed consent forms were received from the 5th grade class. Seven of the eight consent forms from the 4th grade were returned allowing these students to participate in this study. A total of 11 students (*n*=11), through parental consent and student verbal assent, participated in this research study. The consent allowed the researcher to document baseline scores prior, during, and after intervention of the study. The consent also allowed for students to be observed and interviewed by the researcher. Individual interviews were approximately 15 minutes in length, held in a room where the student felt most comfortable in the school. The interview was videotaped, transcribed, and later coded by the researcher. Further, to ensure accuracy, reliability, and validity, the ASL Specialist reviewed both the videotapes and transcriptions of all interviewed students to note any discrepancies in the original transcriptions and coding. Any discrepancies noted by the ASL Specialist was discussed and edited with the researcher.

Role of Researcher

According to Willis, (2007) through the framework of Seymour-Rolls and Hughes (1995), conducting action research entails four moments: "*reflecting, planning, acting*, and *observing*" with each spiraling into the next (Willis, 2007, p. 269). Having experienced first-hand the teaching methods used at this school, and having been the Lead Science Teacher for seven years, this researcher had experience with the context, curriculum, and the struggles the students have had in this school (*reflecting*). Conducting an action research study within the boundaries of a school where the researcher currently works, has allowed for the opportunity to support the staff with how to teach the students through the lens of science (*planning*), but not participate directly with the students. Class observations took place by the researcher to help with support for the 4th and 5th grade classes and allowed for adaptations of approaches to meet the criteria of the goals of this study (*acting and observing*).

Due to the nuances of a signing environment in this particular urban area, the ability to comprehend both the teacher and students through the language of ASL was imperative. Nuances included the "local" signs that are indigenous to this school community and the surrounding area. ASL signs vary within different regions and cities, along with the 'slang' that students pick up from one another. This researcher had worked at this school for over 18 years and was very knowledgeable of these nuances; hence, lessening the risk of misunderstanding what evolved in the classroom as well as the interview and focus group data.

During the time of the study, this researcher was the Lead Middle School Teacher and had not worked directly with the intermediate-level teaching staff who had been invited to participate in this study since the 2011-2012 school year. This researcher has not had direct teaching experiences with the students who had been invited to participate in this study. This has alleviated some biases that may have formed if this researcher had worked directly with these students in the past.

There are several roles that this researcher was involved in during this study. The first role was data collector in relation to documented student reading levels prior to the study. This established a baseline for the students' comprehension level in reading. The second role was supporting the curriculum to be taught to the student participants. Both participating teachers and the supervisor needed to establish specific goals and lessons to be used during both the first section of the study (the English-based lessons) and the second section of the study (the science-based lessons). The Elementary Science Teacher was also involved in this process. The third role was of observer. Notes were taken during lessons given by the teacher to document the academic approaches such as demonstrations, inquiry-based questions, rote memorization, and so on. An observation protocol was developed to document which approaches were being used during each lesson. The fourth role of this researcher was test administrator for the science and ELA vocabulary tests prior to and after intervention. The final role of this researcher was interviewer.

Time Frame

Permission from the school for the Deaf, consent from both staff and students (via the parents of the requested students), along with the accepted IRB proposal, was achieved by the first quarter of the 2013-2014 school year. Research began immediately after consent was received with collecting baseline data of students' reading comprehension using the Running Record assessment tool used at the school. Simultaneously, and sporadically during the beginning of the baseline research, teachers were interviewed by the researcher. After all of the participating students' baselines were completed, a six to eight week intervention (treatment) began with each grade level during the first few months of 2014. Randomly selected participating students were interviewed after the intervention was complete. The focus group consisting of staff involved with the study that met after the intervention was complete. Data analysis began June 2014. The findings and results, along with the summary and discussion was completed by August 2014.

Data Collection

Methods

Data collection of this phenomenological, mixed methods action research case study began with categorizing where the participating students were currently performing within the context of reading and comprehension using the school developed assessment tool. Simultaneously, individual interviews with participating teachers were implemented. The next step was working collaboratively with the participating teachers to help with both the ELA lessons and the science-centered intervention. At the time of treatment, the fourth grade class was studying *Physical and Chemical Changes* from the BSCS series during science class. The ELA trade book that was chosen by the researcher was *Doug Unplugged* by Dan Yaccarino. The running theme between the science and ELA unit was "senses" and the descriptions of varying experiences (see Appendix C for unit plan). The 5th grade class was studying *Heat and Change in Materials* from the BSCS Science series during treatment. *Recess at 20 Below* by Cindy Lou Aillaud, was the ELA trade book that was chosen by the researcher. The threads between both subjects were the change of temperature and its impact on the students both in the book and the participating research subjects in the classroom. The ELA teacher focused on such topics as similes, metaphors, and onomatopoeias (see Appendix D for unit plan).

While this 17-19 week research study began, participating teachers were interviewed. Data was collected at the end of the intervention to document outcomes using the same school developed assessment tool. There was a focus group interview at the end of the intervention to provide teacher perspectives on the intervention and their outcomes as well as two randomly selected participating students from the each grade that was interviewed. This mixed method of data collection and perspectives of those participating was integrated in the results and analysis section of this research.

Qualitative Data

All of the teachers participating in this study were interviewed about their perspectives of the lessons. Four students (two from each grade level) were randomly selected (names drawn out of a hat) to be interviewed about their perspectives of the lessons. Names were drawn randomly to not skew the data, and strengthen the validity of this study.

A phenomenological action research plan was conducted due to the consistency of students who are D/HH reading an average of three to four years below grade level, compared to their hearing peers. According to Creswell, a phenomenological study involves investigating participants' perspectives of a shared phenomenon, including lived experiences (Creswell, 1998, p.122). To document the perspectives of implementing as well as learning within a science-based curriculum compared to English-based curriculum, the following qualitative methods were used: Teacher and student interviews, a focus group meeting (with the 4th and 5th grade teachers whose students were involved in the study), and classroom observations.

Teacher interviews

Research questions guiding this study included investigating the perspectives and perceptions of teachers and how they try to meet the needs of their students who are D/HH. Two sets of interviews were included within the results found in Chapter 4. The first three interviews took place, with IRB approval in 2011 (pseudonyms: IJ, Maria, and Jodi). During this time, these teachers were teaching science. The second set of teachers were interviewed from the current 2013-2014 school year (ME, CS, and JM). These teachers did not teach science. Students attended science class in a lab separate from their main classrooms and were taught by the Elementary Science Teacher. This change of science 'pull-outs' changed the types of questions asked during the interviews, but the themes remained intact. These interviews lead to insights on how teachers both approached learning with their students and their views of supports needed for students to increase their reading comprehension. To obtain this information, the following procedures took place: Individual interviews were conducted by the researcher at the school for the Deaf during a time and place that was convenient for each teacher participant. The interview for the participating teachers was no longer than 45 minutes and was videotaped. The rationale for videotaping was to capture communication via sign language. Videotaping was used during the interview, and then transcribed by the researcher after the interviews took place. Teachers' names were replaced with pseudonyms for confidentiality reasons.

The overarching theme of these interviews consisted of the following questions (See Appendix E for interview questions):

1. What are the perspectives of teachers of the Deaf in relation to student language learning via English-based methods and science-based methods?

2. What challenges and benefits do teachers of the Deaf perceive in relation to each of these instructional methods (ELA compared to science-based approaches)?

Student interviews

Insight of the student's perspective of how they felt they learn best may support how one should teach these students. To support this research study, the researcher did the following; Individual interviews were conducted by the researcher with two students at each grade level involved with the study (a total of four students). The students' names were selected randomly within each class (from those whose parents and students that had given consent for their participation) by a draw of the hat. The interview was videotaped and was no longer than 15 minutes and was conducted in the students' classroom or in a room of the student's choosing (due to both confidentiality and comfort of the student). The rationale for videotaping was due to the fact that all of the participants were Deaf. To capture communication via sign language, videotape was used during the interviews and transcribed by the researcher after the interviews took place. The school's ASL specialist viewed the videotaped interviews and researcher's transcriptions to ensure accurate translation of the students' signing to written English. To cite students' interview comments, each student was labeled as *'S' number-dash-number*. The 'S' identifies the quote as a student. The first number represents the student and the second number represents the grade level (S1-5: *Student 1, grade 5*). In Chapter 4, an additional number before the "S" will appear for the page cited from transcription of the interview (2-S1-5: Page 2 of transcription- student 1- grade 5).

The overarching theme of these student interviews was to answer the following research question (See Appendix F for student interview questions):

What are the perspectives of the students comparing ELA and science based learning in the classroom? (The specific lessons with visuals were shown to the students for support incorporated with the interview)

Focus Group

The importance of a focus group was to receive feedback from teachers who have participated in this research study (the 4th and 5th grade teachers), in relation to the research question. Teachers being able to listen to one another and share their input on the outcomes could possibly support further studies into science-based learning.

The focus group consisted of all participants that met the criteria described earlier and took place after the intervention was complete. The group discussion was approximately one hour in length. This also took place on the school campus in a room of the teachers' choosing. Once again, this discussion was videotaped and transcribed at a later date by the researcher (See Appendix G for initial focus group questions). The focus group participants reviewed the researcher's transcription for accuracy. In Chapter 4 of this dissertation, quotes and topics were cited from this interview as the page number of the transcription followed by *FG* for focus group (ei: 3-FG: page 3-focus group).

Classroom Observations

Classroom observations supported this research study through the use of data collection. Observation of students during classroom instruction had allowed for detailed information of what and how often students demonstrated an understanding of concepts being taught. Observations were conducted during both the English-based curriculum lessons and again during the science-based curriculum lessons (during baseline and treatment).

BSCS: The Biological Sciences Curriculum Study (BSCS) was the curriculum that was in place for the elementary (K-5) students at this school, during the time of this study. Students used this curriculum during both the baseline and intervention phases of the research. The science units that were being taught to the fourth grade [*The Changing Earth* (baseline) and *Physical and Chemical Changes* (treatment)] and fifth grade classes [*Human Systems* (baseline) and *Heat and Change in Materials* (treatment)] were predetermined before the school year. Hence, there were no changes in the order of what the science teacher would be teaching when this research study began.

Observations were made in both the participating teacher's classroom and the science teacher's lab during instruction. Observations overlapped between the two grade levels. All students were observed with the use of a check-list devised by the researcher (see *Figure A*). Observations were for the full duration of the ELA lessons. These classes averaged one hour of ELA three times per week; and Science, one hour, two times per week. Observations by the researcher commenced at least two times per week. Observations of teacher lessons and student participation was documented on a check list using tally marks developed by the researcher and coded. Each tally mark represented a student showing their knowledge to the teacher during the lesson via in writing or in ASL. Tally totals of baseline and intervention during the ELA and science lessons were analyzed separately.

Figure A

Students/ Date:	Shows understanding of vocabulary	Able to answer inferential questions	Uses appropriate materials to find answers	Can explain the topics from prior lessons	Retells stories with accuracy
1					
2					
3					
4					

Tally marks indicate "yes"

During both the ELA classes and the intervention of science-centered learning, the teacher had specific questions developed by both the researcher and the students' teacher that were able to demonstrate the students' ability to answer questions that apply to the topic of the lesson being taught (See Appendices C and D). The first type of questions incorporated an understanding of vocabulary (this could be new vocabulary or vocabulary that students had been exposed to in past lessons). Knowledge of the vocabulary was either shown in writing or in ASL (what is commonly known in schools for the Deaf, as "through the air"). The second type of question was inferential questions. Students needed to show their knowledge of a topic by answering questions that made inferences to the question without finding the answers directly from the text. This was done either through writing or ASL. The third type of data incorporated if students could locate answers within the text. The fourth observation was how well students were able to either retell or reiterate a lesson from a previous lesson. This demonstrated if students were retaining the information presented by the teacher. The final data collection during observations was the retelling of specific stories presented to the class. The retelling could have been from the teacher reading the story given by the researcher to the class via ASL, or the students reading the story with the teacher from the text. Not all of the data applied on all the days of observation. At least three of the five types of data were collected per class observation. A one-tailed paired sample statistics *t-test* analyzed the data to support any statistical significance within the student's increased understanding in ELA and science, comparing both the baseline and treatment of each in this research.

Observations were tallied at the end of each class and then placed on a graph, along with sample questions. (Sample questions may include: What was the theme of this story? What will Doug do next? Why do you think students play outside at noon time?)

Quantitative Data

Quantitative data was collected to support this mixed method study. This study represents a parallel mixed design of quantitative and qualitative data that “occurs in a parallel manner, either simultaneously or with some time lapse” (Teddie & Tashakkori, 2009, p. 143). In the case of this study, data was collected simultaneously. The strands within the stage of this mixed method design encompasses the conceptual, experiential, and inferential stages (2009). The question that underlies the quantitative design of this study asked: Is there a significant difference in learning outcomes from passages that test for comprehension with both text based and inferential questions when using a science-based curriculum to support reading compared to using an English-based curriculum?

The overarching question for this mixed method study was; How do teacher and student perspectives of science-based learning support possible increased learning outcomes through the intervention used to compare English-based test scores with science-based test scores?

The following quantitative part of this study was conducted with 11 (n=11) student participants. In the beginning of this study, all 11 students were labeled as typical students who are D/HH. Typical, meaning there are no additional disabilities among the students. The fourth grade class had seven of eight student participants and the fifth grade had four of six student participants. At the end of this research study, four of the seven students from the 4^{th} grade class were labeled with additional disabilities (Attention Deficit Disorder, Attention Deficit Hyper Disorder, Apraxia, and Language Disorder). These findings were addressed during the summary and discussion chapter. Therefore, 7 participating students continued to meet the full requirements of this research.

A 17-18 week single subject multiple baseline design involved the above fourth and fifth grade classes. A multiple baseline "demonstrates the effects of an intervention by presenting the intervention to each of several different baselines at different points in time. A clear effect is evident if performance changes when and only when the intervention is applied" (Kazdin, 2011, p. 165). The single subject in this study was each grade level as a whole. Each grade level demonstrated if the intervention was effective at different points in time, depending on when the intervention was presented. Effectiveness was an increase in test scores on a consistent basis shown at each point of the intervention within each grade level. The overarching question that was determined by this part of the study was if there was a significant difference in test scores when using a science-based curriculum to support reading compared to using an English-based curriculum.

The independent variable was the ELA program that was in place at this school at the time of this study. The use of specific story books that have themes that fit the students reading level, grammar, vocabulary, parts of speech, and multiple meaning words were all within the realm of ELA. To identify increased comprehension, data was collected through retell of passages read during Running Record assessment. The fourth grade stories prior to intervention were: ELA: *No Lily, Don't* by Katherine Page, *24 Fairmount Ave* by Tomie dePaola (Daybook) and *Snowman Story*; Science: *The Changing Earth: BSCS* Series. The fifth grade stories prior to intervention (independent variable) were: ELA: *The Buffalo Hunt* by Bertha E Bush and *Fishing with Grandpa* by Robert Charles; Science: *Human Systems: BSCS* Series.

The dependent variable was the application of science-based lessons to teach specific story books, grammar, vocabulary, parts of speech and multiple meaning words (Fourth grade: ELA: *Doug Unplugged* by Dan Yaccarino; Science: *Physical and Chemical Changes , BSCS*

Series. Fifth grade: ELA: *Recess and 20 Below* by Cindy Lou Aillaud; Science: *Heat and Change in Materials*, *BSCS* Series). The science classes that were taught by one teacher in the elementary department used hands-on, inquiry based projects in connection with the *Biological Sciences Curriculum Study* (BSCS) science series. This curriculum aligned with the state standards at each appropriate grade level. These science activities were incorporated into the classroom teacher's ELA classes. Stories, grammar, vocabulary, parts of speech, and multiple meaning words were directly connected to the science lessons. This intervention was assessed through the same battery of Running Records that were applied through the ELA lessons. An eleven week time frame for the independent variable and six to eight week time frame for the dependent variable was completed by assessing student growth by use of the Running Record for each individual student as well as vocabulary knowledge (and retention of vocabulary). (Assessments of the Running Records are shown in Appendix H and K.) Data from the Running Record was collected, assessed, and compared to possible growth from each grade level who received the intervention (see below for specific Running Record assessments). To decrease researcher bias, and increase validity of the results, the collection of student Running Records were given and assessed by the classroom teacher and/or the school's certified reading specialist before the researcher received the completed Running Records data.

Running Records Assessment:

The school in this study uses Running Records (Clay, 2000) to gather data on student progress in reading and comprehension. Running Records are given at least three times throughout the school year to see if each individual student is making progress in their reading comprehension. The assessment tool is currently drawn from *Reading A-Z* (www.readinga-z.com) for the elementary school level students. The students are given a passage taken from the

Reading A-Z packet that is at or above the student's reading level (See Appendix H for sample). Students read aloud the passage to the teacher. (The students have an option of signing, voicing or a combination of both dependent on the student's comfort level). While the student reads the passage, the teacher enters: **E** for errors and **S-C** for self corrects on an assessment sheet (See Appendix I for sample). Pieces included in the basic assessment that are not used are: meaning, structure, and visual. There is a tally for how many words were errors along with the self-corrections. Students are then asked to retell the story in their own words to show comprehension of the main idea of the story. Questions are then given to the student (See Appendix J for sample). Questions can be signed by the teacher. Questions include inferences, classification of information, knowledge of vocabulary, comparing and contrasting, and understanding the main idea. Scores are determined by the data collected and students are given a rating of independent, instructional, or frustration level (See Appendix K). The independent level is achieved when the student reads with at least 97% word recognition and 80% comprehension. The student can read fluently with expression and shows no signs of anxiety. The instructional level shows the students reading with at least 91% word recognition and 60% comprehension. It is expected that students can read material with teacher assistance. The frustration level is demonstrated when a student's word recognition accuracy is 90% or below and comprehension falls under 60%. Reading tends to be word for word, with several errors being made, and the student showing signs of tension or apprehension.

To calibrate the percentages for accuracy, the number of words the student signed or said correctly in the story is divided by the number of total words in the story. Comprehension is accrued by the number of questions correctly answered divided by the total number of questions. The comprehension questions are divided into text based questions and inferential questions.

During Running Record assessments, the student is asked to retell the story in their own words to analyze if the student can include the main idea, important details, and show an ability to convert English to ASL. This part of the assessment uses a Likert Scale of; complete, partial, confused, or not evident. (Complete: includes the main idea, important details and shows the ability to convert English to ASL; Partial: can include some of the main idea, misses some important details, and/or converts most of the English to ASL; Confused: does not make clear connections with the main idea, details in the story and/or is not able to convert English to ASL; Not Evident: uses random words and/or details and is off topic.).

Parallel to Running Records that are taken prior, during and after intervention, a vocabulary test was given to the participating students of this study to show knowledge of vocabulary of both science and ELA terms (from the specified trade book) before, after and one month post-intervention.

Vocabulary Tests

Two sets of vocabulary tests were given during intervention to the fourth and fifth grade students that had consent to participate in this study. One test focused on the vocabulary words found in the student's science text book and the second test was vocabulary words found in the trade book that was used during ELA class that had been chosen by the researcher (4th grade*: Doug Unplugged;* 5th grade*: Recess at 20 Below*). Each exact test was given three times (pre, post1, and post2 tests). Due to the length between each time the students were tested, the researcher did not find it necessary to change the word order of the tests. See Appendix M for vocabulary words. The tests were given to the students one-on-one by the researcher. If the word was signed correctly, it was not marked. If the word was signed incorrectly, it was circled. If the sign was finger spelled, a slash mark was made next to the word. At the end of the test, the researcher referred back to the slash marked words to ask for meaning. (Please note that there are words, specifically for science, that do not have a specific sign for the English word. Words such as ‘iodine’ and ‘talcum powder’ do not have an ASL sign; therefore are to be finger spelled.) If the student explained the finger spelled word correctly, the student received credit for that word. If the student signed, “I DON’T KNOW’, the word was circled, hence incorrect. To assess vocabulary, the researcher conducted a repeated-measured analysis of variance (ANOVA) with a General Linear Model (GLM) to compare the individual’s students’ progress from pre, $post_1$, and $post_2$ testing.

The case study began as follows: A review of all of the participants’ latest Running Records at the beginning of the study was documented. Documentation included; the age of the student, the grade level the student was assessed at, the percentage of word accuracy and response to comprehension questions which was converted to one of the following reading levels (independent, instructional or frustration). Documentation also included the Likert scale of how well the student was able to retell the story by including the main idea, important details and transfer from English words to ASL conceptual signing. This became the baseline for each participating individual student before beginning the actual study.

1. Fifth Grade Class:
    a. The independent variable began with the most recent instructional level that was determined by the teacher’s last reading and comprehension assessment of each individual student. For example; the last instructional level of one particular student was showing a reading and comprehension level of 1.4. (Reading and comprehending on a first grade, 4^{th} month, reading level.)

b. During the first eleven weeks, an ELA curriculum was used to support an increase in the student's reading level with strategies, including stories, grammar, vocabulary, parts of speech, and multiple meaning words.

c. Predetermined questions from the collaboration of the teacher and the researcher were asked during lessons for the observer/researcher to identify what the students were retaining, comprehending and answering. As was stated earlier, a tally sheet supported the data collected during observations. The tally sheet was used for all of the participating students with consent in the classroom. Due to the low ratio of teacher to students, this task was possible to be monitored by one person.

d. At the end of the first eleven weeks of the ELA focus, individual Running Records, as well a vocabulary test for the intervention for both science and ELA were used to assess the student's progress. The classroom teacher and/or the certified reading specialist performed the Running Record for validity, accuracy, and trustworthiness. The researcher gave a one-on-one vocabulary test to participating students.

e. Week twelve, the intervention began, using the science curriculum (independent variable) *Heat and Chemical Changes*, BSCS series as the teaching tool to teach related ELA topics. *Recess at 20 Below* by Cindy Lou Aillaud (dependent variable) was the trade book given by the researcher to be taught by the classroom teacher. Specific topics such as simile, metaphor, and onomatopoeia were introduced and taught during this time.

f. Topics taught in the science lab were integrated into the ELA lessons. An example of an integrated lesson would include literature based on the science content; with an emphasis of the vocabulary that was bridged between the science lab and the classroom (see Appendix D for specific examples).

g. The end of the six-eight weeks of intervention of the integrated science component, a new Running Record assessment and vocabulary test was taken by all of the participating students in the same manner as the baseline portion of this study.

h. Comparisons and statistical data through *t*-tests and ANOVA analysis was collected to identify if there were any significant differences between the two methods of teaching ELA (use of the dependent and independent variable).

2. Fourth Grade Class:

   a. The fourth week of research with the fifth grade class, baseline observations and data collection began with the fourth grade class using the same form of data collection with the use of Running Records.

      i. The different starting points in time helped demonstrate if it was the intervention that increased scores, or the natural course of time.

   b. Students followed the same pattern as the fifth grade class.

      i. See Appendix C for specific books used.

Fifth Grade Student	**Baseline** (1st running record)	**Week 11** (English based running record score)	**Week 18** (Science based Running Record score)	**Average Score Differential (+ #/- # /= #)**
(1)				
(2)				
(3)				
(4)				

Data Analysis

A parallel mixed data analysis was used to assess the outcome of this research. In accordance with Teddlie and Tashakori 2009, although the two sets of analysis are by design independent, the knowledge of one method will shape the analysis of the other (p. 266). Support for this mixed method research was shown through the perspectives of both the teachers and the students (Qualitative data) and the scores from assessment tools given during the twelve weeks of each grade level (Quantitative data). The interview method was selected for data collection in this research to provide thick, detailed description from the participants. Brantlinger, et.-al. (2005) describes thick, detailed description as reporting “sufficient quotes and field note descriptions to provide evidence for researchers’ interpretations and conclusions” (p201). In-depth interviews helped retrieve a teacher’s perspectives of students who are D/HH along with the ability to probe for more information.

A transcription of each participant was coded with the use of numbers and color coding of themes that supported the main topics. Each number represented the person interviewed, along with a dash and an additional page number to help retrieve quotes (e.g. 7-1 represents page 7- interview participant number 1). Quotes were highlighted with a specific color depending on a theme that was addressed (e.g. yellow highlights represents support of English Language Arts curriculum and pink highlights represents support for a science-based curriculum). The main themes created sub-themes and participant quotes were placed in the appropriate category to show if there was cohesion between the interviewees.

Within this collection of data, the research was able to answer the mixed method question of how teachers and students’ perspectives of science-based learning correlate to test scores compared to English-based test scores.

Quality Indicators

According to Brantlinger, Jimenez, et.-al. (2005), there are several measures that needed to be met to insure reliability, validity, and trustworthiness within the parameters of research. This research used several methods to insure credibility along with triangulation that was discussed earlier in this chapter. Member checks insured accuracy of interviews of transcripts and/or observations. During this research, all transcribed teacher interviews were disclosed to the participants for accuracy. Student interviews and transcriptions were viewed for accuracy by the school's ASL specialist. Within the consent form, teachers and students had the right to approve or negate any part of their participation. Observations made with the support of videotaping of both students and teacher interviews, along with assessment testing verified results. The school's certified Reading specialists was also asked to review the assessments for accuracy and trustworthiness. The videotaping which was included dates of videotaping, contributes to the audit trail to confirm specific dates and times of when the research was conducted. A focus group with the participating teaching staff confirmed the comprehension phenomena of students who are D/HH. The focus group occurred at the completion of the intervention. The interview questions were clearly worded and appropriate for the research that was conducted. Participants were represented sensitively and fairly and remained confidential (2005). Relevance of all documents (data collection) were established and sufficiently described and cited. Data analysis of the results was coded in a systematic and meaningful way as was stated earlier. Validity, reliability, and trustworthiness were woven throughout this research using these documented methods.

Issues of Validity/Inference Quality

The results of this study may benefit teachers in other schools for the Deaf around the country. Validity of this research is associated with using the same set of teachers with the same group of students, but changing the intervention to obtain the goals of the researcher. All of the students had the opportunity of learning through both teaching methods (English based and science based) and therefore did not lose any important structured teaching time. Comparing scores at two different grade levels simultaneously helped validate and justify if the increase of scores were in conjunction with the intervention.

Limitations of this method

Due to the low incidence population of students who are D/HH in a school setting, the small sample size was a limitation of this study. This limited population also added to the limited number of appropriate staff that could participate in this study, making it difficult to choose from a random pool of participants. However, according to Teddlie and Tashakkori (2009), this purposive sampling "can provide particularly valuable information related to the research questions under examination" (2009, p. 25).

Other limitations may have included the researcher's prior experience and familiarity with the study participants and context. Marshall and Rossman (2011) stated, "participatory action research is full collaboration between researcher and participants in posing the questions to be pursued and in gathering data to respond to them" (2011, p. 23). These participatory actions may have contributed to some biases in relation to the qualitative data collection and analysis However, with knowledge of participants and content, the researcher was able to provide support for the mixed methods aspect of data collection and analysis. In conducting this study through a mixed-method paradigm, the triangulation of data sources, participants, and analysis techniques served to strengthen the reliability, validity, and trustworthiness of the findings. Teddlie and Tashakkori (2009) stated, "one type of data gives greater depth (qualitative), whereas the other gives greater breadth (quantitative); together it is hoped that they yield results from which one can make better (more accurate) inferences" (2009, p. 35).

Chapter 4

Results/ Findings

Results from this phenomenological action research study included both qualitative and quantitative data to determine if science-centered learning will increase reading comprehension for students who are Deaf and/or Hard of Hearing. Statistical data was used to support the perspectives of both the teachers and students in this study.

Perspective and Perceptions of Teachers and Students

The purpose of this research was to gather perspectives and perceptions of teachers who were currently teaching students who were D/HH, as well as the students themselves during the time of this research study. Deficiencies in writing ability, together with limitations imposed by lack of reading ability, have been major contributors to Deaf children's generally poor academic performance (Lang & Albertini, 2001). Today, the focus of teaching students who are D/HH continues to be language-based learning (subjects in math, science, and social studies are secondary supports for learning to read and write). If students continue to show little progress compared to their hearing peers, there needs to be a change in the perspective of how these students are taught to improve their reading skills and to increase their overall performances on mandated, high stakes tests.

The overarching theme of this study included the following questions:

1. What are the perspectives of teachers of the Deaf in relation to student language learning via English-based methods and science-based methods?

2. What are the perspectives of students who are D/HH and what information are they able to retain when learning through ELA and/or Science?

3. What challenges and benefits do teachers of the Deaf perceive in relation to each of these instructional lenses?

Through the interview process of this research study, the six participating teachers, expressed that the students at this school for the Deaf continue to struggle with comprehension and retention in the area of English Language Arts. Through direct instruction of grammar, vocabulary and the writing process, students have not shown an increased understanding of literacy. According to one participant of this study, “They are not like a typical developing language learner. The things we are focusing on writing here are things that (hearing) kids in public school learn in second grade.” The majority of students who are D/HH continue to be delayed in reading. Students who are in 4th or 5th grade are independently reading on a kindergarten to second grade level, which has been documented with the students that have participated in this study. This translates to a three to five year delay compared to their current chronological grade level.

This study has provided the perspectives of both teacher and student participants with the continued necessity to improve literacy for students who are D/HH. However, this study has limitations due to the small number of participants that were interviewed (teachers: *n*=6; students: *n*=4) at one school for the Deaf. Further research needs to be considered on a larger scale (research at a number of schools for the Deaf across the United States) to support the current findings of this study with the perspective of a science centered base for learning.

From the overarching themes, three main topics emerged during the interview process from the participating teachers: perspectives of the English Language Arts curriculum (ELA), perspectives of the science curriculum, and the comparison of the two curricula. Students interviewed for this research study also discussed these topics from their own perspectives.

These initial themes merged into two main topics; ELA curriculum and comparing the ELA curriculum with a science-based curriculum. Sub-topics were analyzed within these two main topics after all of the interviews were transcribed and coded. The information obtained was from two sets of teacher interviews, as stated in Chapter three: a total of six teachers. A focus group was interviewed, post-intervention with the current 4th and 5th grade teacher, with IRB approval (throughout this chapter, the initials FG will identify the Focus Group interview and transcription). A total of four students (two from the 4th grade class and two from the 5th grade class) who had prior parental as well as student consent were randomly drawn to be interviewed by the researcher in a place of their choice within the school. All teachers were given pseudonyms (IJ, Jodi, ME, CS, Maria, and JM) for confidentiality reasons as was stated in Chapter 3. Students' names have been replaced by an *'S' number-dash-number*. The 'S' identifies the quote as a student. The first number represents the student and the second number represents the grade level (S1-5: *Student 1, grade 5*). Within this section, an additional number before the "S" will appear for the page cited from transcription of the interview (2-S1-5: Page 2 of transcription- student 1- grade 5). Overall, the main themes were compatible with all sets of interviews.

English Language Arts Curriculum (ELA)

Support for an ELA Curriculum

Support for an ELA curriculum was emphasized by the teachers during the qualitative part of this study with the use of direct instruction, increased vocabulary skills, and reading skills.

Direct instruction (teaching a topic independent of the content) was a question the researcher addressed to all six interviewed teacher participants due to the statement presented by

Borgna, Convertino, & Marschark,: "Emphasis on reading sub-skills, memorizing vocabulary words, and answering teacher questions takes away from the reading of authentic texts for meaning and may lead students to adopt relatively superficial comprehension criteria while failing to acquire the metacognitive strategies necessary for fluent reading" (Borgna, Convertino, & Marschark, 2011, p.80). Although all of these teachers felt there was a need for direct instruction (the teaching of specific everyday English words to help students retain the information (through direct instruction) (12-2, 8-3, 4-6, 3-4), IJ included the caveat that "direct instruction is really helpful when it's meaningful to what they are doing" (6-1). One student interviewed from the 5th grade class supported IJ's comment by stating, "sometimes they use the same words with JM (ELA teacher) and they can be hard words and then I see them again in science and then in reading I see the word and I'm like, the same word I learned in science sometimes" (1-S2-5). This student has made a connection between what was taught in ELA and in science through the repetition of words across content areas.

Teachers have stated the conflicts between direct teaching methods and experience-based methods. The direct teaching techniques that staff discussed during these interviews have supported the research of best practices for students who are D/HH. One example was the use of visual organizers. "Visual organizers are a favorite field –promoted practice in fostering content-area acquisition with students who are deaf or hard of hearing"(Easterbrooks and Stephenson, 2006 p. 392). IJ discussed the need to use graphic organizers to support the use of identifying the difference between a noun and a verb (7-1). ME also noted and documented "all of their (students) progress with those words that have been explicitly taught. All of them have improved significantly with the words that they have been practicing"(3-4). Such statements made by those interviewed expressed the views of direct instruction with the need of repetition, as well as making meaning connected to the context.

Student knowledge and use of grade-level vocabulary was a concern from all of the teachers interviewed. They all recognize the limited vocabulary their students continue to have to both express their thoughts and ideas on paper and through the air, along with recognition of vocabulary in their reading. Maria stated that with vocabulary, “they are learning how to apply it and their reading in general, how to express ideas and to make sure that other people understand their ideas” (4-3). JM included “when the students see the words over and over again within the classroom (walls) you hope that they will improve their reading and can identify those words in the book they are reading” (3-5). According to past research, this visual technique of seeing the vocabulary on the walls does not support the ability to retain information for students who are D/HH. Both Lang and Albertini (2001) and Marschark, (1997) emphasized the use of a social constructivist theory to support students ability to receive meaning of vocabulary words. “The emphasis in social constructivism is the primary role of communication and social life in meaning formation and cognition”(Marschark,1997 p.259). Social constructivist theory places the teacher in the strategic role of organizer and facilitator of social and cultural activity (Lang, 2001). For students who are D/HH, along with the constructivist model, there needs to be an emphasis on the social/emotional factors to help motivate and promote a desire to develop literacy and retain vocabulary for general academic success.

Reading skills that were emphasized during the interviews focused on the Daybook; a reading skills book that focuses on different short topics that could be applied to other content areas. The Daybook is a form of direct instruction used to teach specific ELA concepts. The Daybook also attempts to make connections between the reader and the author or subject of the story. IJ expressed the need for this ELA approach because "the Daybook is short, so I feel like that's one thing I really like about that sort of mode of teaching; and it's guided"(6-1). Skills are being taught through the use of the Daybook. However, JM stated, "if they don't have any experience, they won't be able to connect with the book" (2-5). Hence, the perspectives of the teachers vary depending on the stories within the books and therefore supports Lang et al. (2007) whom stated, "Imagery has been shown to be a predictor of long-term memory; we also need to investigate how teachers may best promote the development of imagery skills" (p. 78). If students did not have the experiential background knowledge before approaching the use of a story within Daybook, it would most likely not provide support for student learning and/or retention. The perspective of one fourth grade student showed favoritism for the Daybook and stated "really my ultimate favorite (Daybook) reading, did you know that? My favorite is reading and learning and then back to figuring out words I don't know and then writing down what I know, and then I go back to write some more" (5-S7-4). This particular student, during the time of this study was on a 3rd grade level of independent reading, meaning she had the ability to read to learn. Her peers, however, at the time of this study, were reading at a K-2nd grade level and were at the learning to read stage of development. The difference between learning to read and reading to learn impacts the ability to use such tools as Daybook (as does any other type of book such as social studies and science texts which are used as tools for receiving information).

Direct instruction to teach reading skills was also perceived as a concern for those teachers interviewed. Marschark, et.al (2011) concluded that D/HH students generally begin their education with less developed academic and world knowledge and language competence compared to their hearing peers. Their experience of the world is through vision and direct experiences of what is taught to them at home or in school (2011). Direct experiences and direct instruction were of concern with the teachers interviewed. Teachers had contradictory statements and questioned their own form of teaching students with such remarks as, “I think it’s beneficial that they have that direct instruction but I don’t know if grammar direct instruction sticks” (7-1). CS also emphasized that, “word identification seems to be the struggle in addition to the comprehension, but if the story is signed to them or they have enough repetition with it, then they are able to answer more questions” (3-6). According to Borgan, et al., this form of dependency on teachers for reading and other academic opportunities has become a hindrance for students to discern meaning independently (Borgna, Convertino, & Marschark, 2011). However, from the students’ perspective, the ability to “read a book and sign it and then you take turns and share “(1-S4-4) helps students with comprehension and conceptual visualization of stories learned in class. This contradiction to support reading skills needs to be further investigated. Questions about the successes of teaching direct ELA instruction were evident with all of the teachers interviewed.

Concerns with an ELA curriculum

Concerns expressed by the teachers interviewed with the topic of ELA included; student reading levels compared to their age, difficulties with grammar, writing skills, and reading comprehension.

All of the teachers interviewed discussed the low reading levels of their students compared to the age of the students, as well as inconsistencies and struggles with retaining information and words. Jodi sums up what each teacher addressed: “their reading is really low. The one is almost a non-reader. He’s at a kindergarten (reading) level and this is 5th grader” (4-2). This also is a concern for students who are Hard of Hearing. IJ emphasized, “I have a kid who can hear almost everything. You would think there would be no struggles with writing or tno struggles with reading. Some of those kids (Hard of Hearing) have the most struggles"(8-1). (To interject with this comment, one must review the student's socio-economic-status along with the high assumption of communication differences within the home. What the student may hear and what they understand are of two different contexts.) "If you are reading with them one-on-one, and I give them the sign for that word, sometime they will remember the sign for that word and sometimes they won't remember. They are not consistent"(3-5). ME added, "I think they have the weirdest gaps, just stuff that you would expect them to all know. Like, they should know what an opposite is"(4-4). One example of inconsistency was demonstrated during the interview between the researcher and a 5th grade student (please note that this conversation was in ASL. Words in all capitals, means the words have been finger spelled):

> Researcher: How do you spell (points to throat), can you spell that?
> Student 1-5: *Hmm, sometimes. It's a little hard.*
> Researcher: What part of the body do you really know how to spell?
> Student 1-5: *Hmmm, the tongue:*
> Researcher: Spell tongue
> Student1-5: *"MOUTH"*
> Researcher: Oh, mouth.
> Student 1-5: *Yes, I meant mouth, sorry.*
> Researcher: Do you know how to spell tongue?
> Student 1-5: *No, teasing, just mouth.*
> Researcher: Are there other words that you memorized?
> Student 1-5*: I memorized 'mouth', that's easy…and head , "HEAD".*
> Researcher: Oh, head, very good. Any other words you memorized?
> Student 1-5: *Just those two.* (2-S1-5)

This conversation shows the inconsistency between what the student think she knows and the actual knowledge of the words that are known. The student pointed to her tongue but spelled 'mouth'. When redirected, the student was not able to use the correct English vocabulary word for the body part that was questioned. This is just one of the inconsistencies that, according to the teachers, have seen on a daily basis.

The teachers support an ELA curriculum but continue to have a difficult time with seeing retention of instruction from the students on a consistent and long-term basis. “If they don’t have background, then they can’t apply the skills because they don’t have the memory available to sort of apply the skills when they are trying so hard to figure out what the words are” (3-4). This statement includes the transfer of information from ELA to other subject areas. “Taking what they see in reading class and social studies and applying that knowledge to other academic area and writing, that’s difficult for them” (3-6). This concern is a direct implication to the lack of using social constructs to support student retention that was demonstrated in the Boyd and George study in 1971.

Concerns continue with grammar, even when direct instruction is occurring. “You figure they are in 6th grade or 7th grade and they still don’t know when to use a verb and nouns (within an English sentence)”(7-1). Later in the interview IJ added, “I think I can teach them grammar until I was blue in the face and they don’t necessarily hold it in and even students like our kids that are really good writers. They are good writers because they know how to tell a story, not because of their mechanics in writing” (7-1). This researcher reiterates this statement by adding that students who are D/HH can tell stories through the air and then write down the basis of the story. However, it is not grammatically correct in English, and would be confusing and possibly difficult to understand if the person reading was not aware of ASL signs that are translated to English. An example of a fourth grade students’ writing is as follows (the researcher typed the student’s writing specifically as written):

> outside go Play tether ball. then want soccer. I like playing get ball Yes! idea I go tether ball miss d……(*student’s name*) win good game Accept. I fun end ;) (S3-4)

Reviewing the above writing by this typical 4th grade student who is Deaf, the researcher used ASL to decipher the context of the passage for clarity of thought. This was a functional English sentence when presented in ASL. When translating into English, the passage would look like:

> I go outside to play tether ball. Then I wanted to play soccer. I like playing and getting the ball. Yes, I have an idea and go back to playing tether ball. I missed the ball again and D____(student's name) won. It was a good game and I accepted. I had fun. The end. ☺

Creating stories, thinking on an abstract level, taking risks in writing, and organizing their thought process are major concerns these teachers have in relation to their students' learning. "ELA is so abstract what you have to teach them, so abstract", a statement shared by ME (8-4), CS (5-6), and Maria (3-6). Maria's third grade class is not able to create stories on their own (4-3), nor do they know how to organize their writing. Students' writing tends to lack organizational skills (heading, body, conclusion or to remain on topic). Students use ASL structure (which does not translate to printed English, as noted above) when writing independently. "So, you can sort of see the way they think, but they have a lot to say for writing but then they don't have the conventions of English. I am seeing progress, it's just slow" (4-4). CS added, when given a topic to the students, the first reaction from the students are "I don't know, this is hard! I don't know, this is hard!" She continued by adding "they are just shut off by writing and need encouragement to do it, and praise to be willing to try to do it, so yes, it's absolutely a struggle." (5-6). She continued, that students' "…struggle with taking risks, really, so be willing to misspell a word, or being willing to write about something that is made up, just a fantasy thing." (3-6). The willingness to write and to take risk was also emphasized by Borgan et al, who stated, students who are D/HH use fewer strategies, are less accurate in metacognitive judgments and self-monitoring compared to their hearing peers (Borgna, Convertino, & Marschark, 2011).

In the teachers' perspective, reading comprehension also continues to be a struggle. ME sums the feelings of the teachers interviewed by stating "it's a constant battle with word recognition and comprehension. They can't focus on both at the same time" (4-4, 8-1, 13-2, 3-6, and 3-5). "Reading wise, I mean, a lot of the kids read word for word and that's the biggest struggle"(8-1). They are not able to comprehend the meaning of the sentence when reading word for word. According to Borgna, Convertino & Marschark, 2011, such skills largely are acquired incidentally by hearing children (2011, p.5). Students who are Deaf need the use of visualization to go beyond reading word for word. JM included that "it's a big jump for our kids to go from learning to read, to reading to learn" (13-2). As stated earlier, although the students in this study are in 4^{th} and 5^{th} grade, their reading levels continue to fall two to three years behind, hence fluency and reading comprehension are also delayed.

Materials being used to support reading comprehension have also been an issue for the majority of the teachers. In 2001, Luckner & Carter stated, "there is a shortage of curriculum methods and materials specifically designed for students who are deaf and hard of hearing with additional disabilities" (Luckner & Carter, 2001, p. 8). Although this statement was dated back in 2001, the teachers in this study continue to find the lack of materials to support the needs of their students. ME stated "it's hard to find stuff that they can read that fits them. They're 10 years old but all the kindergarten novel stuff, it's pretty babyish."(3-4). The struggle to be able to find high interest/low readability texts for students who are D/HH has been the view of all of the teachers in this study. In addition, interviewees from research presented by Easterbrooks in 2006, "indicated that their states required teachers of students who are deaf or hard of hearing to differentiate materials, instructional strategies, and methods, but none indicated how to accomplish this"(Easterbrooks, 2006, p.151). The lack of materials that best fit the needs of the students is ongoing.

The need for consistency and development of a curriculum to support the teaching of ELA has been a thread through the qualitative section of this study. The overall feeling of the ELA curriculum was best stated by ME, "I feel like it is totally disjointed. There is a lot of freedom and its sort of where do you start, because they are so far behind" (3-4). However, she stated and was agreed upon during the focus group discussion ; "if we got a new science curriculum or something, since there are new core standards, they tend to have reading related to science already and they could build on that and reading books that would include that would be easier in the future"(6-FG). This statement brings the researcher to the next set of interview questions, focusing on the science curriculum.

Science Curriculum

The current science curriculum for 1st to 5th grade is from the Biological Sciences Curriculum Study (BSCS) series. When this research began with the first group of teachers interviewed, each would teach three to four units per year depending on the grade level and student population. As of the past two years, the school employed an Elementary Science Teacher who teaches 1st -5th grade students in a lab separate from the classrooms. The curriculum has remained intact for the present time. The 6th graders (that have become part of the Middle School) do an extension of the BSCS series, focused on the Watershed. A text book was not used, but both narrative and expository books were used to help with concepts throughout the school year.

Benefits of a science-based curriculum. During interviews, the teachers expressed support for a science-based curriculum to support the idea that instruction benefitted student literacy. The following themes exhibited throughout the interview process including: applying science concepts, experience-based knowledge, support through trade books/storybooks and understanding text, and student feeling about science in connection to ELA support.

Applying science concepts.

Understanding the concepts of science to support student literacy was agreed upon by all those interviewed. "I think they can tell me a science concept quicker and easier (than ELA concepts). And I don't know if it's just because, I don't know why" (15-1). ME agreed by adding, "I feel they remembered more" (6-4). What the teachers were not able to fully express, was summed up by McIntosh, Suzen, Reeder and Holt (1994) that stated, in teaching science, the process-oriented approach advocates cooperative learning due to the natural curiosity of the student. This helps with language and communication skills, and gives students opportunity to develop more rapidly and naturally dependent on self-initiation of the student. This process integrates reading, writing, communication and problem solving (1994). One example of ME's statement is shown by a 4th grade student (7-4) when asked about what they remember about a science topic.

> We know about water and powder, salt, corn starch, talcum powder, baby powder, baking soda, not regular soda, and salt, alum, and talcum powder and baking soda, that's it. No, we experimented with them. We would add water and *teacher* would ask us if the powder was still there or did it disappear. My opinion was it was still there because if it's medicine and think it's not there when you mix it, maybe it's special medicine. Also it dissolved, dissolved meaning it's there, it's gone: but it's still there. Not GONE! But slowly dissolved. The powders we feel and mixtures water and iodine, yes iodine… (3/4-S7-4).

With or without the printed word, students were able to retain the information in science compared to ELA. Jodi added, "When they came back (from a holiday vacation), they remembered the information. It was so nice. They could come up and explain it and how it worked and I was like 'yes!' They might not have remembered the vocabulary, but they were able to explain the concepts they understood, and I was like 'yes' (8/9-2)! Maria explained that students are able to "develop their own opinion. They have to think, they have to figure out things themselves and they have to use their brains. It works" (5-3), hence "their ability to predict has really improved" (5-3). All of the teachers agreed, that in their perspective, students' conceptual learning increased with teaching science due to the ability to understand concrete concepts within the realm of science. The perspectives of these teachers were reinforced by research that was conducted by Lang and Albertini (2001). Lang and Albertini stated both writing and discussion about science experiences caused learners to generate verbal representations of their thinking, which, in turn, promoted the construction of understanding. New terms, facts, and unfamiliar usage of vocabulary through science enabled the student to build connections through the use of the "science" experience (2001).

Connections between science and ELA through this study were recognized by the students when the teachers of the focus group commented, "At first, in the beginning I didn't think there was a connection, it seemed very separated out, and then later the kids started saying 'oh, we learned that in science class' and they started making the connections themselves. Maybe I would make a comment like, 'remember you learned that in science' so we would use both...but they would say…'right, right', and make the connection" (2–FG). When shown the science and ELA trade book used during the intervention of this research study, student 7-4 stated "This (pointing to science book) and this (pointing to trade book) is about experiences. Hmm. This is experience itself (points to science) and this is experience (trade book) so, they are connected. But this is connected to water and this is not, but they both are about experiences. There is a connection. Yes, they have comparisons" (5-S7-4). This discussion during the student interview reflected an experiment with students who are D/HH that was presented by Boyd and

George in 1971. The results of the analysis demonstrated a significant change in the level of categorization used by the Deaf children in the experimental group. Boyd and George (1971) indicated that physical experience, rather than language attainment, was the critical factor in the development of categorization within the context of teaching science.

A 5th grade student (2-5) that was interviewed, as well as the 4th grade student also recognized connections with the books used during intervention: "And this (points to trade book) uses heat also. In this book (trade book). In this (points to science book) vapor because you blow out air from your mouth. Vapor. It helped me understand a little bit because temperature was the same, and words were the same, some connections from reading to science and some science connections to reading and you know the words a little bit same, some different. This is about temperature (trade book) and this is about heat (science book) Like hot, something" (4/5-S2-5).

Both students were able to make connections between the ELA and science book, and as they expressed during their interviews, helped with their comprehension and retention of both. These statements from the students in this research study not only supported the teacher's acceptance for an experience-based, science-focused curriculum, but The National Science Education Standards, the American Association for the Advancement of Science, and the National Research Council have supported this approach to learning. These associations have emphasized the commitment to hands-on, minds-on science that have provided richness and excitement of knowing about and understanding the natural world (Mangrubang, 2004).

Experience-based knowledge

Experienced-based knowledge focuses on the ability to physically or emotionally receive information prior to teaching a specific topic. In the perspectives of the teachers during this study, experience-based knowledge had increased students retention and comprehension of science concepts. ME stated, “Science builds on the background knowledge they already have. You can go from here to here and it takes you between (signed progression from beginning to end)” (8-4). One example that was used from this study was stated by ME; “We were on the bus and we were going to an arboretum and we saw a manhole (trade book vocabulary word) cover with a big pipe going into it. And they said “oh, that’s the same as stinky stuff that they need to clean up”, so that is where they make the connections with the book (*Doug Unplugged*) when they saw it outside” (2-FG). The teachers believed that “teaching (hands-on/minds-on) science benefits the students, hence helped them with understanding the reading and not having the book be so scary because they had already experienced it” (14-1). An example of taking the “scary” out of reading was stated by CS who gave an example; “It makes them think when I flip this (light)switch, what does that actually mean that’s going on, like stuff is real that they can see and know about. Like when they see a butterfly, maybe they’ll think, ‘Oh, I remember doing that in class and I see this’, so it can pertain to other parts of their life. Building and designing structures. They live in houses, they live in the city, they see all kinds of buildings and stuff, so I feel like those topics more apply to their life that they can see” (7-6). ME added, “because they already had that experience, it was easier for them to apply it to science and then visa-versa” (5-4). Student 2-5 explained about breathing when asked what was retained from one of the science text books. “I remember about the lungs and if you run, you put in you numbers and click the button then you walk slowly , the lungs inhale exhale slowly then you breathe fast in and out and then you stop, it slows down. And the DIAPHRAM moves up and down And it doesn’t move from side to side and the TRACHEA is in your throat and squeezes all the way down to your stomach and you know the P..., small thing next to your stomach, and body, and veins and it’s blue and red" (2-S2-5). This experienced background knowledge of science was used to support and develop the comprehension during ELA classes. An investigative and experimental design to study the use of the *learning cycle approach*, designed by Barman, 1991, had similar results as this present research study. The response to the *learning cycle* program from the teachers' perspective was that the students (a) became responsible for their own learning, (b) were more apt to try new things, (c) were more motivated, (d) became more confident, (e) retained more information and (f) were more observant (1991). This was also observed with ME:

"When we talked about the weather we did a lot of writing prompts with the weather, 'so how does the weather affect me today?', kind of like cause and effect. If it's raining, what does that mean, and that sort of abstract level of thinking for them was first very hard and I never actually was thinking they would ever get it, and then finally they did. It was like 'it's raining, what does that mean (she cringes for an answer)?' 'Oh, it means we wear our boots and it means recess is inside' and it mean all these things and they finally started to get it and then it was easy for them. And then we started talking about, and it sort of connects to ELA, cause and effect and making conclusions and all these things, so that was another thing that was really easy to link" (6-4). Jodi also emphasized the importance of inquiry-based learning by giving the students a problem and having them try to figure out a conclusion. She adds, "the expression on their face when, that 'ah ha!' moment, you know, I just love that, I look for that, you know" (6-2)! Quotes such as: "real life experiences" (11-2), "be curious and want to know how it works" (7-2), "they get excited" (5-3), "they feel good about themselves" (4-3), and "science is good for the kids"(5-3) shows a different level of motivation for students and how the experience of science gets them involved with learning. Students also responded with 'it's fun and active and you do experiments and I learn and it makes me think, and it's hard. And experiments and a lot of things. I like reading a little bit but I prefer science best because it's fun vocabulary words' (1-S2-5).

Support through trade books/story books

In the perspective of the teachers, trade books were also used to support science concepts. Trade books are defined as "a book published for distribution to the general public through booksellers, as distinguished from a textbook or a limited edition" (The American Heritage Dictionary, 1982, p. 1284). The term trade book can also be referred to as a story book. IJ and Jodi have found that if trade books were used after a science concept was taught, the reading (of the trade book) became more comprehensible to the students. "I would rather they have the background knowledge and say, yea, remember we talked about this? Now here's the English printed word to that. And you know why it happens? Tell me why it happens. OK, now we are going to read a story about it" (10/11-2). The focus group was able to explain the benefits of the trade books for their class during the researcher's study stating: "I will definitely use that book (*Recess at 20 Below*) again for next year" (5-FG). "I think the kids were more motivated with the other science book (connected to *Recess at 20 Below*) they got to experience first. They went outside and experienced and then they became motivated like "the same as us" so it motivated them more because of the experience" (3-FG). According to Kinder, Bursuck, & Epstein, there is a discrepancy between students with disabilities' ability to read, comprehend, and have the skills to decipher at the science textbooks levels compared to the reading levels represented in the textbooks (Kinder, Bursuck, & Epstein, 1992). However, with the use of the students' personal experiences that were shared among the class prior to the reading, students were able to have a greater understanding of both the trade book and science text book simultaneously. This concept of experiential learning supports a paradigm shift that lends itself to the use of hands-on/minds-on learning that science presents itself naturally to students. An example of how students are able to demonstrate comprehension of text was shown with the 5th grade class story, *Recess at 20 Below* writing of both the study group and the actual writing from the author.

Recess at 20 Below by 5th grade students (prior) experience and writing (post) the story	***Recess at 20 Below*** by Cindy Lou Aillaud
First I get my clothes on. I have many clothes. I put on my coat, snow pants, hat, scarf, gloves and boots. Then I finish (student) said "Are you ready to go to recess to play?" We walk and arrive there. We go and play in the snow. We have fun!	*Getting dressed to go out takes a long time. First, we wiggle and squirm and twist into our thick snow pants. Then we pull on winter boots and zip our parkas as high as the zippers will go- we don't want any cold air getting in.*

(comparison of writing by the students in this study and the author)

The 4th grade class also showed comprehension of their book, *Doug Unplugged*, with the use of graphic organizers. According to Marschark, et al., 2011, one strategy that supports the learning for student who are D/HH is the use of concept maps and other diagrams that provide a visual relationship among categories within and among themselves (2011).

"We had shared background knowledge and "remember that picture? Same as Doug (*Doug Unplugged*). It has more value/importance because they experienced it themselves. I thought the questions were good and the way they answered and thought about what would happen next, what do you think about ..." (4-ME).

Doug Unplugged by Dan Yaccarino (4th grade students' experiences prior to the story) (teacher translates student's ASL to English on the board)	***Doug Unplugged*** by Dan Yaccarino (excerpts)
What We Know About The City • There are many people in (named city). It is busy. • The subway trains are loud! We saw subway trains with many people going in different places. • The (skyscraper, named building) has 58 floors. The (named) building showed reflections because it is made out of glass.	*Doug learned about many city things:* • Population: There are 8,175,133.5 people living in the city… • Subways: There are 840 miles of subway tracks and 468 stations… • Skyscrapers: The tallest skyscraper in the city has 102 floors… • Pigeons: More than 500 million pigeons live in the city….

Understanding text

Text books have also helped student reading skills, according to IJ and Jodi. Teaching science would "definitely"(6-2) help with reading (17-1). They continued to address that students were able to find information in a text book. "They might not be able to read it, but they know how to use it, to find information, to look at a map, to identify cities or read a graph. If you are able to do that I think that's a step in the right direction" (13-2). CS stated that the "science units we use also have a lot of language in them which I think lends itself to do a lot of overlap between science and ELA. For example, one of the units is called, materials and descriptions, essentially, its adjectives, so this is yellow, this is brown, this is whatever. It's adjectives so I did a lot of linking between ELA and using the MVL (Manipulative Visual Language) symbols for adjectives and linking them to what they are doing in science and then visa- versa so I can go back. Yes, it was a natural connection" (5-4). The students had made connections as well stating, "I think together they connect. Because (science) has chapters. Reading has it too" (1-S7-4). "Yes, they are the same. Yes, they both have feelings" (2-S1-5). Student 2-5 made specific references to both the science and ELA class during intervention when she stated, "Well, we learned similes in one class and we see the same picture in science class with the tongue stuck because heat and it was explained that's ice and that freezes and if you touch it with your tongue it gets stuck " (2-S2-5). This overlap of instruction was noted by both students and teachers. This supports and educational shift in learning by demonstrating students have the ability to reference cross-curriculum topics, which therefore implies retention of material being taught.

Students' perspective of science

Maria was emphatic about the importance of how the students feel about science. Both her feelings for science and the students feeling about science can become the driving force of learning. (Love what you learn). “Because I was excited about it, they were excited about it” (6-6)! “…it’s the best” stated one student, “…because of (*named Science teacher*) .You know because we do the hot and cold waters separate and then we put one in the other, and they share and become warm. During the interview with the students, they favored science because of the experiments (S7-4, S6-5, S 1-4, S2-5). A common theme that ran through most of the teacher’s interviews was their own experiences when they were students. “I remember hating science when I was a kid because it was “here’s the text book, here’s the definition, define invertebrates…I just remember hating science and we never did experiments until I got to HS. But I feel it’s nice because it’s hands-on, this curriculum now. Now, hands-on, I would probably like it now if I were a kid (6-4).

“They (the students) love when I ask them what they think. ‘Wow, the teacher is asking me what I think’ and “they like science because they feel more involved” (7-3). Motivation is the main link between Science to support ELA. However, there are concerns that arise with a science-centered curriculum.

Concerns with a science-based curriculum

Concerns that were raised by the those teachers interviewed for this study with a science-based curriculum included: trade books and appropriate (reading) level books for science, direct instruction integrated with science, as well as time to be able to develop a strong foundation for an incorporated science-based curriculum.

Trade books and appropriate reading levels for science

Trade books were a concern for all of the participants ranging from; not having trade books available or offered to use with each unit (“anything I have ever been given for ELA has never been science, it’s always been social studies” (19-1/8-3); and finding the appropriate age level compared to the concepts that are being taught (“ I just might find like sunny and rainy and words, or, it is sunny, it is rainy, it is snowy (basic primer books), you know, I would want to (signs “expands”) give them more than just that, you know what I mean”(11-2)? CS breached the topic of students’ ability to read the trade books independently stating “to introduce topics and stuff like that were not stories they could necessarily read independently. They needed support, like they wouldn’t be able to read them. The majority of them are not there on that grade level. Any ability, I feel like I need to explain it” (7-6). ME continues this thought and stated “to find the appropriate reading level can be hard. Because if it is on their reading level and it’s more sophisticated content and it’s connected to science, it needs to be simple language and it’s tough for the kids because they are still learning how to read vs. reading to learn”(6-ME). According to Lee, (2005), “High quality materials that meet current science education standards are difficult to find and are even less likely to be available in inner-city schools where nonmainstream students are concentrated” (Lee, 2005, p. 500). This is a direct link to students who are D/HH to compare concepts to reading at grade level in science. The students are not able to read the text to support the concepts due to their reading comprehension. This goes beyond students at the elementary level. In addition, Gallaudet University (a university in Washington, D.C. for the Deaf and Hard of Hearing) reported the majority of incoming students did not read well enough to make effective use of first-year college textbooks (Marschark, 1997). To support the use of trade books, the focus group recommended “required reading into the (ELA) schedule to connect with science books. We would need to improve and update the list (current required reading list)” (6-FG).

Direct instruction integrated with science

Within the context of grammar, writing a story, or reading a book, teachers interviewed were unsure how to use a direct instructional approach to literacy skills while teaching science concepts. IJ shared her thoughts about using grammar throughout science, stating, “what am I going to do, stop in the middle of class and say “this is a verb”(18-1)? She also struggled with what a teacher might deem more important, vocabulary or concept? “I try and give them the scientific vocabulary but sometimes for me it’s more important that they understand that they are ‘breathing’, so maybe the teacher last year thought that oxygen and carbon dioxide, they don’t need to know that, they need to know they are breathing in and out, OK, fine, done” (15-1). Student 1-5 gave an example of the concepts that were learned during science class (prior to intervention) stating “This is the body, like the stomach, and the mouth and food goes down to the stomach. That’s what we learned. Also about pooping, and we learned a lot and we took a test and I really had to think a lot. I gave it a good try” (2-S1-5). This student showed the general concept of digestion without use of the scientific vocabulary that accompanies these concepts. In the context of writing, Maria also ponders how to approach science with ELA as she states, “Hmm, science and ELA. We have to teach the kids how to write, predict, document, and write conclusions. Maybe at first direct instruction and then later begin so the students get used to it” (8-3). IJ agrees with Maria and stated, “it would be possible, (to support science) but again I would still have to take time out for direct instruction for writing” (18-1). As for reading either expository or narrative books, students continue to “struggle with not having background knowledge to bring to discussion” (8-2). CS, although accepted the thought of more exposure to science vocabulary would be good for the students, she questioned, “if reading a science story would necessarily make their reading better” (11-6). She continued, “Science is more hands on. So, I think anything’s that concrete is going to help anybody learn better, but they’re so many rules with grammar and that kind of thing that, and they can’t hear it. So that makes it that more difficult" (9-6). The contradictions that lie between science and ELA are evident with the teacher concerns. However, teachers that were involved in the intervention stated they could integrate both science and ELA if there was time to collaborate with the Elementary Science Teacher.

Time

The final concern that threaded through the interviewees was time. When the researcher asked if it was possible for science to coordinate more with ELA for the following school year, JM responded with "I think yes but we need a lot of time, a lot of coordinating with (*named science teacher*), what is she doing, what am I doing, what books do you suggest, that give and take, so it will take more time, but it's possible, yes. We need to find the time" (6-FG). The concern of finding time was stated by IJ (11-1), J (7-FG), and ME (7-FG). The need for time was consistent with Sutman & Guzman's research in 1992 that stated "many elementary school level teachers argue that they have little time for science instruction because subjects like language arts and math require most of the available classroom instructional time" (p.10). Although there is a Science Elementary Teacher, teachers expressed their concerns with the ability to find compatible times to meets, as well as time to search for books that may be applicable to the science being taught. Time constraints will continue to be an issue unless the curriculum supports and provides the materials needed to adjust to best practices for students who are D/HH.

An overall qualitative view

Overall, the teachers were willing to incorporate ELA into their science lessons if trade books that matched the actual age of the students were available. They also supported their need for direct instruction and questioned how to combine this with contextual learning. There was also the question of what part of the learning process works for the students? ELA, Science? To sum up the perspective of the teachers, IJ emphasized, “I am the kind of teacher that I want to put as many things as I can in there because something *has* to work” (20-1).

The importance of increasing the students’ ability to read and write was noted by CS, who stated, “If they (the students) want a future, they need to be able to read and write. And more so, some of their families that don’t sign, and can’t communicate with them, if they learn to write then they have a better opportunity to communicate with their parents” (4-6).

When the researcher asked the participating interviewed students which sets of books they preferred (BSCS and trade book prior to intervention, or BSCS and trade book during intervention), all four students chose the intervention books. Quotes such as; “I learned both and they were easy, but this was about playing in the snow. That” (4-S1-5); “ I like this one (*Recess at 20 Below)* because, it’s kind of fun, cool book and what they do in A… Yes, Alaska, it’s fun what they do and we have to know what they do and their sun don’t set, it only sets in 3 hours. Like, slightly touching the horizon. Because the earth and the sun the rays barely touch that part of the earth. And in America, it’s full sun” (5-S2-5); “this one I read *(Doug Unplugged*)! WOWWW , it has words, and science has other words too, so I learn both” (5-S7-4) ; (Points to Doug Unplugged) “It was my favorite signed story, unplugged…..DOUG, Doug Unplugged because a boy is lost, that’s why, and because he finds his mom and dad and download all of this information into his brain and work” (3/4-S4-4). Students made connections to these books due to their own experiences and connection with science. The students showed motivation and the concept of sharing a background with the characters in both trade books.

The perspectives and perceptions of both the students and teachers have made it evident that science can support ELA reading comprehension through motivation, hands-on activities, and the overlapping of reading to support of ELA trade books with science classes. To further show evidence that science can be the focus to support reading comprehension, quantitative, statistical evidence for this study was analyzed and recorded.

Observational/Statistical Documentation

To support the teachers and students' perspective of ELA and science, this research included observations (by the researcher) during both ELA and science classes prior to the science intervention and during intervention for both the 4th and 5th grade. The students with signed consent were the only students that were documented during this time. Four students out of six were observed in the 5th grade class, and seven of eight students observed in the 4th grade class received documentation. The researcher would sit in class as an observer and add tally marks to a chart when a student was able to show an understanding of the following categories: retelling of a story with accuracy, explaining the topics from a prior lesson, demonstrating vocabulary comprehension, ability to answer concrete questions, ability to answer inferential questions, and demonstrating the use of appropriate materials to find answers.

Time

The observations of the 5th grade class began November 19th, 2013. The baseline observations were eleven weeks in length. The treatment began February 11th and ended on April 4th, 2014. The treatment was a total of eight weeks. The observations of the 4th grade class began (baseline) on December 18th (11 weeks of baseline data) and the intervention began March 26th and concluded on May 2nd (6 weeks of treatment). Each treatment was in accordance to the length of both the beginning of a new science unit and trade book that was specified for this research study during ELA class. Due to conflicts, such as researcher-teacher schedules, weather related school closings, and standardized testing schedules, the number of science and ELA data ranged from two to 15. Science observations were critically low due to a student teacher in the science lab beginning her teaching experience during both the baseline and treatment times of this research. This was a conflict due to not meeting the criteria of having at least three years teaching experience with students who are D/HH.

Chart 1: Observations

The following chart represents the number of observations for each class. Each observation was an average of one hour in length.

Grade	Subject	Baseline Observations	Treatment Observations	Total
5th grade	ELA	5	15	20
	Science	2	6	8
4th grade	ELA	6	9	15
	Science	2	5	7

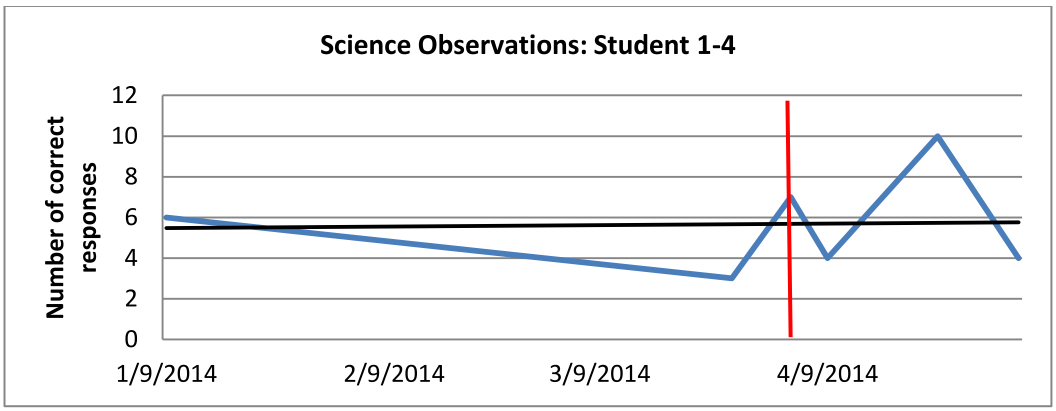
Statistical *t*-test results

The following information analyzed the individual grade levels as well as the subjects of science, ELA and the categories within ELA. Although the power of using inferential statistics was threatened by using small sample sizes, the results of which yield potential violations of homogeneity of variance and normality, de Winter (2013) indicated that “there are no principle objections to using a *t*-test with *N*s as small as 2” (p. 1). He further indicated that using the “paired *t*-test is feasible with extremely small Ns if the within-pair correlation is high (de Winter, 2013, p.1). However, when using the *t*-test with small sample sizes, a significance of *p* value may be misleading: therefore, effect size and/or power analysis should accompany the results, where possible, to provide an indicator of practical significance or variance explained by the difference between the groups (Cohen, 1988) or that the minimum, assessment of the within-pair correlation should be provided (de Winter, 2013). Paired samples *t*-tests were used to analyze the current data along with respective effect size statistics.

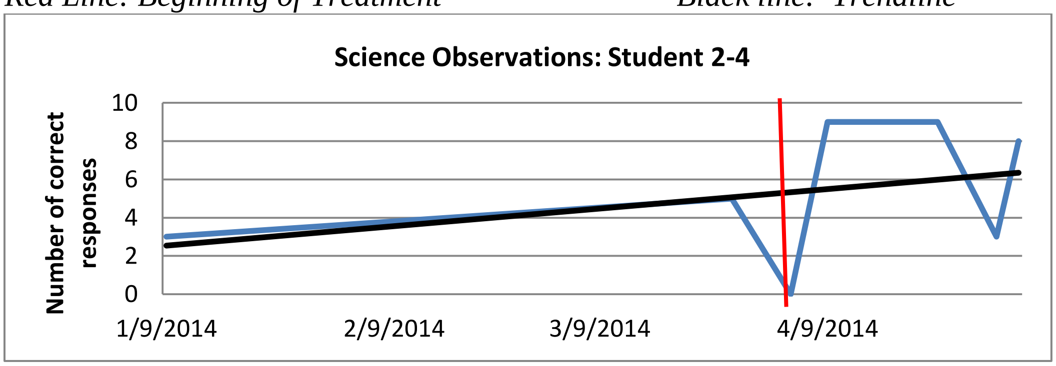
Science Observations from 4th and 5th grade

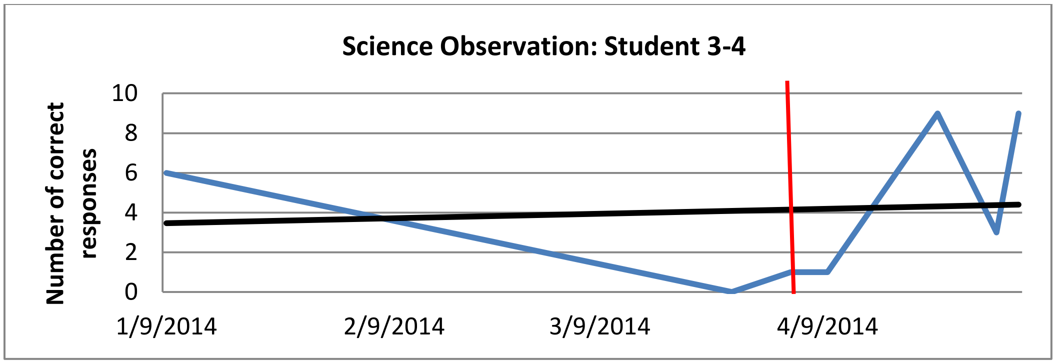
The comparison of the baseline and treatment of the science observations for both the 4th (p =.181) and 5th (p = .221) grades showed no statistical significance when comparing baseline to treatment conditions. (This lack of statistical significance may be due to the relatively few observations made during science class). See Chart 1 for sampled observations and behavior patterns from baseline to treatment conditions. Baseline for both the 4th and 5th grade classes during science observations represented two sets of observations. Treatment for both grades averaged 5.5 observations. Although both baseline and treatment observations were limited, several conclusions have been noted.

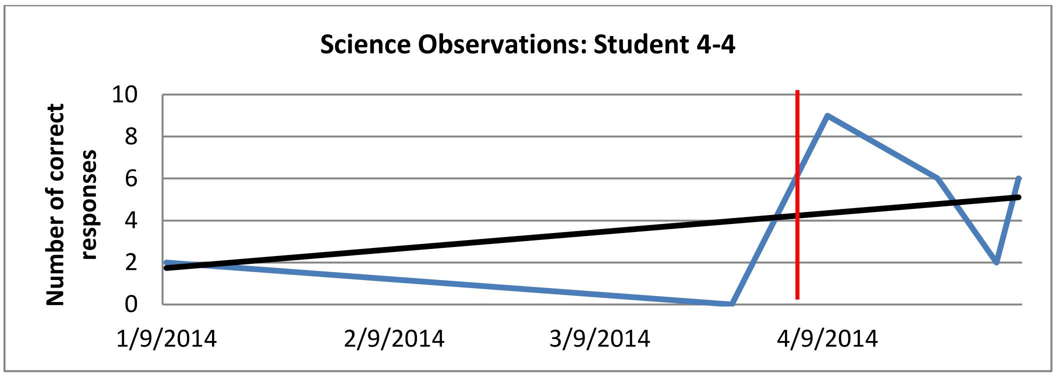
Graph A: Baseline and Treatment Conditions for 4th grade science



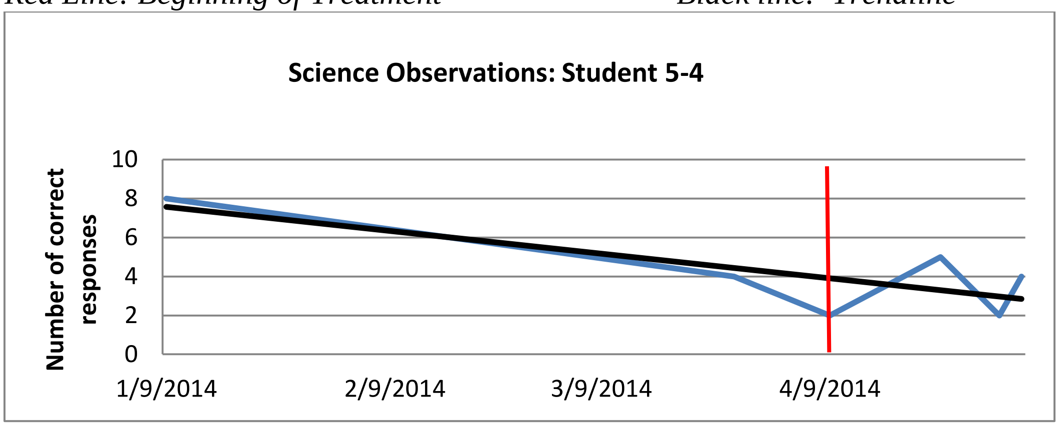
Red Line: Beginning of Treatment *Black line: Trendline*

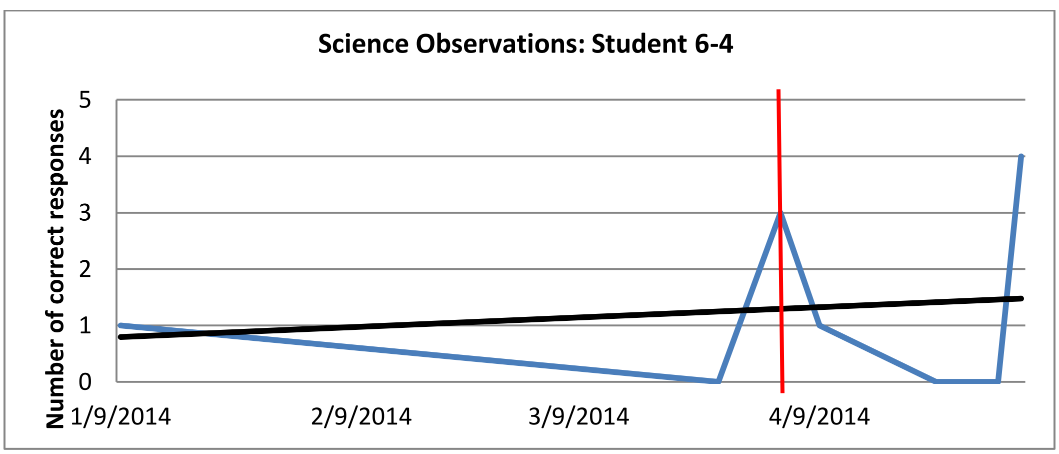






Red Line: Beginning of Treatment *Black line: Trendline*

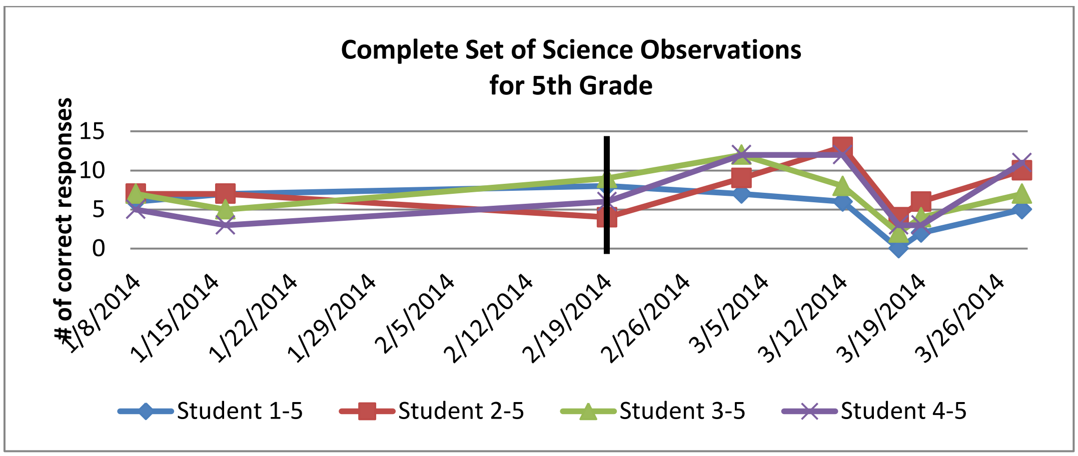




Red Line: Beginning of Treatment *Black line: Trendline*

Five of the six students from the 4th grade class demonstrated an upward trend in the ability to correctly answer questions pertaining to science content (see Graph A). Student 5-4 had a severe downward trend from baseline to treatment, as well as Student 6-4. Student 5-4 was diagnosed with Apraxia at the end of this study. This disorder of motor planning may have been the cause of the number of responses/participation during class on any given day. Student 6-4 was diagnosed with Attention Deficit Disorder at the end of this study which may account for the drop in treatment.

Graph B: Baseline and Treatment Conditions for 5th grade science



The black vertical line represents the beginning of treatment.

The 5th grade students demonstrated a split in their ability to answer questions post baseline (Students 2-5 and 4-5 had an upward trend. Students 1-5 and 3-5 showed a downward trend) (see Graph B). It should be noted that there was a severe drop on 3/19/2014, and then an upward swing for all participating students. Reviewing observation notes on 3/19/2014, students were doing small group experiments with measuring the change in temperature of cold water every minute for 20 minutes. Observations were of students working together on an experiment and not answering questions presented by the teacher. This may explain the lack of observational tallying that was noted on that particular day.

ELA Observations from 4th and 5th grade

A one-tailed paired sample statistics *t*-test was used to compare mean changes from baseline to treatment conditions of the ELA observations with all six categories (dependent measures) (see Table 4.1 and Table 4.2). Nine of eleven students demonstrated an upward trend line from beginning to the end of this research study for the overall ELA observations. See Appendix L for individual scores.

4th and 5th grade ELA categories

Table 4.1

Comparison of 4th grade students' observed knowledge of the following categories in ELA (n = 7) during baseline and treatment conditions.

Variables/ Measurements	Baseline		Treatment		*Effect Size*	t	**p* - value
	$\bar{x}$	*SD*	$\bar{x}$	*SD*	*d*		
Retells stories with accuracy	.57	.47	1.25	.49	1.08	2.83	***p* = .01
Explain topics from prior lessons	.57	.47	1.25	.49	1.08	2.63	***p* = .01
Vocabulary comprehension	1.50	.31	2.01	.78	.77	2.04	***p* = .04
Able to answer concrete questions	2.40	.58	3.58	1.22	1.10	2.88	***p* = .01
Able to answer inferential questions	1.43	.35	1.25	.46	-.32	.86	*p* = .21
Uses of appropriate materials to find answers	1.47	.40	1.30	.36	1.83	-1.21	*p* = .12

** one-tailed paired samples t-test was performed*
*** significantly different comparisons*

Table 4.2

Comparison of 5th grade students' observed knowledge of the following categories in ELA (n = 4) during baseline and treatment conditions.

Variables/ Measurements	Baseline		Treatment		*Effect size*	t	**p* - value
	$\bar{x}$	*SD*	$\bar{x}$	*SD*	*d*		
Retells stories with accuracy	2.10	.60	1.00	.67	.89	1.77	*p* = .08
Explain topics from prior lessons	.85	.30	1.21	.37	.27	9.0	***p* = .00
Vocabulary comprehension	1.70	.50	3.18	.70	4.11	8.22	***p* = .00

Able to answer concrete questions	1.70	.77	4.03	.27	2.33	4.66	***p* = .00
Able to answer inferential questions	2.30	.90	1.91	.79	.92	1.86	*p* = .82
Uses of appropriate materials to find answers	.55	.34	1.50	.21	1.82	3.65	***p* = .01

** one-tailed t-test was performed* ***significantly different comparisons*

The comparison of the baseline and treatment conditions of ELA knowledge observed by the researcher included; retelling of the story, explaining prior topics, vocabulary comprehension, answering concrete question, answering inferential questions and use of appropriate materials. Significance was found among most comparisons, even in cases where the overall standard deviations of baseline and treatment conditions were relatively high while the overall means were low. The paired samples *t*-test was used to measure within subject differences from baseline to treatment. The distribution of the difference scores were sufficiently homogeneous to be able to maximize the *t*-value and reject the null hypothesis for most of the comparisons presented in tables 4.1 and 4.2.

Table 4.1 represents the knowledge gained by the 4th grade using a paired samples *t*-test that showed statistical significance for the following: retelling of the story (p= .01), explaining prior topics (p= .01), vocabulary comprehension (p= .04), and ability to answer concrete questions (p=.01). The 4th graders did not show statistical significance ($p \geq .05$) within the realms of answering inferential questions (p=.21) and use of appropriate materials (p= .12). What will be noted is the effect size (d). The criterion used to evaluate effect size is as follows: ≤ .20 (small effect size); .50 (medium effect size); and ≥ .80 (large effect size) (Cohen, 1988, p 25-26). The fourth grade class showed a large effect size for four of the five categories: retelling stories (d = 1.08), explaining prior topics (d = 1.08), ability to answer concrete questions (d = 1.10), and the use of appropriate materials (d = 1.83). There was a medium effect size of d= .77 for the category of vocabulary comprehension and a small effect size (*d*= -.32) for answering inferential questions.

Observational data of the 5th grade class was conducted in the same manner as the 4th grade students in this study as well as the use of the paired samples statistics *t*-test to analyze the data. The following categories of knowledge in ELA for the participating 5th grade students showed evidence of increasing their scores within the categories of: explaining prior topics (p=.00), vocabulary comprehension (p= .00), answering concrete question (p= .00), and use of appropriate materials (p= .01). As with the 4th grade class, the 5th graders did not show increased ability (p= ≥ .05) in answering inferential questions (p= .82). The 5th graders also showed a lack of evidence to increase their ability to retell a story (p= .08). However, the *SD* for all categories ranged from .21-.90, which can be interpreted as all the variations of scores were within a range to show a homogeneous influence during both baseline and treatment. The fifth grade class also showed a large effect size in five out of the six categories: retelling stories (d = .89), vocabulary comprehension (d = 4.11), answering concrete questions (d = 2.33), answering inferential questions (d= .92), and the use of appropriate materials to answer questions (d = 1.82). A small effect size was shown in the category of explaining prior topics (d = .27).

Overall, four of the six categories (66%) within each class observed had made significant increases in their abilities to show their knowledge of ELA topic during the time of intervention. Would this increase also apply to the students' comprehension of vocabulary? The goal for the next set of statistical tests was to determine not only an increase of vocabulary terms in both Science and ELA, but the ability to retain the information one month post-treatment.

Vocabulary Tests for Science and ELA (pre-test, post-test ($_1$), post-test ($_2$))

A pre-test for both science and ELA single word lists were given to each individual student by the researcher to understand what prior vocabulary knowledge students could show before intervention. The lists of words were directly taken from the text and trade books to be used during intervention (4^{th} grade: ELA: *Doug Unplugged* by Dan Yaccarino, Science: *Physical and Chemical Changes*, BSCS. 5^{th} grade: ELA: *Recess at 20 Below* by Cindy Lou Aillaud, Science: *Heat and Change in Materials*, BSCS). Students were given a one minute timed test. They were permitted to go beyond the time. The purpose of the timed test, as well as how it was presented on paper, was similar to techniques presently used in the classroom to check for understanding, hence having familiarity with this type of testing. If a student finger spelled a word (words such as *iodine* did not have a specific sign and needed to be finger spelled) during the one minute, there would be a slash mark next to the word. After the one minute was complete, the researcher would go back to the finger spelled word to ask for meaning. If the student was able to explain the word, they would receive credit. Students were given the option for which test they would prefer to do first. The $post_2$ testing, all 11 students chose the science test first.

A repeated –measures design was used for determining if there was an effect size when students were tested on their vocabulary knowledge before treatment (pretest), directly after treatment ($post\text{-}test_1$), and one month after treatment ($post\text{-}test_2$). This repeated-measured analysis of variance (ANOVA) was conducted due to the "condition or level of the independent variable connected to each of the other conditions or levels of the independent variable"(*IBM SPSS for Introductory Statistics* Morgan, 2011, p.90). A General Linear Model (GLM),(Morgan, 2011) was conducted to give a full range of statistical relationships between the three tests given to each individual student. For this data collection, the focus was on the effect size (*d*), defined as "the strength of the relationship between the independent variable and the dependent variables, and/or the magnitude of the difference between the levels of the independent variable with respect to the dependent variable" (2011, p. 99). The source of measurement used for this analysis was *Sphericity Assumed.*

4th grade ANOVA for Vocabulary testing in Science and ELA

Table 4.3

Test within subjects effects for 4th grade (n = 7) to determine if data can be measured for significance. Showing Statistical significance: (≤.05) Test Measure Source: Sphericity Assumed.

Measure	*df*		*F*	*Sig*	Partial Eta Squared (η²)	Observed Power [a]
	Time	Effect				
Science	2	12	39.160	.00	.867	1.0
ELA	2	12	92.080	.00	.939	1.0

Table 4.3 demonstrates a statistically significant difference, hence, further data may be provided to show the variance of the pre (baseline), $post_1$ (treatment) and $post_2$(one month post treatment) tests for both ELA and Science.

Table 4.4

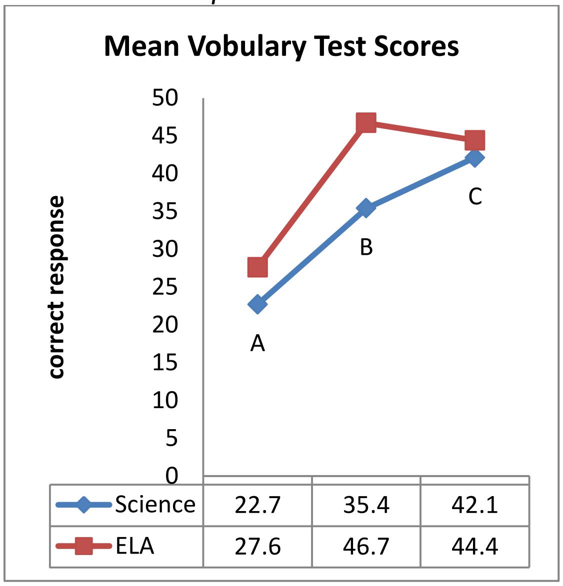
Pairwise Comparisons ANOVA of 4th grade Science and ELA vocabulary test scores.

Measure	Variables	$\bar{x}$ Difference	*SD Error*	*Sig* [a]
Science	A → B	-12.714	2.044	.001
	A → C	-19.429	1.925	.000
	B → C	- 06.714	2.652	.045
ELA	A → B	-19.143	.962	.000
	A → C	-16.857	1.920	.000
	B → C	2.286	1.584	.199

A - Pre-test (2/19/2014) B - $Post-test_1$ (5/06/2014) C- $Post-test_2$ (6/05/2104)

Graph C.

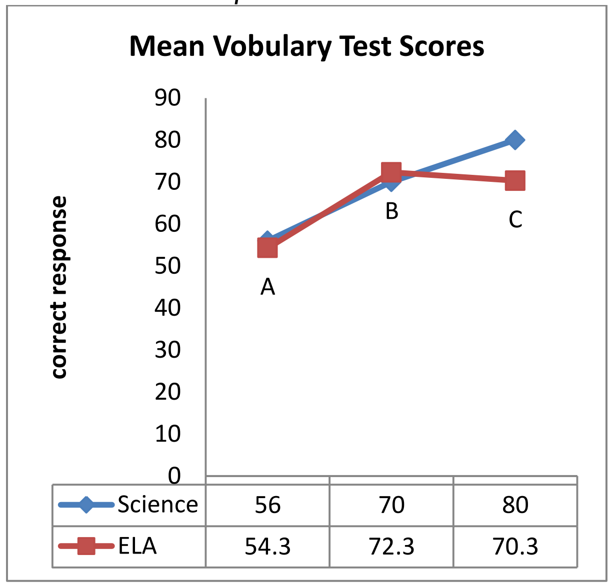
*The graph below represents the **4th grade** mean scores of both Science and ELA tests.*



Science	22.7	35.4	42.1
ELA	27.6	46.7	44.4

Graph D.

*The graph below represents the **5th grade** mean scores of both Science and ELA tests*



Science	56	70	80
ELA	54.3	72.3	70.3

For Graph C and Graph D, points A,B,and C were indicated for both the ELA and science vocabulary tests; points A showing the pre-tests, points B showing the post-test immediately after intervention, and the points C showing a post test one month post-intervention. Both the 4th and 5th grade classes were tested on 30 science vocabulary words. Due to the variance of trade books used for the individual ELA classes, the 4th grade class was tested on 49 words and the 5th grade class was tested on 35 words.

Reviewing the Pairwise Comparisons ANOVA 4th grade vocabulary test scores, the variables from A-B as well as A-C in both science and ELA showed a statistical significance (sig ≤..01). Students were able to show an increase in vocabulary knowledge prior to and one month post intervention. Students also increased their retention scores in science post intervention with a significance of .04. However, from the $post_1$ to $post_2$ for vocabulary connected to their ELA book (*Doug Unplugged*), there was a drop in retention by a mean difference of 2.3 (*sig* = .19). The researcher would like to note that four of the students in the 4th grade were diagnosed with an additional disability at the end of the intervention stage of this research study. All four of these students had a decrease in test scores in the realm of ELA and the three remaining students had either increased or maintained their scores one month after intervention.

Table 4.5

Pairwise Comparisons ANOVA of 5th grade Science and ELA vocabulary test scores. (Source: Sphericity Assumed)

Measure	Variables	$\bar{x}$ Difference	(η^2)	d^a
Science	A → B	-14.0	------	------
	A → C	-24.0	.929	1.000
	B → C	-10.0	------	------
ELA	A → B	-18.0	------	------
	A → C	-16.0	.865	.998
	B → C	2.0	------	-----

A - Pre-test (1/28/2014) B - Post-test$_1$ (4/10/2014) C- Post-test$_2$ (5/13/2104)

Due to the small 5th grade subject size (n=4), both the effect size (η^2) and the observed power (d^a) were analyzed for this study. The effect size "indicates the strength of the relationship or magnitude of the differenece and thus is relevant to the issue of practical significance " (Morgan, 2011, p 101). If $d \geq .8$ supports a large difference (Cohen, 1988), the findings from Table 4.5 shows a powerful outcome represented prior to and after intervention with the vocabulary test scores within ELA and science.

Refering to Graph B, 5th grade students increased their scores overall in science during post-test$_2$ but had a decrease in scores with a mean difference of 1.9. This margin shows minimal change in the retentions of words learned in ELA.

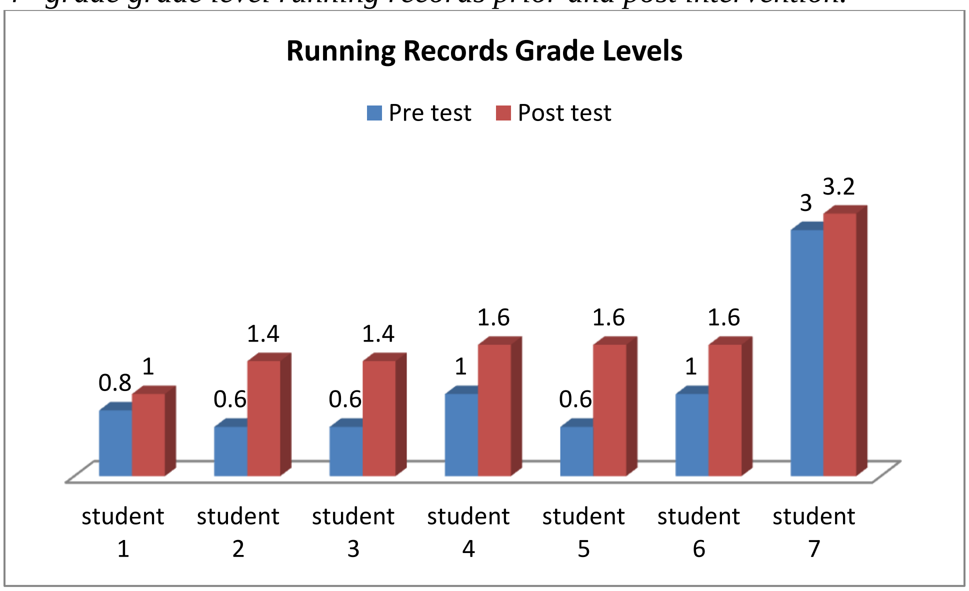
This statistical data brings the researcher to the next question; Will students improve their reading scores when given a random sample to read provided by the teacher through with specific criteria to meet?

Running Records

Running Records, with the use of the *Reading A-Z* tool is used at this school for the Deaf to assess the following: instructional grade level reading, word count accuracy rate, and comprehension. Testing is done at least three times a year by the teacher or reading specialist. Students read a passage (with no previous knowledge) 'aloud' and answers both inferential and text based questions. For the purposes of validity and reliability of this study, the Running Records were given by the classroom teacher or reading specialist during pre-intervention and then post-intervention. The results of the Running Records were given to the researcher after the data was documented for the individual students. The following graphs (Graph E and F) represented the participating individual students' grade level scores prior to intervention and post intervention.

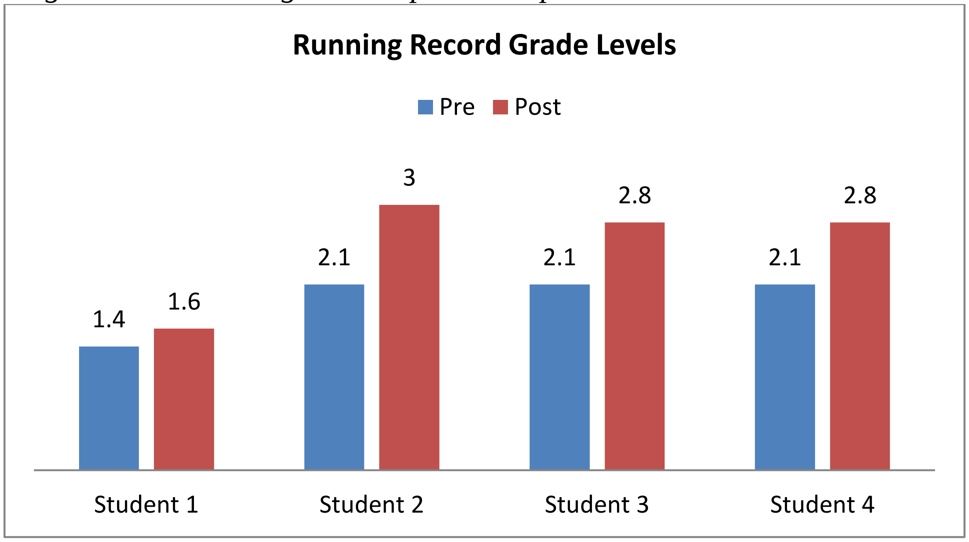
Graph E

4th grade grade level running records prior and post intervention.



Graph F

5th grade level running records prior and post intervention



The average increase of the 4th grade class, as shown in Graph E, is 0.7 years (average increase from 1.0 to 1.7). However there was an outlier, student 7, and therefore skewed the mean difference for the remaining six students. If student 7 were to be omitted, the average increase for the 4th grade class would be 0.6 years (average increase from 0.8 to 1.4). The average increase of the 5th grade class, as shown in Graph F, was .07 years (average increase from 1.9 to 2.6). Although both grade levels increased, they still remained anywhere from 2 -3 years behind their grade level.

Chart 2

Individual 4th grade running record

4th Grade Student	Word Count Accuracy Rate (WCMP) (percent % correct)		Comprehension (percent of correct text and inferential questions)	
	Pre intervention	Post intervention	Pre intervention	Post intervention
Student 1-4	87% (*K-6)	88% (1.0)	100% (K-6)	100% (1.0)
Student 2-4	88% (K-6)	95% (1.4)	100% (K-6)	33% (1.4)
Student 3-4	85% (K-6)	81% (1.4)	100% (K-6)	33% (1.4)
Student 4-4	97% (1.0)	88% (1.6)	66% (1.0)	66% (1.6)
Student 5-4	91% (K-6)	92% (1.6)	100% (K-6)	66% (1.6)
Student 6-4	95% (1.0)	89% (1.6)	100% (1.0)	66% (1.6)
Student 7-4	93% (3.0)	---silent reading	80% (3.0)	35% (3.2)

*Grade level tested

Chart 3

Individual 5th^h grade running record

5th Grade Student	Word Count Accuracy Rate (WCMP) (percent % correct)		Comprehension (# of correct text and inferential questions)	
	Pre intervention	Post intervention	Pre intervention	Post intervention
Student 1-5	42% (*1.4)	98% (1.6)	25% (1.4)	50% (1.6)
Student 2-5	97% (2.10)	95.5% (3.0)	100% (2.10)	38% (3.0)
Student 3-5	97% (2.10)	97% (2.8)	64% (2.10)	36% (2.8)
Student 4-5	98% (2.10)	97% (2.8)	71% (2.10)	86% (2.8)

*Grade level tested

A percentage of ≥ 97% in word count accuracy and ≥ 80% comprehension was identified as an *independent* level. When an *independent* level was achieved, the student was tested at the next higher level (ei: K-6 to K-8). A percentage of ≥ 91% in word count accuracy and ≥60% comprehension was identified on the *instructional* level. Dependent on the teacher, students may be tested on the next level. Percentages falling below 91% (word count) and 60% (comprehension) were at the *frustration* level and would be tested on the level below to reach an *instructional* level score. 63% of the eleven students reached an *instructional* level prior to intervention. 27% began at an *independent* level and .09% was at the *frustration* level prior to intervention. With a mean average increase of +0.6 for all eleven students, 50% of the *instructional* students remained on an instructional level, with an increase in in grade level. 30% of the *independent* students went to the instructional level with an average increase of +0.8 grade level. One student raised their level from *frustration* to *instructional* with a grade increase of +0.2. One student decreased their i*nstructional* level to *frustration* when the grade testing went up a +0.8 grade level.

Running Records was one method of analyzing and collecting data to support student progress. It was noted by the researcher that these passages were random, hence the background knowledge that the students had with any given topic may have varied, dependent of their own experiences.

Overall Findings

The findings among both the qualitative and quantitative data within this chapter have allowed for this researcher to state that the use of a science-centered support for students who are D/HH in the realm of English reading comprehension has strong outcomes. Statistical significance along with the perspectives of the teachers, as well as the motivation of the students leads to greater retention of information to be used in a cross-curricular setting, with science being at the core of learning.

This hypothesis was in connection with how students who are ELLs learn best in an educational setting. In Chapter 5, this researcher discussed the views of the data collected as well as how this data could be used to continue improving the reading skills of students who are D/HH.

Chapter 5

Summary and Discussion

Summary of Methods

The goal for this Mixed Methods research study was to determine if a science-centered curriculum demonstrated a significant increase in reading comprehension compared to an English-based curriculum for students who are Deaf and/or Hard of Hearing. The findings included responses to the following qualitative and quantitative questions: How do teacher and student perspectives support or negate science-based learning to increase reading comprehension? Is there a statistically significant increase in comprehension from students when using a science based theme to support learning during English Language Arts (ELA) class? Is there a significant increase in retention of vocabulary and it's meaning from both ELA and science class? Will students' reading levels increase when a science-based approach supports ELA?

This phenomenological action research study focused on fourth and fifth graders in a school for the Deaf in the northeast region of the United States. A total of 11 out of a possible 14 students were involved with this study (with IRB consent); four students from the 5th grade class and seven students from the 4th grade class that met the criteria at the beginning of this study. Four of the students (two from each class) were interviewed. Data of reading levels and comprehension were collected by all of the participating students, along with being observed during both science and ELA class and tested on vocabulary. A total of eight staff members (three Deaf staff and five hearing staff (one hearing staff was a CODA, Child of Deaf Adult) were involved with this study; six teachers of the Deaf, one certified reading specialist and one American Sign Language (ASL) specialist. The six teachers met the researcher's criteria for this study. Three of the teachers were interviewed in 2011, with IRB consent, and three teachers were interviewed during the 2013-2014 school year. Two of the teachers from the later date were involved with the teaching of the science-centered ELA class.

Summary of Results

Perspectives of Teachers and Students

The results from the perspectives and perceptions of those students and teachers interviewed in this research study concluded that experience-based knowledge and student motivation is the key to increased retention and comprehension of reading. This result supports the social constructivist methods and how science lends itself naturally to inquiry, hence, retention of information. All of the students interviewed stated that they enjoyed science due to the experiments and activities involved during science class. When asked which trade book they preferred (trade book during baseline or during intervention that supported the science curriculum), all four students chose the books used during intervention.

The teachers that were interviewed concluded; (a) students who are D/HH continue to be delayed in reading and writing skills;(b) science methods help students retain concepts; (c) the shift between direct instruction and science is difficult; (d) and there continues to be a lack of instructional tools and time to support a science-based curriculum. However, the teachers involved with the fourth and fifth grade students noted that the students enjoyed and showed motivation when reading the books chosen by the researcher during intervention. The staff also found that when a concept was taught in science, the reading of the trade book became more comprehensible for the students. These statements are supported by past researchers.

Yore (2000) stated students need to “do first and read and write later” (p.105). This was consistently stated among the present interviewees. Background knowledge through hands-on/minds-on science prior to reading and writing supported students ability to retain information compared to reading alone. Teachers interviewed reiterated that students were able to retain science concepts through science inquiry-based learning more effectively than through the English-based curriculum.

Comprehension of Subject

Boyd and George (1971) stated that Piaget's cognitive theory posts the roots of intellectual development in the direct manipulation of the environment, not in the verbal symbol (1955). "The basic cognitive structures are derived from actions with the observations that young children classify manually before they can classify linguistically"(p.3). The current research in this paper also supports the cognitive theory with the teacher's perspective. The statistics found from this research has also shown a significant growth in participation and comprehension when the intervention began in the science and ELA classes for both the 4^{th} and 5^{th} grade classes.

The comparison of the baseline and treatment of the science observations for both the 4^{th} (n=6) (p =.181) and 5^{th} (n=4) (p = .221) grade showed no statistical significance when comparing baseline to treatment conditions. (This lack of statistical significance may be due to the relatively few observations made during science class). Although both baseline and treatment observations were limited, several conclusions have been noted.

The comparison of the baseline and treatment conditions of ELA knowledge observed by the researcher included; retelling of the story, explaining prior topics, vocabulary comprehension, answering concrete question, answering inferential questions and use of appropriate materials. Significance was found among most comparisons, even in cases where the overall standard deviations of baseline and treatment conditions were relatively high while the overall means were low. The paired samples *t*-test used to measure within subject differences from baseline to treatment. The distribution of the difference scores were sufficiently homogeneous to be able to maximize the *t*-value and reject the null hypothesis for most of the comparisons presented in tables 4.1 and 4.2.

The knowledge gained by the 4th grade using a paired samples *t*-test that showed statistical significance for the following: retelling of the story (p= .01), explaining prior topics (p= .01), vocabulary comprehension (p= .04), and ability to answer concrete questions (p=.01). The 4th graders did not show statistical significance ($p \geq .05$) within the realms of answering inferential questions (p=.21) and use of appropriate materials (p= .12). What will be noted is the effect size (d). The effect size is distributed as the following: ≤ .20 (small effect size); .50 (medium effect size); and ≥ .80 (large effect size). The fourth grade class showed a large effect size for four of the five categories: retelling stories (d = 1.08), explaining prior topics (d = 1.08), ability to answer concrete questions (d = 1.10), and the use of appropriate materials (d = 1.83). There was a medium effect size of d= .77 for the category of vocabulary comprehension and a small effect size (d= -.32) for answering inferential questions.

Observational data of the 5th grade class was conducted in the same manner as the 4th grade students in this study as well as the use of the paired samples statistics *t*-test to analyze the data. The following categories of knowledge in ELA for the participating 5th grade students showed evidence of increasing their scores within the categories of: explaining prior topics (p=.00), vocabulary comprehension (p= .00), answering concrete question (p= .00), and use of appropriate materials (p= .01). As with the 4th grade class, the 5th graders did not show increased ability (p= ≥ .05) in answering inferential questions (p= .82). The 5th graders also showed a lack of evidence to increase their ability to retell a story (p= .08). However, the *SD* for all categories ranged from .21-.90, which can be interpreted as all the variations of scores were within a range to show a homogeneous influence during both baseline and treatment. The fifth grade class also showed a large effect size in five out of the six categories: retelling stories (d = .89), vocabulary comprehension (d = 4.11), answering concrete questions (d = 2.33), answering inferential questions (d= .92), and the use of appropriate materials to answer questions (d = 1.82). A small effect size was shown in the category of explaining prior topics (d = .27).

As with the 4th grade class, the 5th graders did not show increased ability in answering inferential questions. Research from Marschark, Spencer, and Adams (2011) found that "parents and teachers frequently demonstrate over-directedness and over-control of DHH children". This leads to the inability to think inferentially. Inferential thinking needs to begin at an early age, allowing for children to use their imagination and creativity to support problem solving ideas, as well as thinking beyond the words of a story. Students at the 4^{th} and 5^{th} grade levels of learning have relied heavily on over-directedness and therefore, their inferential skills suffer.

The 5th graders also showed a lack of evidence to increase their ability to retell a story. However, the *SD* for all categories ranged from .21-.90, meaning all the variations of scores were within a range to show a homogeneous influence during both baseline and the treatment. An outcome of ≤ 1.0 among scores for standard deviation supports the validity of this treatment. Nine of eleven students demonstrated an upward trend line from beginning to the end of this research study for the overall ELA observations.

Overall, four of the six categories (66%) within each class observed had made significant increases in their abilities to show their knowledge of ELA topic during the time of intervention.

Vocabulary Retention

Boyd and George's (1971) research showed that students were able to comprehend new science concepts with greater success compared to new vocabulary words learned through an

English-based curriculum which they stated was "sensory experience over language attainment." Although this research was presented in 1971, the current study in this paper has supported this theory.

A pre-test for both science and ELA words were given to each individual student by the researcher. A repeated –measures design was used for determining if there was a powerful effect size when students were tested on their vocabulary knowledge before treatment (pretest), directly after treatment (post-$test_1$), and one month after treatment (post-test $_2$). Reviewing the Pairwise Comparisons ANOVA 4^{th} grade vocabulary test scores, the variables from A-B as well as A-C in both science and ELA showed a statistical significance (sig ≤ .01). Students were able to show an increase in vocabulary knowledge prior to and one month post intervention. Students also increased their retention scores in science post intervention with a significance of .04. However, from the $post_1$ to $post_2$ for vocabulary connected to their ELA book (*Doug Unplugged*), there was a drop in retention by a mean difference of 2.3 (*sig* = .19). Further review of the results will be found in the discussion part of this chapter.

Due to the small 5^{th} grade subject size (n=4), both the effect size (η^2) and the observed power (d^a) were analyzed for this study. The effect size "indicates the strength of the relationship or magnitude of the difference and thus is relevant to the issue of practical significance" (Morgan, 2011, p 101). If $d \geq .8$ supports a large difference (Cohen, 1988), the findings show a powerful outcome represented prior to and after intervention with the vocabulary test scores within ELA and Science. 5^{th} grade students increased their scores overall in science during post-$test_2$ but had a decrease in scores with a mean difference of 1.9. This margin shows minimal change in the retentions of words learned in ELA.

Reading Levels

Marschark, Sapere, and Convertino (2009) stated the delays in language of students who are D/HH average at the age of 18 are typically at a 9-year-old reading level (4th grade). The students at the 4th and 5th grade level at the beginning of this research study ranged from K-3rd grade independent reading level in accordance with the assessment tool (Running Records) used at this school.

The average increase of the 4th grade class during the intervention of this study was + 0.7 years (average increase from 1.0 to 1.7). However there was an outlier and therefore skewed the mean difference for the remaining six students. Negating this outlier, the average increase for the 4th grade class was +0.6 years (average increase from 0.8 to 1.4). The average increase of the 5th grade class was +.07 years (average increase from 1.9 to 2.6). Although both grade levels increased, they still remain anywhere from 2 -3 years behind their grade level. With a mean average increase of +0.6 for all eleven students, 50% of the instructional students remained on an instructional level, with an increase in grade level. 30% of the independent students went to the instructional level with an average increase of +0.8 grade level. One student raised their level from frustration to instructional with a grade increase of +0.2. One student decreased their instructional level to frustration when the grade testing went up a +0.8 grade level.

These findings need to be further analyzed if the reading levels increased due to the natural progress of age and independent variables, or supported by the intervention of this study. A longitudinal research study would need to continue to follow student progress to assess their increase in reading comprehension.

The overall findings of this research support the lens of science-based learning for students who are D/HH. Questions and discussions need to continue both within this chapter as well as future investigations within the realm of reading comprehension for students who are Deaf and/or Hard-of Hearing.

Discussion

The purpose of this study was to determine if students who are Deaf and/or Hard of Hearing could increase their reading comprehension through the lens of a science-centered curriculum. The rationale for this theory was obtained through evidence-based research of how hearing English Language Learners increase their understanding of a second language. This discussion piece will link hearing ELLs and students who are D/HH through the topics developed during this study in connection with the literature review.

Science-centered Learning Theme

The focus of the science-centered learning experience began with knowledge of the science units that would be presented by the Elementary Science Teacher during the time of intervention. These units were not altered or arranged in any way by the researcher during intervention. The fourth grade science unit was *Physical and Chemical Changes* and the fifth grade science unit was *Heat and Changes in Materials.* Both science text books were from the BSCS series. Finding trade books that show a connection to these two topics, as well as students' ability to read and comprehend the text was challenging. The books that this researcher best matched these units and the level of learning were *Doug Unplugged* by Dan Yaccorino for the 4th grade class and *Recess at 20 Below* by Cindy Lou Aillaud for the 5th grade class. The search for books started with the National Science Teachers' Association (NSTA) Outstanding Trade Books list that is published annually through the NSTA. *Recess at 20 Below* was on this list. This book was also in the school's library, giving this researcher access to review and decide if this was the best book to connect to science. Topics such as temperature, vapor, freezing points and transfer of energy were all found in this book about a group of students who live up in Alaska and their experiences with playing outside, to support the science text. Developing a unit plan that was both rich in vocabulary and figures of speech to support ELA as well as making strong and direct connections to the topics of Heat and Change in materials for science class, was found in *Recess at 20 Below*. The teachers noted that students did not tire from this book as they did with the books being used pre-intervention. “I didn’t hear them complain and say, ‘it’s boring’ which happens with them”. For this 5th grade book the teacher also noted with the two very distinct reading levels within the class, she was able to involve a variety of skills with the two different groups, differentiating within one book. The 5th grade teacher stated, “I could adapt to more visualization, words, gestures, so it showed me a new way. And at the same time can involve science, social studies and other topics could parallel. It started opening up my mind”.

The trade book for the 4th grade science topic of *Physical and Chemical Changes* was extremely challenging. Trade books at the reading level of these students, as well as being a story based on physical and chemical changes had to go beyond NSTAs Outstanding Trade Books list, since there was none to be found by this researcher. After searches through NSTA, the school’s library, and the local public library, nothing was found until entering a popular book store. After scanning row to row, *Doug Unplugged* was found. The connection between the 4th grade science and ELA class was through descriptions and the use of senses through ‘experiences’. In science class, students were exposed to different powders and their reactions when a variety of liquids were poured on these powders. In ELA, the character in the book, a boy robot named Doug, was comparing plain facts that were downloaded into his head to going out and actually experiencing the city, focusing on the use of all his senses. When students were interviewed, they were able to note the connections between science and ELA during intervention of this study but struggled to find any connections with science and ELA prior to intervention. The students expressed their enjoyment of both the ELA book and the experiences of learning through both the science and ELA. The 4th grade teacher added that “It was cute. It was not full of sentences like her (5th grade) book where there was a lot of text but it was connected to more visual observations, experiences. It talked about technology and connections/relationships with technology and how to let it go and have true world experiences but I think maybe the kids missed that “theme”, more adult point of view, know what I mean? Put your IPads down and go outside and play!”

Like students who are D/HH, ELL students who are exposed to experiential learning, make connections with the written language. The 4th grade teacher continued by adding, “Really I thought they got it. It was good thinking about themselves and their own experiences and how it is connected to the book…..about robots, about technology, things they are interested in. This supports Sutman’s (1993) research statement about ELLs: “Since limited English proficient (LEP) students learn English skills most effectively when they are taught across the curriculum, it is especially productive to integrate science and English teaching” (Sutman, 1993, p.2).

The struggles of students who are D/HH compared to ELL students

Singleton, Morgan, & DiGello, (2004) emphasize that children who are profoundly deaf have great difficulty acquiring English vocabulary in the same manner as hearing children do, through the incidental learning process. Not being able to overhear conversations and the limit of an early literacy experience, children who are Deaf struggle to develop age-appropriate English as their hearing peers (2004). This research statement continues to ring true for the participating students in this study. These students are not just delayed, but deficient in the English language. According to the American Heritage Dictionary (1982), the word *delay* is defined as “to postpone until a later time; defer “(p. 377). *Deficient* is defined as “lacking an essential quality or element” (p. 375). An example of deficiency is as follows: The majority of participating students come from an urban setting but only one student could identify the word ‘city’. Words that hearing students pick up through incidental learning; words such as ‘hug’, ‘smart’, ‘group’, ‘population,’ ‘clumsy’, and ‘shrink’ are lost on students who are D/HH, meaning students who are D/HH cannot identify the written word. These words are expressed through the air, but they cannot identify them as a printed word. This makes them deficient, not delayed. These students have the skill to sign it, but are lacking the essential element to identify it in English. With this statement, the question turns to how does one make up for a deficiency in language? Throughout this research study, exposure to words that had an experiential connection was the key to retention and recognition of the printed word.

Before beginning the story *Doug Unplugged* with the fourth grade class, the students were taken on a field trip to the city. The tour of their own city included full exposure and experiences with skyscrapers, pigeons, crowded streets, people in long lines at a popular lunch spot, and the subway system. With this tour, not only were the students exposed to the sights, but the smells, and the feel of the city (and for some of them, the sounds). Pictures were taken, and then back in the class, the written words to these pictures they experienced, as a group, were revealed. Now there was a group connection between what they experienced, what they signed, and what they could identify in print. Only after this experience, the book *Doug Unplugged* was introduced. The impact of this experiential learning for the students increased their vocabulary knowledge in ELA with an average of 16%. This city field trip was only a one day experience, but this was enough to pull from their background knowledge to make connections to the written word. Within science class, students were constantly exposed to both visual materials and the written word during the hands-on labs that were presented. Materials such as salt, alum, cornstarch, vinegar, and baking soda were used in experiments throughout the full six weeks during the intervention of this research. The students increased their science vocabulary knowledge, in accordance to the pre, $post_1$ and $post_2$ tests by an average of 20%. This is a 4% greater increase then the ELA vocabulary.

The fifth grade class was also exposed to experiential learning before beginning the ELA story, *Recess at 20 Below*. The extreme cold and amounts of snow during this past winter was to the students' advantage. Students were asked to bundle up and go outside to play in the snow. The participating teacher had them experience the same types of experiences the students in *Recess at 20 Below* had experienced; walking in the hard snow, going down the icy slide, playing soccer and running around, throwing snow up in the air, and then coming back into the classroom perspiring. As with the fourth grade class, the students now had exposure and a group experience to discuss and place the written word with the experiences they had. This group of students, like the fourth grade group, increased their vocabulary knowledge by 16%. Science vocabulary, with constant exposure by the science teacher with experiments focused on gases, heat, freezing points, thermometers, liquids, Celsius, and Fahrenheit, students increased their science vocabulary by 26%. This was a 10% greater increase then the ELA scores.

Even with the exposure and experience, the recognition and retention of science words remained stronger than in the context of ELA for both the participating 4^{th} and 5^{th} grade students. This may be due to the repetition of the science topic, with hands-on experience being taught on a weekly basis, unlike the one time experience of playing outside in the snow during recess or visiting the city, to gain experience before reading a story. Scruggs, Mastropieri & Okolo, support this perspective by stating; "Science and social studies help students attain skills, information and dispositions that are important for success in school and everyday life" (Scruggs, Mastropieri & Okolo, (2008, p.1).

Additional Disabilities

An important note within this research study is the secondary labels that were attached to four of the seven fourth grade students at the end of this study. The criteria for student participation in this study was to have only one label; Deafness with no additional disabilities. The goal was to apply the science-based learning to typical learning students who are D/HH first. If there was a significant increase in reading comprehension from this population, further research would be involved with students with comorbid disabilities. The four students (participants: 2-4, 3-4, 4-4, and 6-4) were identified with different additional labels: ADD (6-4), ADHD (3-4), LD (2-4), and Apraxia (4-4). When reviewing the ELA observations, two of the four students increased their overall correct responses during the intervention ≤ 0.2 . One student's correct responses decreased by 0.4 and one student increased their responses by 2.0. All four students showed minimal to no increase between the baseline and treatment. This statement also supports the scores from their ELA vocabulary tests. All four, although they increased their vocabulary knowledge from the pre-test to the post-test$_1$, all four students were not able to retain the information one month post intervention with an average decrease in retention of 5%. Even though these scores showed only minimal, at best, increase in ELA, both observations and vocabulary in science showed an increase in answering correctly, and retaining vocabulary. All four students showed an upward trend of correct responses during observations in science with an average of a 2.3 increase. Within the post$_1$ and post$_2$ science vocabulary tests, three of the four students not only retained their science vocabulary knowledge one month after intervention, but increased their vocabulary knowledge by an average of 8%. One student (3-4) had a decreased score of 3%. This development supports the research by Lang and Albertini (2001) whom stated both writing and discussion about science experiences cause learners to generate verbal representations of their thinking, which, in turn, promotes the construction of understanding. They provided information connecting authentic science activities with writing (2001). New terms, facts, and unfamiliar usage of vocabulary through science enables the student to build connections through the use of the "science" experience (2001).

Would student's ability to increase their reading comprehension happen during this intervention? This is a question that needs further investigation. Reviewing students' Running Records, it needs to be noted that students are given a story with no background knowledge that has been addressed during class. They may have some personal knowledge of the topic, but does not necessarily comply to all of the students reading from that text. At the beginning of the school year one 5^{th} grade student (3-5) received an instructional score at the 2^{nd} grade/10 month level. When tested again, at the 2^{nd} grade/6 month level she received a frustration level of 42%. The teacher deducted that this student had background experience with the first round of testing and showed no knowledge of the topic being introduced at the 2.6 level. This seemed to be the case with the students' third Running Record at the 2.8 grade level and continued to score at the level of frustration. Running Records tools are based on a straight reading of a passage with no direct or background knowledge the teacher provided for the student. All of the research gained during this study focused and supported the use of experiential knowledge. Teaching strategies should be centered on teaching students to think and problem-solve, including a learning environment identifying the importance of multisensory active learning with real-life experiences (Luckner & Carter, 2001). Due to the nature of the Running Records tool to assess student learning and to review the level at which the student is at an instructional or independent level remains questionable. The lack of real-life experiences or background knowledge places these students at a disadvantage, and as stated earlier, focuses not on their delay, but their deficiency. This observation turns to one important factor as to why students have increased their knowledge of science vocabulary…motivation.

Motivation in Science

The National Science Education Standards, the American Association for the Advancement of Science, and the National Research Council emphasize the commitment to hands-on, minds-on science that provide richness and excitement of knowing about and understanding the natural world. Science is highly significant for diverse learners. (Mangrubang, 2004). This statement was shown consistently during both the qualitative and quantitative research of this study. Nine of the eleven students showed an upward trend in classroom participation with the focus on being able to answer questions throughout their ELA classes when in conjunction to science concepts. This trend also showed, during the two different times when intervention began with the 4^{th} and 5^{th} graders, that correct answers increased from baseline to treatment.

To increase reading comprehension in school, both students who are D/HH and ELLs must become involved in a rich variety of language and instruction so that the pace allows for great individual flexibility (Sutman, 1992). The constructivist model uses an inquiry-based approach that includes; looking for questions, using personal experiences, promoting collaboration in learning among other students, using open ended questions developed both by teachers and students, and includes the availability of adequate time for reflection, analysis, general problem solving, and understanding through the use of both the first language and English (Sutman, 1992). This may all stem from motivation. Students playing in the snow or taking a tour of their own city produce inquiry based questions that lead them into the science lab. Experimenting with temperature change, and students becoming involved with inquiry based questions that they develop such as, “How can we avoid ice sticking to our lips?” shows an understanding of concepts as well as a growing curiosity for the world around us. This natural curiosity is what builds the need to find the printed (English) word with the questions to be asked and experiments to help them answer such questions. This is motivation at its purest form, when it comes from the student. The teacher’s job is to guide the students that lead them to asking questions, and wanting to write down and express their findings. The students in the 4^{th} grade class that were interviewed were very specific to spell out and explain the differences between alum and baking soda. They shared their experiences from their work in the science lab. They were able to connect the ideas that were used in the lab to what “Doug” experienced when he went exploring in the city. For students who are D/HH, along with the constructivist model, there needs to be an emphasis on the social/emotional factors to help motivate and promote a desire to develop literacy and general academic success (Marschark, 1997). Making a science-centered learning environment for students supports this social/emotional factor to encourage the motivation within the students. Lang et al. (2007) stated, “Imagery has been shown to be a predictor of long-term memory; we also need to investigate how teachers may best promote the development of imagery skills” (p. 78). How to teach this skill and ability to use the hands-on/minds-on based science centered program to develop imagery in students and to apply this ability to teaching reading comprehension and writing continues to be questioned by the teachers that participated in this study.

Teacher Concerns

Materials to support learning (matching text with reading levels), time, and how to use science for direct instruction to teach reading comprehension in ELA, were the thread that ran through all of the teacher interviews during this study.

There is a discrepancy between students' ability to read, comprehend, and have the skills to decipher at the science textbooks levels compared to the reading levels represented in the textbooks (Kinder, Bursuck, & Epstein, 1992). Although students can learn concepts at their grade level in science, they are not able to read the text to support the concepts due to their reading comprehension. This statement is true for both students who are D/HH as well as ELL students. To support learning of science concepts, trade books and other sources that connect to the science concepts need to be obtained and used in the classroom to support the science text at the grade level of the students. Lee stated back in 2005, that there is the lack of high quality materials that meet current science education standards (Lee, 2005). Appropriate trade books that have a comparative concept level are missing, and therefore there is a lack of high quality materials. Teachers who were interviewed in this current study concurred that there was a lack of literary support for science. Although Lee was focusing on actual science materials and the lack of training in inquiry-based science, literature to match the science curriculum falls short to support both ELA and science. With the new *common core* standards that are being addressed within the states, it is the hope of the teachers that such trade books will support (and a list of these books will be available to the teachers) science text books. However, with the new *common core*, it remains questionable if the trade books that are suggested are at the level of the students' ability to read them. This would need to be investigated further. As the researcher of this study, to find trade books to match both the concepts and the reading levels of the students were not only challenging, but time consuming. Teachers emphasized they do not have the time to do a thorough search of trade books to match science concepts. Time to find books and time to make connections between ELA and science was a constant cry from the teachers interviewed.

Time to teach, time to make cross-curricular connections, time to find appropriate materials, and time to meet with the Elementary Science Teachers were all valid concerns from the interviewed teachers. Currently, students at this school go to a science lab to be taught by the Elementary Science Teacher. This separation of teachers impact the time to collaborate to support the connections between ELA and science. Reasons include a conflict with preparation times with the classroom and science teacher, as well as understanding the science topics that are being taught. The focus group in this study expressed the need to make connections, but the ability to find the time with the stressors of a more stringent ELA program has not allowed the flexibility to work with the science teacher. This research study has shown the benefits of using science to support ELA. Students' progress was evident and there needs to be time within the program to support the time needed for collaboration within the two subjects.

Before the intervention, all six teachers also expressed that they would have a difficult time separating the concepts of direct instruction with learning through a science-based curriculum. Teachers shared their hesitation with accepting science as a means to teach reading and were more comfortable with continuing daily practices of vocabulary and grammar instruction independently. This researcher found these comments interesting due to contradictory statements that were being made. Teachers would express frustration for lack of retaining vocabulary on an annual basis, but continued to express the importance of teaching vocabulary and grammar through methods such as the Daybook and Word Wall. However, after the focus group that was involved with the intervention, an understanding of how connections could be made that were natural and conducive to supporting student learning. It would be the goal of this researcher to allow the teachers that were in this study to share their insights with other teachers throughout the school with how a science-centered curriculum could show positive and significant outcomes in student learning. Comments from one focus group teacher stated “if they combined the two, science and ELA concepts together it would work out”. This support from the teachers that have experienced the change of learning from ELA-centered to science-centered will allow for acceptance from other teachers to change through this research-based finding.

Implications of this Study

The implication of this study shows a need to continue researching how to improve the levels of reading for students who are D/HH. There continues to be a struggle with how students learn through an English-based curriculum and their lack of retaining information of literacy skills. This action research study may have given some insight to identify the need to change the lens of learning from English-based learning to science-based learning. The literature suggests that the use of hands-on/minds-on learning through science has shown student comprehension of literary skills increase compared to an English-based curriculum for ELL students. This research has now added the increase of learning for students who are D/HH. The new common core, when completed, may support science centered learning by providing expository text to gain cohesion between science and ELA, as well as within the realms of math and social studies.

Science leads naturally to a social constructivist approach to learning. It is the nature of science that lends itself to experiential learning, such as the study found that Boyd and George conducted in 1971, as well as the extensive research of Marschark whom focused on how the social constructivist model supports social and cultural activities to achieve greater learning for students who are D/HH (1997).

Further research needs to be conducted to support a science-based curriculum for students who are D/HH on a larger scale, including other schools for the Deaf in this country.

Limitations of this Study

The main focus of this study was for students who are Deaf or Hard of Hearing and have not reached a proficient level in accordance to standardized test scores to satisfy the requirements for NCLB. Therefore, this study did not include hearing peers or students who are D/HH that had received a proficient level on their exams. This action research study also excluded high school students, since the questions were conducted with self-contained classrooms.

Other limitations included the use of research in only one school. Due to time, research could not have been completed if other schools for the Deaf (distance, time, and approval of the schools for IRB purposes). Limitations also included the number of staff involved due to years of experience, time constraints, and the small population of staff in the school that focus on the primary diagnosis of deafness of the students.

Student numbers also limited this research study. The small class sizes, and with consent from the participants and parents of the participants led to four of six students from one class and seven of eight students from another class. A size of eleven participating students does not allow for true significance, although the effect size of the participants was strong in the outcomes.

Limitations also included staff response during the interviews due to my professional and personal relationships with these staff members.

Future Research

Significant finding in this study, both qualitatively and quantitatively lead to an opportunity to further investigate science-centered learning for students who are D/HH. Further research may include; a larger sample size, a full year study, vocabulary tests during baseline conditions, and an inclusion of students with additional disabilities.

The larger sample size would include grade levels from 3rd to 5th grade in schools for the Deaf throughout the country. With the addition of the *common core* in education, students would have the opportunity to use similar experiential learning through the lens of science to increase reading abilities.

This research study was within a 19 week time frame within one school year. Research to track students during a full school year of a science-centered curriculum, becoming a longitudinal study, can determine if such approaches will become evidence-based compared to 'best practices'. Provisions for teachers would be required prior to the school year. Provisions would include appropriate trade books and a specific curriculum to guide the teachers to make connections with science, as well as adequate meeting times with the science teacher for instructional planning.

Comparisons of vocabulary testing during baseline condition, as well as during treatment may validate the possible gain in retention of word recognition in the context of the data collected. This would be a recommendation if students were not able to have a full year of intervention.

This study was conducted with students who were D/HH with no additional disabilities. However, at the end of this study, four of the eleven students were diagnosed with additional disabilities. To continue a science-centered based curriculum, with documented increases in their vocabulary retention within the realm of science, may benefit these students within the schools for the Deaf.

Conclusion

As a teacher of the Deaf for the past 19 years, this researcher has shown how science motivates and increases the learning of students who are D/HH. This mixed methods action research study has proven that a science-centered approach supports an increase in student reading comprehension. It is time to change to the lens of learning for students who are D/HH. It is time for science to lead the way for greater learning.

Appendix A

Informed Consent for Research Project Participants:
Teacher's Perspectives of Using a Science-Based Curriculum to Teach Reading to Students Who are Deaf or Hard of Hearing.

Dear Teachers,

I am currently in a doctorate program at Arcadia University, Glenside. I would like to invite you to participate in an action research project focused on how teachers can help increase and retain students' reading skills. I am interested in your perspective of how your students learn English (your struggles and your successes).

Your participation will include being interviewed for about 45 minutes at a place and time at your convenience. Given our use of sign language for communication, this interview will be videotaped and transcribed to word at a later date by me. You will also be asked to join a focus group with the other participants for approximately one hour to discuss further ideas, concerns, and thoughts about the issues of the structure of teaching reading to the students. This will also be videotaped and then transcribed at a later date. There is minimal risk involved in participating in this study, no greater than those encountered in everyday life. Although we are colleagues, I am not your supervisor, nor evaluator; no information you provide will be shared with anyone outside the research context, and your decision to participate, or not, will not negatively influence your relationship with me, the school, or Arcadia University.

On completion of the transcript, you will be given a hard copy to review and make any changes you feel are necessary. After your feedback, the videotapes will be deleted and names will be changed to a pseudonym along with the name of the school, for right to privacy reasons. All information will be stored on my password-protected computer in my home. I may use some of the information you provide in subsequent research and professional presentations, while maintaining confidentiality in relation to your true identity.

You have the right to withdraw from this study any time up until April 15, 2014. At that time you can ask to have me remove your previous information from my study, or allow me to keep what you have provided to that point. After April 15, 2014, I will be in the final stages of the writing process and will not be able to remove quotations from the document.

This document will be shared with my Arcadia professor and other appropriate members of the Arcadia University community. This study protocol was approved by Arcadia University Institutional Review Board (IRB) Committee. To make sure that this research continues to protect your rights and minimize your risk the IRB reserves the rights to examine and evaluate the data and research protocols involved in this project. If you want additional information regarding your rights in this study please contact the Committee on the Protection of Research Subjects (CORPS) at (267) 620-4111, or via email at irb_iacuc@arcadia.edu.

I appreciate you giving time to this study, which will help me learn more about the perspectives of teachers and methods of teaching English to students who are Deaf or Hard of Hearing. If you have any further questions, please feel free to contact me at fpatalano@arcadia.edu .

Thank you.

Francine L. Patalano

Please sign below if you are willing to participate in this action research project outlined above. In doing so, you understand that your participation in this study is completely voluntary and that you may stop your participation at any time without a penalty.

****
This study has been explained to me, I have read the consent form and I agree to participate. I have been given a copy of this consent form.
Signature: ____

Print name:____

Date:____________________

Signature of Researcher: ____________________________

Appendix B

Informed Consent for Research Project Participants:
Student's Perspectives of Using a Science-Based Curriculum to Learn Reading.

Dear Parents/Guardian,

I am currently in a doctorate program at Arcadia University, Glenside. I would like to invite your child to participate in an action research project focused on how teachers can help increase and retain students' reading skills. I am interested in your child's perspective of how he/she learns English and the ways it is taught.

Your child's participation will include being interviewed for about 15 minutes in their classroom or in a room at school that is comfortable for him/her with myself (the researcher) and another staff that your child feels safe with during the interview. This will take place during school hours (but not interfering with academic time). Given our use of sign language for communication, this interview will be videotaped and transcribed to word at a later date by me. I also requesting the consent of recording your child's assessment scores prior to, during, and post research for data collection. Your child's name and the school which they attend will remain anonymous and confidential at all times. There is minimal risk involved in participating in this study, no greater than those encountered in everyday life. Although I am a staff person, I am not the child's teacher and no information your child provides will be shared with anyone outside the research context, and you and your child's decision to participate, or not, will not negatively influence your relationship with me, the school, or Arcadia University.

On completion of the transcript, your child will be given a hard copy to review (with support from the researcher) and make any changes he/she feels are necessary. After your child's feedback, the videotapes will be deleted and names will be changed to a pseudonym along with the name of the school, for right to privacy reasons. All information will be stored on my password-protected computer in my home. I may use some of the information you provide in subsequent research and professional presentations, while maintaining confidentiality in relation to your true identity.

Your child has the right to withdraw from this study any time up until April 15, 2014. At that time you can ask to have me remove your child's previous information from my study, or allow me to keep what has provided to that point. After April 15, 2014, I will be in the final stages of the writing process and will not be able to remove quotations from the document.

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I appreciate your child giving time to this study, which will help me learn more about the perspectives of teachers and methods of teaching English to students who are Deaf or Hard of Hearing. If you have any further questions, please feel free to contact me at fpatalano@arcadia.edu .

Thank you.

Francine L. Patalano

Please sign below if your child is willing to participate in this action research project outlined above.
In doing so, you understand that your child's participation in this study is completely voluntary and that he/she may stop his/her participation at any time without a penalty.

****
This study has been explained to me, I have read the consent form and I agree to participate. I have been given a copy of this consent form.
Parent Signature: ____

Print name:_______________________________________

Student Signature:____

Print name: _______________________________________

Date:_____________________

Signature of Researcher: ______________________________

Appendix C

4th Grade Unit Plan

4th grade: ELA: Reading; Level 1-2 students: ***Doug Unplugged*** by Dan Yaccarino
Curriculum map goals (Reading):

- **ELA Essential Questions:**
  - What are the reasons we read and write?
  - What do good readers do to make sure they understand?
  - What do good writers do to make sure they are communicating clearly?
- **Guided Reading (Level 1):**
  - Settings, predictions
  - Problem solving
  - Main character
  - Supporting characters
  - Story/sequence
  - Comprehension
  - Relationships with characters
  - Creating comprehension questions to ask other students
  - Problem/solution

Going beyond visualizing!!!! Reading and then experiencing! Facts and Experiences combined!
The connection between ***Doug Unplugged*** and ***Physical and Chemical Changes*** is the ability to describe and observe using many of your senses. Vocabulary will be the key to help build students' ability to describe what they do, see, feel, and smell. Words will be introduced and used in Science and ELA, with constant overlaps to help build retention of new vocabulary words.
(**Facts**: Nouns and Verbs **Experiences:** Adjectives)
Suggestion: A trip into the city! Where: Reading Terminal Market, Comcast Building, (and around that area and if you c an, go to the top of a skyscraper!), subway. When: During lunch time!!!!
Introduction:

- **The front cover**: Questions to begin dialogue

What do you see (be as descriptive as possible)?
Who is this?
What is he holding in his hand?

- **Page 1: *This is Doug***

Nouns: Robot, Facts
Verbs: Fill, Love, "plug him in"
Adjectives: Smart
Possible Topics/Activities

- How do you think Doug learns? How do you learn?
- What do you think will happen when he gets "plugged in?"
- Do you think learning lots of facts are important? What kinds of facts did you learn today? How did you learn them? (from books, movies, the teacher, ipads, computers, your parents, friends?)
- Make a Venn, how are they the same-different than Doug?

Science concepts: alike, different, characteristics

- **Page 2: *Learning about the City***

Nouns: City
Verbs: Downloading, Learning

Adjectives: Happy
"Happy Downloading" (like saying…have a good day!)
Possible Topics/Activities

- What do you think is important to learn about the city? List things that you think are important for Doug to learn!
- What do you see and know about the city? (get students to talk and list all the things they know about cities) (if needed, compare them to the country…how are they different….might trigger some topics)
- Leave a blank area to see what kinds of things Doug will be learning about.

Science concepts: Predictions, Data, Identify

- **Page 3 and 4: *Info on the City***

Nouns: people, population, manholes, trash, fountains, firefighters, fire engines, fire hydrant, skyscrapers, cabs, pigeons, subways, eye
Verbs: living, throw out, pump, respond, making, caught
Adjectives: many, tallest, yellow
Possible Topics/Activities

- Compare what you predicted with what you thought Doug should learn and what he "downloaded".
- Do all of these facts seem interesting? What would you do to make all of these facts interesting?

Science concepts: Identify, investigation

- **Pages 5 & 6: *Seeing a Real Pigeon***

Nouns: pigeon, flocks, groups
Verbs: learned, traveled, made, wondered, went out
Adjectives: funny, cooing
Possible Topics/Activities

- "*So……*" What is Doug going to do next? (what would you do next?)
- Start making a chart broken into FACTS and EXPERIENCES)(include nouns, verbs, and adjectives under each)
    - What FACT did he learn about pigeons? (more than 500 million in the city).
    - What EXPERIENCE (observations) did he learn about pigeons? (they made funny cooing sounds)

Science Concepts: Predictions, observations, characteristics

- **Page 7: *Doug Unplugged***

Noun: Doug
Verb: Unplugged

- **Page 8: *Flying into Pigeons***

Nouns: pigeons, flocks
Verbs: learned, flew, scattered
Possible Topics/Activities

- Add to the list of FACTS and EXPERIENCES (observations)

Science Concepts: observations, characteristics, investigation

- **Page 9 &10: Sidewalks**

Nouns: people, sidewalks, cities
Verbs: teeming, knew, discovered, see
Adjectives: crowded, hard
Possible Topics/Activities:

- Continue chart

Science concepts: physical, property, observations

- **Page 11 and 12: *The Subway***

Nouns: subway, trains, corners
Verbs: found, ran, rode, screeched, wait
Adjectives: entire, free
Possible Topics/Activities:

- Continue chart

Science concepts: physical, property, identify

- **Page 13 and 14: Skyscrapers**

Nouns: skyscrapers, frames, steel
Verbs: view, amazed
Adjectives: strong, high, top
Possible Topics/Activities:

- Continue chart

Science concepts: physical, property, observations, investigation

- **Page 15 & 16: *Learning more things***

Nouns: feet, cement, fire engines, garbage cans, manholes, flowers, sidewalks, taxis, water, fountains
Verbs: learned, grow, raise, feels
Adjectives: wet, squishy, loud, smelly, dark, pretty, cool, hot
Possible Topics/Activities:

- Continue chart
- Take a tour around the block of PSD to see how many of these things you can experience with the students. (Science class: make cement like material for students to put their hands in!)

Science concepts: physical, property, observations, investigation, mixture, germs, identify, characteristics

- **Page 17-21: *Finding a friend***

Nouns: boy, hide-and-seek, tag, friend
Verbs: asked, learn, called, play, different, found
Adjectives: little, happy, new,nice
Possible Topics/Activities:

- Continue chart
- Have students write down what they like to play outside. Can they use descriptive words to explain how they play?
- Go outside and have them play. Video tape them and have them describe again “through the air” how they play.
- Come back inside and watch the video and write the words the students used to describe their play outside.
- Compare how the students play outside with Doug and his new friend. (Venn)

Science concepts: physical, property, observations, identify, alike, different, characteristics

- **Page 22: Where is *Mom & Dad?***

Nouns: mom, dad, friend, things
Verbs: scared, view, see
Adjectives: sounding, better
Possible Topics/Activities:

- How is Doug's friend feeling? How do you know? What do you thing Doug will do next? What words in the story make you predict that?

Science concepts: observations, prediction

- **Page 23 & 24: *ZOOM***

Verbs: flew, shouted
Adjectives: high
Possible Topics/Activities:

- Was your prediction correct? Why or why not?

Science concepts: investigation, solution

- **Page 25: *Found***

Nouns: mother, father, parents
Verbs: landed, ran, wanted, tell, learned
Adjectives: little
Possible Topics/Activities:

- What did Doug learn today?

- **Page 26: *The End***

Nouns: parents, hug, robot
Verbs: learned, show, give, thought
Adjectives: best, great, big, smartest
Possible Topics/Activities:

- Complete the chart
    - Discuss the differences between reading about something and experiencing it.
    - Make another Venn about the similarities and differences between Doug and the students.

Post -test of both *Doug Unplugged* vocabulary and science vocabulary.

Appendix D

5th grade Unit Plan

Blue: science vocab
Red: science concepts

5th grade: ELA: Reading; Level 3 students: ***Recess at 20 Below*** by Cindy Lou Aillaud
Curriculum map goals (Reading):

- **Word Work:**
  - 1.1.5.B: use world analysis skills, the glossary/dictionary, and context clues to decode and understand new words during reading.
  - R5.A.1.1.1: Identify and/or interpret meaning of multiple-meaning words used in text.
- **Guided Reading:**
  - R5.A,1.3.1: Make inferences and/or draw conclusions based on information from text.
  - R5.A.1.4.1: Identify and/or explain stated or implied main ideas and relevant supporting details from text.
  - R5.A.1.5.1: Summarize the key details and events of a fictional text as a whole

Inferential questions and text based questions
Introduction:

- **The front cover**: Questions to begin dialogue

What do you see?
Who are they?
Where do you think they are?
What is your experience with really cold weather?
Do you remember when it was -6 degrees? What did it feel like?
Are the trees you see in the background the same you see here around school?
How are they different?
What words would you use to describe what the children are feeling and or seeing?
Cover page: **(Concepts**: What is that thing in the center with the numbers on it? (***Thermometer***) What ***temperature*** is it reading?

- **Page 1:** ***Walking to school***

(Similes, metaphors, onomatopoeia)
"cold ***takes my breath away***" (metaphor)
"the snow on the ground ***sparkles like diamonds***" (simile)
"***Crunch, Crunch, Crunch***! (onomatopoeia) ...it sounds like I'm ***wading through a bag of potato chips***". (simile)
Air is filled with tiny ice crystals

- **Page 2:** ***Moose crossing***

Where is Alaska?
"There's only snow on the ground from September to April." When do we get snow in in Philadelphia? What month does it start? When does it stop?
"We have to wear a LOT of clothes." What do you wear when you go out to play in snow, or go sledding? (Have students explain the layers of clothes they wear…or they can videotape how they get dressed…maybe even bring in some clothes to show students what it's like to get all bundled up)
(Before you turn the page, have them discuss and write down what they think is a lot of clothes. Do you think they wear the same clothes in Alaska when it's cold?
What is that picture on the sign?

- **Page 3 and 4: *Getting dressed***

Fun Verbs: wiggle, squirm, twist, pull, zip
Fun Adjectives: thick, high
(Have student put on snow pants, boots, etc….have them experience putting on layers)
What is the order of how they get ready to go outside to play. What happens if you put your mittens or gloves on first?

- **Page 5: *Ready for play***

(similes and metaphors)
"As big as a sumo wrestler" (simile)
"giant pickle in her green parka" (metaphor)
"looks like a jar of grape jelly" (simile)
Fun verbs: waddle

- **Page 6: *Sledding***

What would you play outside if you had piles of snow to play with?
Fun Verbs: Dumps, grows and grows
onomatopoeia: Yippeeeeeeee!

- **Page 7: *The playground***

The teeter—totters usually ***freeze*** to the ground
Describe the pictures you see. (The swings that you can't swing because there is no place for your legs, the see-saw/teeter-totter that doesn't go up and down and the snow covered slide.
How do the children swing? How do they play on the teeter-totter?
(Similes, metaphors, onomatopoeia)
Bang! Bang! Bang! (onomatopoeia)
Ice crystals that sparkle like glitter (Simile)
Like sliding down a glacier (simile)

- **Page 8: *Problems in the snow***

Why would your tongue stick to metal? **(Concept: *freezing point, transfer of energy*)**
How would pouring a glass of warm water over it get your tongue free? (**concepts: *melting point, transfer of heat*** **)**
The air is so dry (no humidity? Too advanced?) ????
Fun adjectives, *Puffy* snow clouds and *swirling* tornadoes.

- **Page 9 and 10: *The hard snow***

(Similes, metaphors, onomatopoeia)
Like giant bricks (simile)
We look just like bear cubs spying on the action.
Brrrrr (onomatopoeia)
Fun Verbs: howling, packed, stack, spying
How will being inside the snow fort make it nice and warm? (***Insulator***)

- **Page 11 and 12: Playing hard**

What kind of group games do they play?
Why would it be hard to run around?
How can you get warm when it is 20 below zero?
(Vapor) "Moisture from our breath floats up to our faces and makes our eyelashes *freeze*"
(concepts of *freezing point, vapor, evaporation, transfer, energy*)
Fun Verbs: floats
Fun Adjectives: Old and gray
What does "playing hard" mean?
Would your frozen hair break if you touched it?

- **Page 13: *Moose visit***

What happens if it's more than 20 below?
What kind of animals have come to "visit" the school? Can the students go out and pet them?
What kinds of animals have visited PSD? (similarities/differences)
Fun Verbs: munch, sprint, attacked, swooped, gobbled.
Fun Adjective: Bright red

- **Page 14: *The sun***

Why do they have recess at noon?
Have you ever played hide-and-seek during the day? Have you ever played hide-and-seek with flashlights?
(**concepts of sunrise, sunset…for another science topic**)

- **Page 15: *Coming in from the cold***

How are the students feeling when the get inside? How do they describe how cold they are?
How do you feel when you come in from out of the cold?
"we create a cloud of ice fog from everyone breathing in one place. Our breath freezes into tiny specks of ice that hang in the cold air" **(concepts*: gases, vapor, evaporate, freezing point, transfer of heat, air, direction)***

- **Page 16: *Getting off the layers***

(Similes, metaphors, onomatopoeia)
Clomp, clomp, clomp!, Zap? Ouch! (onomatopoeia)
Sound like a bunch of elephants (simile)
Fun Adjectives: clumsy, wild
Fun Verbs: peel
(**concepts: electricity, static….for another science topic**)

- **Page 17: *A mess of clothes***

Fun verbs: stare, settle, hunting
Fun adjectives: frosty
(maybe play the shoes in a pile game, to show how it takes a bit to find your things!)
Why is the student hoping that it's not colder than 20 below tomorrow?

- **Page 18: *End of the day***

(Similes, metaphors, onomatopoeia)
Drip, drip, drip, (onomatopoeia)
Midnight sun to chase away the darkness (metaphor)
Fun Verbs: Shrink, **melt, stow**
How can a mountain shrink? What is happening as the days continue? What happens at PSD when the months get close to June?
Would you love recess at 20 below?
(**concept: heat, liquid, solid, melt, melting point**)

Appendix E

Individual Teacher Interview Questions

I. Background Info:

A. What is your position here at school?

B. Grade level taught?

C. How many years have you been teaching here?

D. How many years have you taught your present grade level?

E. What type of population do you have in your classroom? (deaf only, deaf with behavioral issues, deaf with other disabilities?)

F. Have you taught in other schools and if so, how long and what grade level (or capacity did you teach)?

II. ELA Questions

A. Do you teach English (ELA)?
B. Tell me about your perspectives with how you teach ELA.
C. What types of results have you seen with your students? (overall improvement of their skills and proof of their skills) .
D. What do you see as the benefits of teaching ELA to your students?
E. What struggles are reoccurring if any?

III Science Questions

A. Do you teach science?
B. Tell me about your perspective with how you teach science?
C. What types of results have you seen with your students? (overall improvement of their skills and proof of their skills) .

D. What do you see as the benefits of teaching science to your students?

E. What struggles are reoccurring if any?

IV. Comparing Science and ELA

A. What topics do you see your students having a greater success with (ELA or Science)? Why?

B. If science has better outcomes (grades, comprehension, connections), would teaching science help students with ELA?

C. How could you restructure your teaching around the topics of science with ELA?

D. Is it doable?

Appendix F

Individual Student Interview Questions

(Students will be shown work from both prior to and during the intervention to help with the interview)

1. Do you like learning to read and write?
2. What do you like about it?
3. What do you not like about it?
4. Do you like learning science?
5. What do you like about it?
6. What do you not like about it?
7. Which part of the two "projects" did you enjoy? Explain.
8. What do you remember from the first project?
9. What do you remember from the second project?

Appendix G

Focus Group Guiding Questions

1. What were your thoughts about changing from English based to science-based learning?
2. What were the differences between the first six weeks and the second six weeks?
3. What were the strengths?
4. What were the weaknesses?
5. What are your thoughts about comparing ELLs with D/HH?
6. If ELL have been researched to acknowledge that science based learning helps them learn English, is it possible the same can be true for D/HH?
7. How would you change your focus to teach D/HH through science?
8. Is it doable?
9. If your strength is in teaching science, how can we support those that are not strong with teaching inquiry-based science?
10. What does inquiry-based science mean to you?
11. What types of support would you need for a science centered approach to be used at this school?

Appendix H

Sample Of *Reading A-Z* Benchmark Passage (Level D)

Name__________________________ Word Count: 68

At the Playground

A playground is near my house.

The playground is where I play.

At the playground I look up.

I look up at the sky.

I look up at the clouds.

At the playground I slide.

I slide down the slide.

I slide down to the ground.

At the playground I run.

I run on the ground.

I run on the grass.

I like to play at the playground.

Appendix I

Sample of Reading A-Z Benchmark Passage Running Record (Level D)

Student's Name________________________ Date_________ Word Count: 68

Have the student read out loud as you record. Assessed by___________________________

Word count	**E** = errors **S-C** = self-corrected **M** = meaning **S**= structure **V**= visual	**E**	**S-C**	**E** **M S V**	**S-C** **M S V**
6	A playground is near my house.				
12	The playground is where I play.				
18	At the playground I look up.				
24	I look up at the sky.				
30	I look up at the clouds.				
35	At the playground I slide.				
40	I slide down the slide.				
46	I slide down to the ground.				
51	At the playground I run.				
56	I run on the ground.				
61	I run on the grass.				
68	I like to play at the playground.				
	Totals				

WCPM: ☐ **Error Rate:** ☐

Accuracy Rate: ☐ **Self-Correction Rate:** ☐

Appendix J

Sample of Reading A-Z Passage Quick Check (questions) (Level D)

At the Playground

Name________________________________ Date______________

1. The girl goes to the playground because she_____________.

    a. likes to learn about the sky

    b. likes to be near her house

    c. likes to have fun

2. What does the girl NOT do at the playground?

    a. Run on the grass.

    b. Slide down the slide.

    c. Meet her friends.

3. A ***playground*** is an outdoor place to play. What can be found at a **playground**?

    a. A book

    b. A cake

    c. A swing

Instructions: Sit next to the student and read the first question as you run your finger under the words. Ask the student to wait to answer until you have read all the choices. Repeat them if necessary. Have the student choose the best answer. Repeat with the remaining questions.

Appendix K

Running Records and Reading Strategies Used for Assessment

Name:_______________________________ Age:___________ Date:_________________

Reading Passage: ____________________________________ Grade Level of Passage:_________

Reading Strategies

Useful Strategies Observed	**Disruptive Strategies Observed**
___Uses picture clues	___Relies too heavily on picture cues
___Uses context clues	___Substitutes words that don't make sense (semantics)
___Reads fluently	___Substitutes words that don't fit in sentence (syntax)
___Uses conceptual signs	___Reads word for word, does not use conceptual signs
__Makes reasonable guesses	___Does not recognize high frequency words
__Self corrects errors	e.g. ____.
__Recognizes when words are unknown	___Does not recognize errors
__Rereads to take a guess	___Makes omissions
__Substitutes syntactically correct words	___Ignores unknown words
	___Relies too heavily on fingerspelling

COMPREHENSION

Text Based Questions $\frac{\text{\# correct}}{\text{\# total}}$ = %	Inferential Questions $\frac{\text{\# correct}}{\text{\# total}}$ = %
Retelling: _____complete _________partial ______confused __________not evident	
_____Included main idea _____Included important details _____English to ASL	_____Used random words and/or details _____Off topic
Comments:	

Recommended teaching strategies to improve this student's reading:

Accuracy $\frac{\text{\# words correct}}{\text{\# total words}}$ = % accuracy ______ %	Comprehension $\frac{\text{\#questions correct}}{\text{\#total questions}}$ = % comprehension __________%
Suggested Instructional Reading Level (see reverse side):	

____

Signature of Rater

11-3-06 sm, psa, js

Appendix K (continued)

How to do a Running Record

Read title together. Student makes prediction about content.
Instruct students to read passage silently.
Have student read "aloud" independently. Do not tell him/her any words.
Record errors. If a student uses incorrect sign, write "WS", but do not deduct points. *

Have student retell (summarize) without referring to the passage (record what he/she says).
Ask fact based and inferential comprehension questions (record responses)
If student asks to look back at passage to locate answer, record "LB"- this is helpful, they know to use text as a resource.

Determine word identification accuracy (percentage)
Determine comprehension accuracy (percentage)
Complete reading strategies page
Record Instructional Reading Level
Make recommendations for teaching strategies

Reading Levels
Independent level
Achieved when the child reads with at least 97% word recognition and 80% comprehension. At this level the child reads fluently with expression, and there are no signs of anxiety. Children should receive recreational reading materials that are written at this level of difficulty.

Instructional level
The highest level at which the child reads with at least 91% word recognition and 60% comprehension. It is expected that children can read materials of this difficulty with teacher assistance. Because this level is the focal point of instruction, its determination is most important. At this level material should challenge children without frustrating them.*

*It is more meaningful to think of the instructional level as a <u>range</u> rather than as a fixed point.

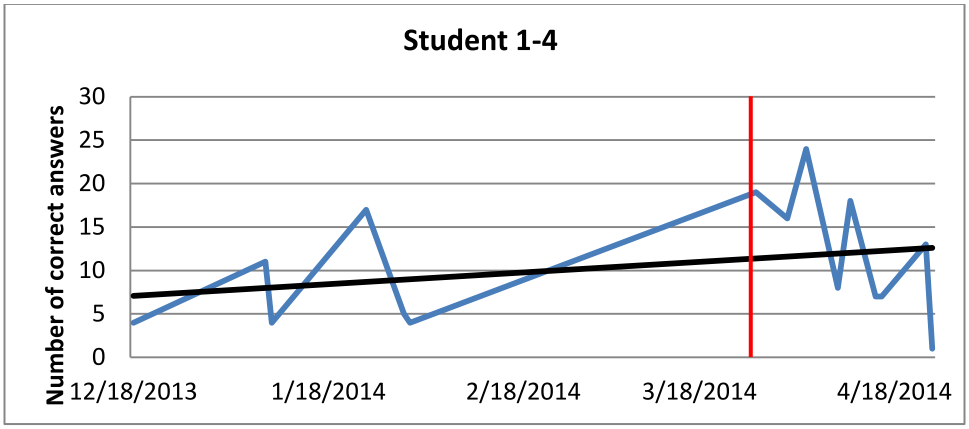
Frustration level
The level at which reading is simply too difficult for the child. Word recognition accuracy is 90% or below and comprehension falls under 60%. Reading tends to be word by word, several errors are made and the child exhibits signs of tension and apprehension.

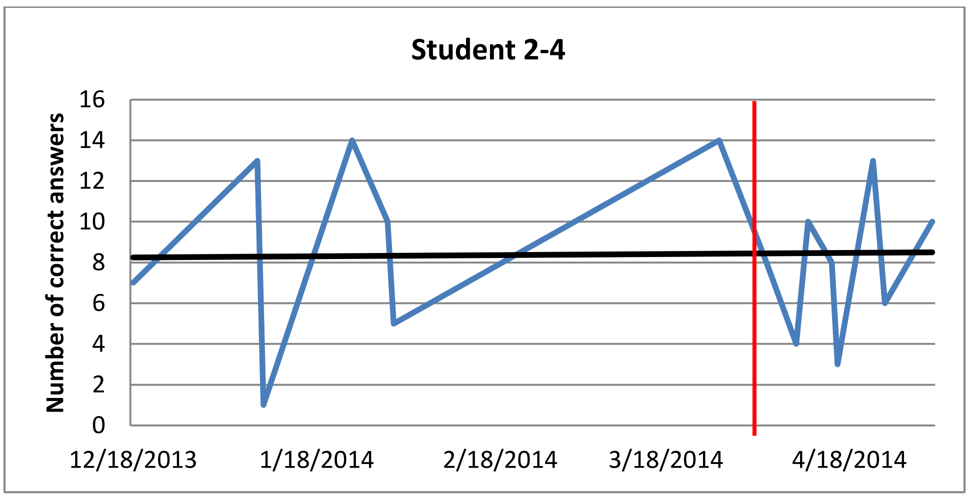
11-3-06 sm, psa, js

Appendix L

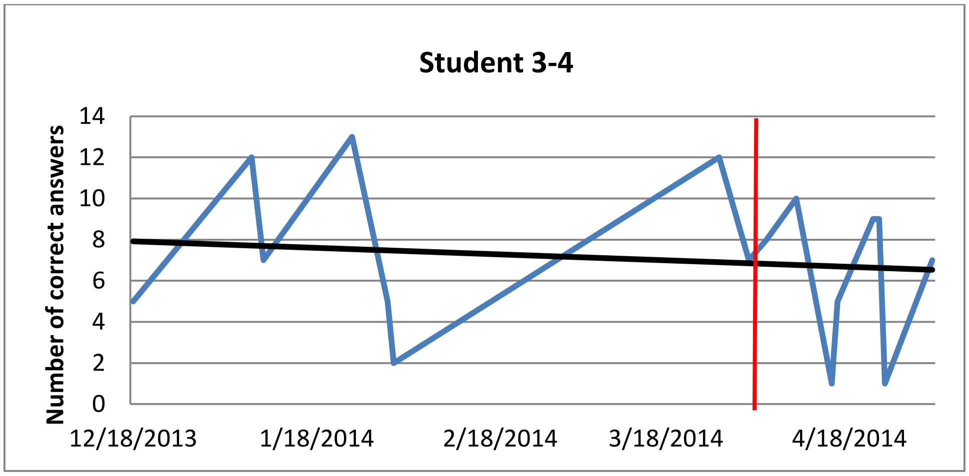
Complete Student ELA Observations during Baseline and Treatment

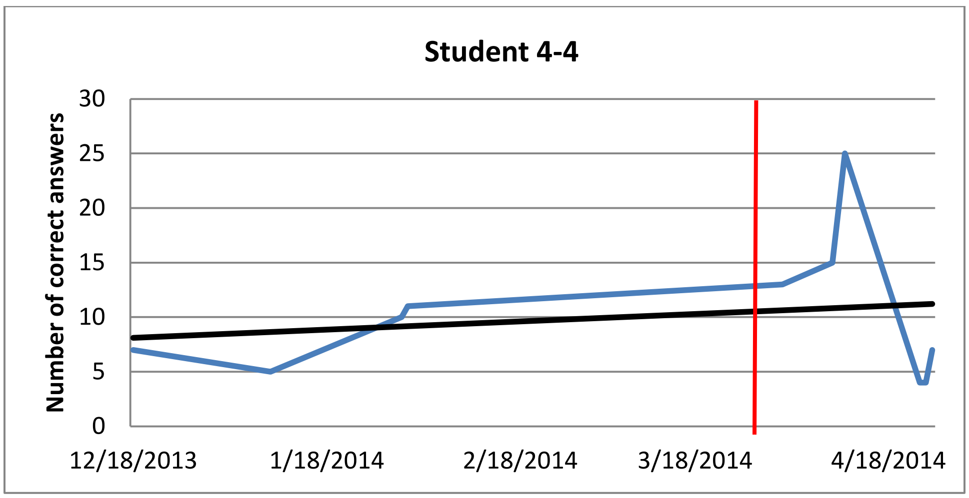
Red line: represents the beginning of treatment
Black line: Trend line

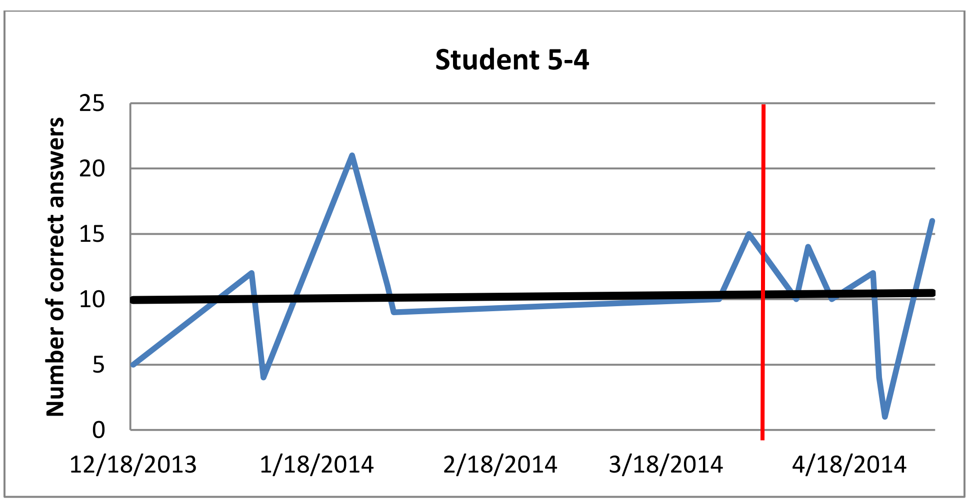




Appendix L (continued)







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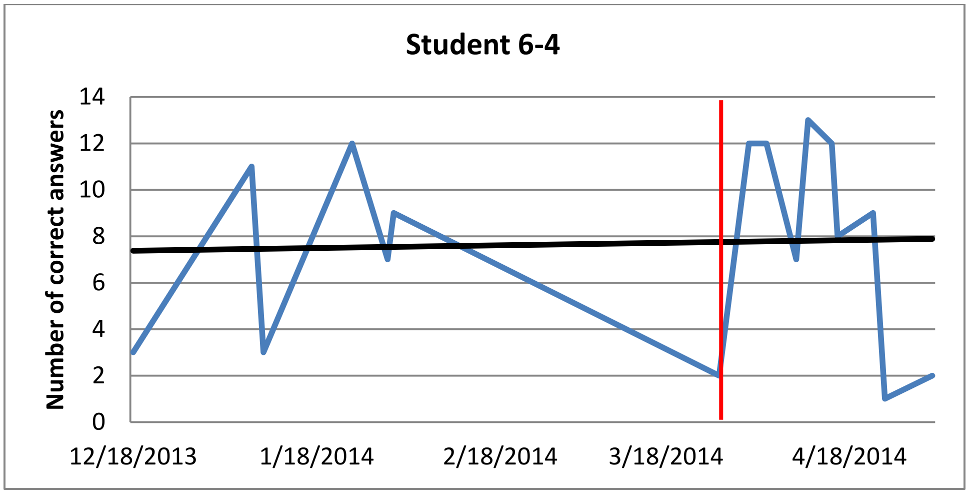

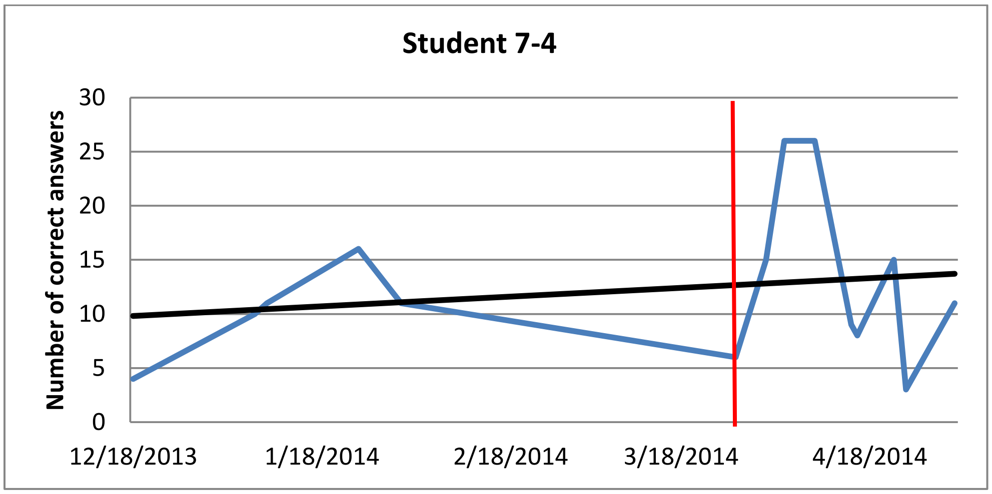

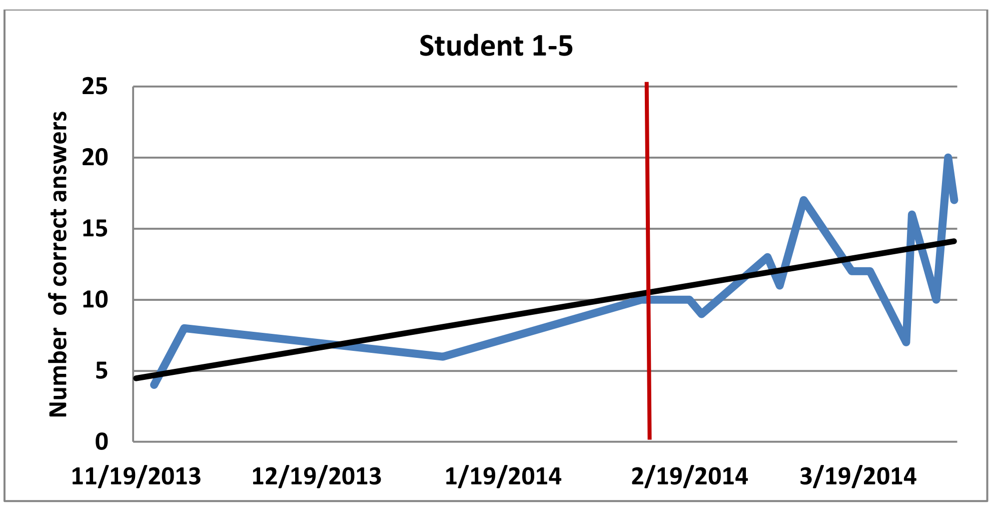

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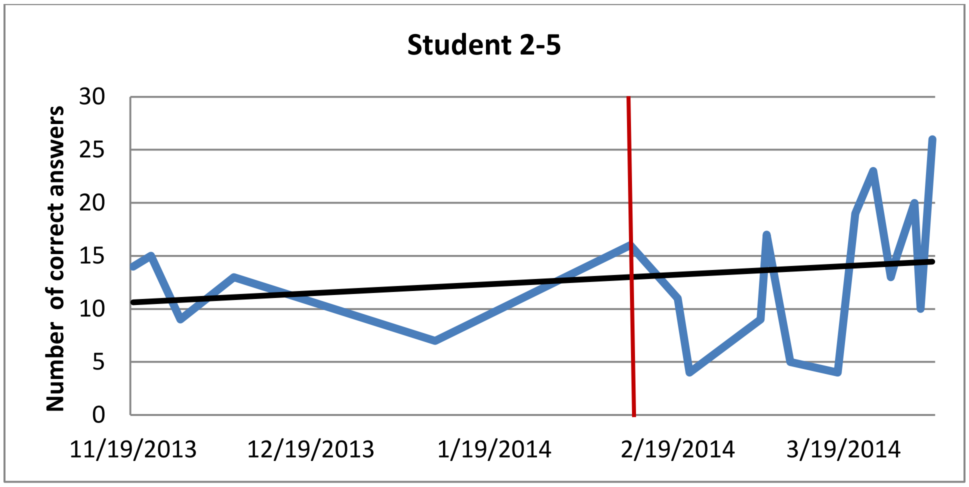

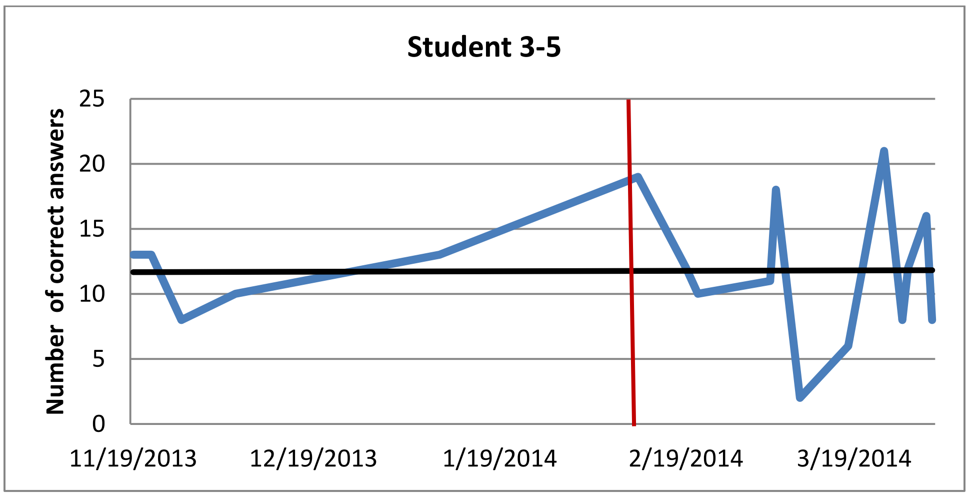

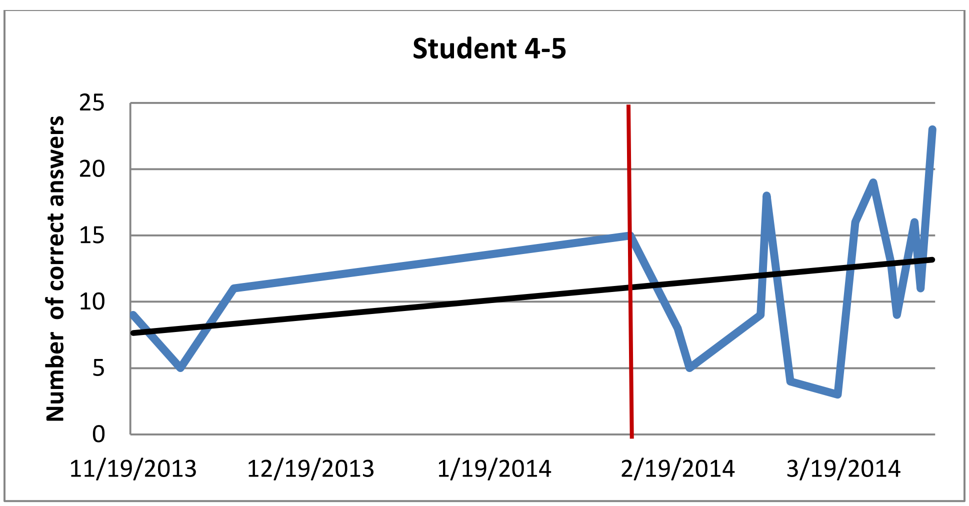

Appendix M

ELA and Science Vocabulary Words for 4th and 5th Grade

5th Grade: Recess at 20 Below (ELA)

Howling	Packed	Stack	Spying	Wiggle
Squirm	Twist	Pull	Zip	Thick
High	Waddle	Dumps	Grows	Puffy
Zero	Float	Old	Gray	Munch
Wild	Sprint	Attacked	Bright	Swooped
Gobbled	Clumsy	Peel	Stare	Settle
Hunting	Shrink	Melt	Stow	Chase

5th grade: Heat and Change in Materials (Science)

Liquid	Solid	Heat	Data	Objects	Melt
Freeze	Refrigerator	Freezer	Insulator	Temperature	Cool
Cooled	Thermometer	Celsius	Fahrenheit	Scale	Variable
Flow	Direction	Energy	Transfer	Melting Point	Freezing Point
Gases	Evaporate	Vapor	Air	Boil	Boiling Point

4th grade: Doug Unplugged (ELA)

Robot	Plug	Smart	Morning	City	Downloading	Population
Trash cans	People	Throw out	Manholes	Fountains	Minute	Skyscrapers
Pigeons	Travel	Flocks	Groups	Funny	Wondered	Unplugged
Scattered	Discovered	Sidewalks	Crowded	Hard	Subway	Underneath
Fire	Strong	High	Amazed	View	Wet	Squishy
Feels	Loud	Smelly	Dark	Grow	Cool	Play
Friend	Scared	Flew	Shouted	Suddenly	Best	Hug

4th grade: Physical and Chemical Properties (Science)

Ingredients	Powder	Salt	White	Cornstarch	Characteristics
Different	Alike	Baking soda	Alum	Talcum powder	Property
Physical	Observation	Minerals	Data	Identify	Prediction
Chemical	Vinegar	Iodine	Liquid	Cabbage	Germs
Secret	Mystery	Investigation	Mixture	Dissolve	solution

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