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Impact of Education Policies on STEM Education for Deaf/Hard of Hearing Students

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Impact of Education Policies on STEM Education for Deaf/Hard of Hearing Students

By

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master

of Science in Science, Technology, and Public Policy

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1. **Abstract**

The thesis is focused on STEM education and education policy for students who are deaf/hard of hearing. The research broadly examines the impacts of legislation such as the Individuals with Disabilities Education Act (IDEA) and No Child Left Behind (NCLB) on science education for deaf/hard of hearing students. Additionally, the thesis argues that the benefits of greater accessibility in STEM for deaf/hard of hearing students would be beneficial.

The findings considered STEM education in the deaf/hard of hearing community and how their perspectives and practices may improve science education. Deaf students' personal experiences and available services in schools may spark their interest in science, technology, engineering, and math. Education policies such as IDEA were established to improve support for students with disabilities and broadly in their everyday lives while No Child Left Behind policies held schools nationwide accountable for the quality of services they provide.

The three questions asked were: What were the impacts of IDEA and NCLB on science education for D/HH students? How do policy mandates impact academic support for deaf students in schools? Does better academic support make a difference in student performance for STEM education?

The impacts of IDEA and NCLB on science education were explored through a combination of historical and contemporary literature on deaf education, science education, education policy, interviews, and categories found within the policies were analyzed: Accountability and Proficiency, Principles (which includes Qualified Teachers, Educational Methods, Individualized Education Program and Mainstreaming).

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Figures and Tables

Table 1. List of Abbreviations

Abbreviation	Meaning
IDEA	Individuals with Disabilities Education Act
ADA	Americans with Disabilities Act
NCLB	No Child Left Behind
D/HH	Deaf/Hard of Hearing
FAPE	Free and Appropriate Public Education
LRE	Least Restrictive Environment
AYP	Adequate Yearly Progress
IEP	Individualized Education Program

2. Introduction

Deaf/hard of hearing students (D/HH) are oftentimes encouraged to focus on English, writing, and speech rather than other areas of study such as math, science or personal character development (Moores, 2011). If studies have shown deaf students to continuously fall below the national average for reading and writing, would shifting the curriculum to be more science-centered be worthwhile?

The chapter will explain why STEM education is very important for deaf students and introduce policies that had a profound impact on the United States' educational system for everyone, in particular, students who are deaf/hard of hearing. The research questions will be introduced and will lead to the methods, explaining the data collection, data processing and limitations in research.

2.1 Background: Why is STEM education important for deaf/hard of hearing students?

Many deaf students are pursuing degrees and careers in science, technology, engineering and mathematics (STEM) across the country. Students' education usually begins when they are in elementary school. For each student, the educational experience is different. Some students have skilled teachers and curriculum while others find the curriculum challenging with poorly trained teachers. There is minimal research about deaf students' abilities to succeed in STEM, and therefore, examining what strategies and policies best assist Deaf students in schools would uncover patterns in the curriculum and accessibility (Marschark et al., 2008).

In many institutions, like schools, from a medical viewpoint, "deafness" is a devastating condition and a physical flaw (Ladd, 2003). Note that in some instances in this study, the first letter of the term, "Deaf" is capitalized which denotes a Deaf person's membership in a cultural, socio-linguistic community. Alternatively, the term "deaf" describes the trait of hearing loss

from a medical perspective (Lifeprint). There are two groups of deaf people: those who are culturally Deaf, and use American Sign Language (ASL), and individuals who do not consider themselves culturally Deaf and may not use ASL. Some who consider themselves culturally Deaf may not accept people who are not culturally Deaf and vice versa. In this study, when describing deaf students in schools, the lower case "d" will be used under the assumption that not everyone is culturally Deaf.

For those who identify as culturally Deaf, Deaf Gain is the concept that the Deaf community contributes something special to society (Bauman et al., 2009). Many hearing people cannot imagine what it is like to be deaf. Individuals who are deaf learn how to utilize their deafness and enrich their culture with the perspective that they are indeed contributing to society rather than being an outlier. Oftentimes, Deaf people are a member of a community, created akin to other communities with their own language and culture. Given the community's status as a socio-linguistic minority, much research has focused on the impact of deafness on education and learning (Cawthon, 2007; Large, 1980; Steffan, 2004; Yell, 2007).

Some research focuses on the negative aspects of deaf students in schools, with the perspective that having a physical trait of deafness differs from the norm (Moores, 2011; Cawthon, 2007). Such research reveals that society often views hearing students as the norm and deaf students as an anomaly (Bauman et al., 2009). Patterns in research reveals deaf students are oftentimes behind in reading and writing for their age, compared to their hearing peers (Van Cleve, 2007; Antia et al., 2009). With this perspective and approach, many researchers have emphasized the weak areas of deaf individuals. Personal growth does not seem to be encouraged and rather, emphasizing the improvement of their weak areas in order to become equal to hearing peers have become the standard in society. Many parents and schools focus on deaf students'

weaknesses rather than their strengths. Truthfully, deaf people are extremely resilient due to experiencing prejudices and oppression in many forms on a daily basis. This includes persevering in schools to succeed. The perseverance indicates that deaf students can persevere and succeed in STEM.

Currently, many schools find the foundation of providing accommodations and the curriculum for students satisfactory. It took the schools years to develop a system for students with disabilities while satisfying compliance requirements with federal laws. Many experts are now turning to fine-tuning deaf students' education and curriculum plans (Antia et al., 2002). There are many benefits for deaf students to be educated in the STEM field, from gaining jobs in engineering and research to contributing to a new field of study and adding their own unique perspectives to science. In the United States, deaf and hard of hearing students attend college at almost the same rate as their hearing peers, but have a lower graduation retention rate. 60% of deaf/hard-of-hearing people attend some college compared to 68% of hearing people, but only 24% of deaf/hard-of-hearing students graduate compared to a graduation rate of 40% for hearing students (DeafTec).

It would be important to also emphasize many Deaf students' first language is American Sign Language, and a few students use gestures and home signs in lieu of formal ASL. Research has shown less competency in English compared to their hearing peers (Lang et al., 2001) The combination of writing ability, with limitations of reading ability, have contributed to deaf children's generally poor academic performance (Lang et al., 2001). The continued emphasis on writing and reading has not led to stellar results for students. Science and math are both visual, and would provide far greater opportunities for D/HH students who have an opportunity to succeed in this field (Pagliaro, 1998).

One such example of a talented deaf individual who succeeded in the field of science is Tilak Ratnanather. Students are continuously breaking the barrier in so many fields, including Tilak Ratnanather ("Helping Deaf and Hard of Hearing Students Succeed in STEM", 2015). In 1991, when he began his postdoctoral fellowship at Johns Hopkins in the departments of Otolaryngology and Biomedical Engineering, there were only two individuals with hearing loss pursuing a graduate degree in the auditory sciences in the world. In 2015, there are at least 15 pursuing graduate degrees and 10 faculty members in the auditory sciences, along with many others who have completed a medical degree or training in otolaryngology. Rathnanther was the first congenitally deaf person to pursue an undergraduate degree at the University College London, and then, becoming the first congenitally deaf person in the world to receive a Ph.D. in mathematics. In comparison to 1991, there are many deaf and hard of hearing students graduating today in the field of science and math. However, it is critical to keep the number of deaf students in STEM on the rise and continue to break barriers.

2.2 Education Policies

Table 2. Laws relating to education

Abbreviated name of law	Full name of Law	Year it passed	Description
PL 89-10	Elementary and Secondary Education Act	1965	Improve the quality of education for children attending elementary and secondary schools
PL 94-142	Education for All Handicapped Children's Act	1975	Provide federal funding to state and local schools that offer services to children with disabilities
PL 101-476	Individuals with Disabilities Education Act	1990	Reauthorized from Education for all Handicapped Children's Act, parents were allowed to request services for their children
PL 107-110	No Child Left Behind	2001	Sought to correct achievement gaps between groups of students
PL 108-446	Individuals with Disabilities Education Improvement Act	2004	Merges No Child Left Behind and Individuals with Disabilities Education Act
PL 114-95	Every Student Succeeds Act	2015	Modified NCLB but still retains provisions for standardized exams

Table 2 is a short summary of the laws, with its labels of Public Law, the complete name of the law, the year it was passed and the goal.

Deaf people's participation in education and STEM increased tremendously due to several different laws, starting with Public Law [1]89-10, known as the Elementary and Secondary Education Act of 1965. The law authorized federal funds to aid states and local education agencies to enhance and improve the quality of education for all children who attend elementary and secondary schools. The law effectively enforced that any school that receives federal funding must follow the requirements and not discriminate against students with disabilities (Percy, 1989). Thus, began the progression of better education for all students.

The second law, Education for All Handicapped Children's Act, also known as Public Law 94-142, was passed in 1975. The law was created partly in response to parents' fight for equal protection for their own children with disabilities. The Act can be traced to the civil rights movement and the Supreme Court case *Brown vs Board of Education* of 1954 which sparked an education movement (Large, 1980). The law granted recognition that children with special needs had a right to free and appropriate public education (FAPE). The legislation required students to be assessed to determine if they needed special education services (Yell et al., 2006).

Later, the law was renamed the Individuals with Disabilities Education Act (IDEA) in 1990. Under IDEA, parents were allowed to request education services for their children. One of the many requirements includes being deaf/hard of hearing in the policy, which allowed deaf/hard of hearing children qualify for the services. The IDEA is a federal law that covers all deaf/hard of hearing students across fifty states (Cawthon et al., 2017). Therefore, there are approximately 70,000 deaf and hard of hearing students receiving services under the IDEA since the law was passed (Moores, 2011).

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[1] The Public Law is given a number, the first set being the session of Congress and the second set of number identifies the number of the law in the chronological order of which the laws were enacted during the session.

This parallels with the expansion of the new law, Americans with Disabilities Act in 1990. Public schools must comply with Title II of the ADA of 1990 not to discriminate against students with disabilities. The ADA, like many other civil rights laws, ensure public entities cannot discriminate in any shape or form, of gender, disability or race (Americans with Disabilities Act.gov). Forbidding discrimination in schools led to the ability to mainstream deaf students in public schools.

No Child Left Behind (NCLB) is another law that expanded the government's aegis. Signed into law on January 8th, 2002, the policy sought to correct systematic issues including the achievement gap between poor, minority students and their relatively advantaged peers. Additionally, the law included improving Special Education programs. Most importantly, the law sought educational accountability for students. The administration's goal was raising the country's education standards and increasing competition against other countries.

While IDEA focused on including students with disabilities in public schools, NCLB included all children to have a fair, equal and significant opportunity to gain a high-quality education with proficiency at different academic standards, including those with disabilities, students in poverty and with limited English skills. NCLB had three aims which were 95% of students must participate in assessments that measure proficiency, meet the benchmarks for core classes and both aims met by a subcategory of students including students with disabilities (Cawthon, 2004).

Ultimately, the three laws became parallel to each other, their mandates sometimes contradicting and complementing each other. It was not until George W. Bush's administration that the laws would fully become linked to each other. At this time, the IDEA was reauthorized as the Individuals with Disabilities Education Improvement Act (IDEIA) in 2004. The purpose of

reauthorizing IDEA into IDEIA was merging the law with NCLB. The administration worked to connect both laws for uniform application of its rules across all groups of students, an attempt at promoting stability. Most importantly, it brought attention to improving Special Education and incentivizing schools to improve their Special Education programs. The two laws fall under the breadth of ADA's guarantee of accessibility and rights for people with disabilities in public spaces.

Eventually, in 2015, NCLB became Every Student Succeeds Act, which did not impact public schools until 2017-2018. This time, ESSA allowed states to have a larger role in holding schools accountable for student achievement. The law still focuses on groups such as students with disabilities, students in poverty, and those with limited English skills. The new law mandated states must have challenging academic standards in reading, math and science which apply to all students. Only 1 percent of students can receive alternate exams (Lee, 2015).

The policies require schools and other educational institutions that teach D/HH students to follow the mandates, but there are variations in each school with levels of support services provided. There are many different levels of funding and ability to introduce new strategies in the schools. Some school districts may not have the resources to provide optimal education, most particularly, in science and math courses. The increased focus on standardized education profoundly changed the way schools operate and work with their students. Many stakeholders felt the impact of the laws in schools. Expectations increased through the high pressure to achieve high scores, and comparison of scores between students with disabilities and hearing peers.

Based upon the goals and requirements of these laws, each chapter of this thesis is organized into a number of categories and subcategories: Accountability, Proficiency and the

third category is Principles, which contains the subcategories of qualified teachers, educational methods, Individualized Educational Plan and Mainstreaming under Free and Appropriate Public Education (FAPE) in Least Restrictive Setting (LRE).

Accountability and Proficiency are a major component under No Child Left Behind which requires accountability for student achievement. Accountability also guides assessments, standards-based curriculum and resources for students who do not achieve the benchmark goal (Cawthon, 2004). Schools are being held accountable under Adequate Yearly Progress (AYP). Proficiency is dependent on accountability and assessments, since schools are being held accountable to ensure their students achieve benchmark goals through assessments. The standard proficiency goal across the laws is proficiency in reading and mathematics (Cawthon, 2004).

The third category, Principles is a component of the IDEA law that has a profound impact on students in schools. It contains 6 principles but for the purpose of the subcategories, only three will be detailed at length. The four principles explained in the chapters are: qualified teachers, educational methods with evidence-based practices and mainstreaming under Free and Appropriate Public Education in Least Restrictive Environment.

2.3 Research Questions

The thesis will evaluate factors of the educational policies and their impacts on schools, which in turn have had an influence on STEM education for deaf/hard of hearing students. There are some variations of services in schools under the policies of ADA, No Child Left Behind and Individuals with Disabilities Education Act, including accommodations, Individualized Education Program (IEP) procedures and the priority of certain programs implemented for special education students. The following questions will be focused on:

- What were the impacts of IDEA and NCLB on science education for deaf/hard of hearing students?

- How do the policy mandates impact academic support for deaf students in schools?

- Does better academic support make a difference in student performance for STEM education?

2.5 Methods:

The study was conducted with different parts- literature review, historical primary and secondary sources and interviews with stakeholders. With the combination of the three parts of the study, the analysis will reveal the impact of policy implementation. Finally, suggestions will be made for deaf students in STEM courses and how schools could improve policy implementation within the districts.

A case study was conducted to evaluate differences in methods and compliance working with deaf/hard of hearing students for math and science. The setting for this study was in the Rochester, New York Region. The study included stakeholders who played a role in public schools, BOCES and a Deaf School. People were interviewed for their experience and work in different sectors. The differences in their curriculum, and approach of working with deaf students revealed a pattern of how they followed the mandates of the education policies and what the impacts on their students were.

2.6 Participants

Due to confidentiality, the names of the schools and interview participants will not be disclosed. The participants were interviewed voluntarily, and consisted of two teachers and one administrator who work at a deaf school, a professor at a university in the region, with experience working at a deaf school, and an administrator and two teachers who work at a public school. Two college graduates were also interviewed about their experiences in school and what services they received, as a perspective to offer in addition to the administrators and teachers' experiences and perspectives.

Table 3. Participants

Position	Number of participants
Teachers	4
Administrators	2
Students	2

2.7 Data Acquisition

The data collection was used with mixed methods research case study. The individual interviews were included in the analysis section of the research.

Recruitment for participants was conducted through emails, of which most chose to have an in-person interview while two opted to answer a list of questions via email. Most of the interviews were conducted between March 2019 and in May 2019. The interviews were not strictly structured but had a list of questions to guide the conversation (See Appendix). The informed consent form, under approval from RIT's Institutional Review Board, was first shown and explained, then signed prior to the start of the interview. The questions covered topics of the

education policies, its mandates, observed impacts, IEP and what did they feel about their own math/science education. The questions were adjusted to fit each person's experience and knowledge. During the interview, a recorder and video recording on the iPad was used. The interviews were then transcribed through a website.

For the analysis of the historical documentation, a literature search was performed using Google Scholar and Rochester Institute of Technology Libraries database search engine. Individuals with Disabilities Education Act, Americans with Disabilities Act and No Child Left Behind were prominently used. The objective was finding journals that analyzed the impacts of IDEA, ADA, and NCLB on education. Combinations of words used were "impacts of IDEA on schools", "impacts of IDEA on deaf students", "hearing impaired", "deaf", "special education", "Impacts of NCLB on schools", "education policies impacts on stem education". Several sources were found from the Journal of Policy Analysis and Management, a few dissertations that touched on those topics had a wealth of sources to choose from. Dates were specified in the search range between 1997 and 2018, which is a wide range but it would expand the resources needed to determine STEM education impacts. Congressional records were used to analyze the Individuals with Disabilities Education Act, ADA and No Child Left Behind.

HeinOnline is a database that specializes in legal information including congressional records and law journals. The database was used as a resource to look up the Individuals with Disabilities Education Act. The time span for the search was between 1988-1998 to cover the 1990 and 1997 reauthorizations. Both reauthorizations contained changes to the laws, intended to fix unsatisfactory results. A third timeline, 2000-2005 was also entered to look into the 2004 legislation: the most recent change in the law that has also profoundly changed the goal of the law to become more results-oriented, following No Child Left Behind guidelines. The results-

orientation also lead to a focus on standardized tests in math and science rather than the arts and other subjects. Did this impact how much students are learning about STEM in schools? To further narrow down the records, the congressional hearings and the most cited articles were examined. There was some success but took some time to find viable information. Any promising records that contained "deaf" and "IDEA" were then downloaded. Congressional hearings that also discussed IDEA was researched. This gives a personal perspective to the decisions the Senate made regarding the bill. Four contain transcripts of hearings, including a field hearing on Americans with disabilities act. Reading the records provided a window onto what people at that time were thinking about the laws.

2.8 Data processing:

The interviews all had a general list of questions. For each interview, the questions were modified based on each person's knowledge and experience. The coding process involved tagging similar themes, such as mandates, IEP, and experience growing up learning STEM. A comparison was conducted to identify the differences in experiences and the implementation processes schools had for NCLB and IDEA. After reading through the interviews, the answers were analyzed based on different elements such as working at different types of schools and how many deaf students were enrolled at the schools. Data was highlighted for relevance to factors that had a direct link to the mandates under the educational laws.

2.9 Rationale and Limitations:

The lack of research for the impact of educational laws on STEM education for deaf and hard of hearing students have significance. Improved science and math education in schools for

D/HH students can lead to better academic performance in some areas of the students'

curriculum. The research has its limitations. Rochester, NY is the only place interviews took

place. There is already a well-established deaf history in the city, with knowledge about Deaf

culture, its deaf school and Rochester Institute of Technology is a leading school that also

contains National Technical Institute for the Deaf.

Many participants in Rochester, NY already have knowledge about deaf education and

what could be the best strategies for them compared to other locations in the country. Therefore,

interviewing participants who have worked with deaf students will answer questions more

accurately than interviewing those who have never worked with deaf students.

3. Literature Review

The primary purpose of this literature review is to document the impacts of educational policies on stakeholders, and to track practices and trends in teaching students who are Deaf/Hard of Hearing in science and math. The review summarizes the history and impacts of the educational practices that involve D/HH students.

The articles used in the literature review are summarized in two different tables (Table 4 and Table 5). Several criteria were used to find specific literature, including dates, studies and policies. The dates, 1975 to present was chosen for the years the laws were established. Following this timeline, the studies were searched for their published years with the development of Education for All Handicapped Children's Act in 1975, the Americans with Disabilities Act in 1990, the No Child Left Behind in 2002 as well as Individuals with Disabilities Education Improvement Act of 2004 (IDEIA).

The majority of articles were written in the 2000s, which allowed time for researchers to analyze the impacts of NCLB and IDEA. Two charts below are organized differently. Table 4 lists literature about federal policies' impact on deaf education while Table 6 list studies that analyze the teaching, curricula and students in science programs. The first half of the section is focused on Table 5, the paragraphs follow the order of the table from Accountability and Proficiency, to Principles with subheadings of Qualified Teachers, Educational methods, evidence-based practices, Individualized Educational Plan and Mainstreaming.

3.1 Review of federal policies impact on deaf education:

Table 4. Summary of Papers Reviewed

Author	Year	About
Antia et al., (2002)	2002	Developing membership in inclusive settings for D/HH students
Antia et al., (2009)	2009	Inclusion and progress of D/HH students in general education classroom
Cawthon, (2007)	2007	Impact of NCLB on deaf education
Cawthon et al., (2004)	2004	Impact of NCLB on deaf education
Cawthon et al., (2012)	2012	Assessment accommodation on achievement for students who are deaf/hard of hearing
Cawthon (2015)	2015	Assessment Accessibility for D/HH students
Gaumer et al. (2014)	2013	IDEA compliance
Hyatt et al. (2007)	2007	IDEA and NCLB
Eckes et al., (2009)	2009	Impacts of NCLB and IDEA for students with disabilities
Large, (1980)	1980	Issues deaf students faced under Education for All Handicapped Children's Act
Spaulding et al., (2015)	2015	Review and analysis of history of special education and disability advocacy in the United States
Steffan, (2004)	2004	No Child Left Behind's impact on Deaf Education
Madaus et al., (2006)	2006	Impacts of IDEA 2004
Moores (2011)	2011	Impacts of IDEA and NCLB
Yell et al. (2007)	2007	Assessment for eligibility under IDEIA and 2006 regulations
Turnbull, (2005)	20005	IDEA reauthorization
Van Cleve, (2007)	2007	Academic Integration of Deaf Children
West et al., (2008)	2008	Outcomes of impacts of NCLB and IDEA

Table 5. Factors Identified in the Studies, the X's show what was covered in the articles

Author	Accountability and Proficiency	Principles	Study conducted
Antia, (2002)	X		
Antia, (2009)	X		X
Cawthon, (2004)	X		X
Cawthon et al., (2007)	X	X	X
Cawthon et al., (2013)	X		X
Cawthon, (2015)	X	X	
Eckes et al., (2009)	X	X	X
Hyatt et al. (2007)	X	X	
Gaumer et al. (2014)	X		X
Large, (1980)		X	
Madaus et al., (2006)	X	X	
Moores (2011)	X	X	
Yell et al. (2007)		X	
Turnbull et al. (2005)	X	X	
Steffan, (2004)		X	
Van Cleve, (2007)		X	
West et al., (2008)		X	

The main focus here is the Individuals with Disabilities Education Act and No Child Left Behind. The review is composed of articles that include information about mandates under the laws, the research of teaching science to D/HH students, best practices for D/HH students, and how the mandates impact curriculum and accommodations in schools.

The sections have been divided below into the categories labeled in Table 5: Accountability, Proficiency and Principles. The Principles section is divided into five subcategories. The first category describes what the principles are, the second category discusses qualified teachers, the third section is focused on educational methods, evidence-based practices and the fourth principle is the Individualized Education Program while the last subcategory is mainstreaming under the Free and Appropriate Education in Least Restrictive Environment.

The articles reveal that educational institutions were transformed socially and methodically in terms of inclusion of D/HH students in public schools. The majority of the authors agree schools shifted ideologically to a results-driven curriculum due to NCLB principles. Many children with disabilities in schools are now following the mandates of IDEA as well. Seventy thousand students who are D/HH were covered by IDEA, slightly more than one child in a hundred children with an Individualized Education Program (IEP) (Moores, 2011; Cawthon, 2007). The numbers are considered very small compared to the total number of students who qualified for IDEA in 2004 which was six million students (Eckes et al., 2009; Moores, 2011). The numbers reflect a vast improvement in education since before 1975 when millions of children with disabilities received inadequate or nonexistent education (Large, 1980). Those students covered under IDEA faced several elements to succeed in an educational setting, including mainstreaming successfully, teachers, the curriculum and accommodations (Antia et al., 2002). But, the consensus across the researchers in this review was that there was a lack of

good policies, guidance and sufficient funding that would allow best practices to be implemented in schools (Moores, 2011; Cawthon, 2007; Large, 1980; Madaus, 2006). To this day, the best practices are still undetermined. The results have been disappointing for all stakeholders involved, from schools to politicians.

3.2 Accountability and Proficiency

Accountability and Proficiency mandates are the cornerstones of NCLB policy and very dependent on assessment scores. The researchers agree deaf students were not achieving proficiency (Moores, 2011; Cawthon, 2007; Antia et al., 2009). Fully participating in an assessment to achieve proficiency is challenging, especially when schools are being reported based on their students' proficiency and assessment scores (Cawthon, 2007).

The large scale of the accountability system set by NCLB holding schools to the same standards is uneven due to many factors including the discrepancy in test results, assessments of subcategories of students with disabilities, and documentation (Cawthon, 2007; Eckes et al., 2009; Madaus et al., 2006).

NCLB data on students with disabilities are mainly available only when there is a significant subgroup of students to be tested (minimum of ten students per school). This impacts deaf students in a public school, since in most educational settings, students with disabilities were reported as a single group with no subgroup information reported for students with hearing loss, before IDEIA was created (Cawthon, 2004).

Since D/HH students were put in the category with students who have other disabilities under NCLB, it is much more difficult for teachers and administrators to ensure resources are being evenly distributed among the students for each school. The resources impact schools'

abilities to provide academic support. Therefore, documentation and transparency are extremely important to measure the growth dictated by their IEP to see results of academic support (Madaus et al.,2011; Cawthon, 2007; Hyatt, 2007). This includes reporting test results for subgroups of students including minorities, and students with disabilities. States must test 95% of students in each subgroup and report the results separately so they cannot hide the low performance of any particular group of students (Eckes et al., 2009). In this case, all students face the added pressure to perform well. However, special education and D/HH students face the greatest amount of pressure due to being outliers in school-wide exam results (Cawthon, 2015).

One researcher conducted a state to state evaluation of participation and proficiency rates for students with disabilities in large scale assessments. At the 4th grade level, more than half the states had achievement gaps of 25 percent to 50 percent between students with disabilities and students without disabilities. The gaps in proficiency increased for students only students in 8th and 10th grade (Cawthon, 2004). The achievement gap for students who are deaf or hard of hearing is similar to those students with disabilities as a whole. Overall performance was low, as revealed in several studies. In an earlier study by Cawthon in 2004, 15 states reported standardized assessment results for students attending state-administered schools for the deaf, and the overall performance was low. No more than half of the students assessed at any school demonstrated grade-level proficiency in math or reading. In some schools, no student met the state benchmark (Cawthon, 2007).

According to Eckes, research conducted in California shows that Special Education has the lowest proficiency levels of California public schools for English and math but have improved between 2001 and 2005. According to Moores, 2011, results from 2009 National Assessment of Educational Progress reported 38% of high school seniors demonstrated

proficiency in reading and 26% reached proficiency in math, a sharp contrast from the 100% proficiency goal. The focus on proficiency has shown some improvement in student performance over the years.

D/HH students are being expected to maintain the same proficiency levels as their general education peers. It is problematic because special education and D/HH students start with lower average test scores. Factually, there is an achievement gap of thirty percent between students with disabilities and their nondisabled peers in a 2004 report of a study of 30 out of 39 states with complete data on fourth-grade readers (Eckes et al., 2009; Cawthon, 2007). In an earlier study by Cawthon in 2004, fifteen states reported standardized assessment results for students attending state administered schools for the deaf. The overall performance was low. No more than half of the students assessed at any school demonstrated grade-level proficiency in math or reading. In some schools, no student met the state benchmark (Moores, 2011; Hyatt et al., 2007; Gaumer et al., 2014; Antia et al., 2009).

In response to the discrepancy in overall performance, there was a concern for the validity of exams since trustworthy accommodations are crucial when documenting the exams due to their weight in adequate yearly progress (AYP). Schools need to accomplish the same score or better from the previous year. There are serious repercussions when they do not achieve AYP (Eckes et al. 2009). Schools submit a report based on participation in assessments, proficiency in reading and mathematics as well as graduation rates for high schools and attendance rates for elementary schools (Cawthon, 2004).

Teachers were worried about students' participation in assessments at several grades above their proficiency but with the merging of NCLB and IDEA, students are allowed to participate in alternate assessments (Cawthon, 2007). This allowed some relief in pressure for

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students with disabilities and teachers. However, accessible exams include having parts of the exam signed using ASL and extended time. If changes to the exam were deemed too extreme, the exam was invalidated in school reports (Cawthon 2015; Moores, 2011).

Schools struggled to bring students who are D/HH to academic proficiency in literacy and areas that require strong reading and writing skills. The focus under NCLB/IDEA has shifted to the outcomes and scores rather than student access as a way to measure equity for students with disabilities (Cawthon, 2007). The reasoning behind bringing students with disabilities to public schools in a free and appropriate public setting, encourages students to have the greatest possible chance of academically succeeding.

3.3 Principles

IDEA and NCLB are closely connected through six principles including accountability, highly qualified teacher principle, using evidence-based instruction, local flexibility, safe schools and parent participation and choice (Turnbull, 2005; Steffan, 2004; Cawthon, 2007; Eckes et al., 2009; Moores, 2006). The six principles were created to ensure no child was left behind, in which, principles included: all students in the United States would attain proficiency or better in reading and mathematics, all students with limited English proficiency (sans deaf students) will become proficient in English, taught by highly qualified teachers, with a safe, drug free schools conducive to learning, with 100 percent retention rate (Steffan, 2004).

A. Qualified Teachers

No Child Left Behind established another principle, highly qualified teachers in schools. Additionally, IDEA required special education staff to be highly qualified. This mandate is causing a difficulty to fill teaching positions with qualified teachers (Hyatt, 2007). More than

two million teachers will be needed in the next ten years (Steffan, 2004) Teachers must be certified in all subjects they teach. For an elementary school teacher, it means holding a bachelor's degree and passing rigorous tests in reading, writing, mathematics and other areas. For Middle/High School, highly qualified equals to holding a bachelor's degree and demonstrating competency in subjects they teach (Steffan, 2004). Deaf education and special education degrees require a high number of credits, requiring more school.

The expectation for teachers to be highly qualified for every subject seems unreasonable and can deter teachers from teaching. The IDEA new regulation in 2004 did not provide specific guidance for what is deemed highly qualified criteria for special education teachers who do not teach core academic classes. The mandate does more harm than good by having unreasonably high expectations for teaching degrees (Eckes et al., 2009; Moores 2011).

B. Educational Methods, evidence-based practices

The merging of deaf education with special education under the IDEA led to a loss of independence in the field of deaf education, making it difficult to address the needs of deaf students. Many researchers, including Cawthon and Moores would agree the educational programs became focused on speech, English and grammar, rather than math, science, social studies and literature. Moores emphasized that expectations of deaf students were too low, therefore, schools and teachers should adapt the curricula under assumptions deaf students will be in different educational environments.

` 	With IDEA of 1990, NCLB of 2001 and the IDEIA of 2004, teachers are required to use evidence-based practices, provide services for students with disabilities in the least restrictive environment (Cawthon et al., 2004). The theory of evidence-based practices would ensure students are receiving quality instruction and research would show which type of instruction is

best for the students. One researcher, Yell believed moving away from compliance-based system by having extensive knowledge about research-based educational procedures, so professionals could tailor students' educational programs (Yell et al., 2007).

However, students have to fail before they receive the intervention (Moores, 2011, Yell et al., 2007, Cawthon, 2013, Hyatt, 2007, Madaus et al., 2006). Through a wait to fail system, and possibly missing prevention and early intervention, deaf students have a possibility of not getting the help they need to have a head start in their education.

C. Individualized Education Programs

Individualized Education Program (IEP) offers a written plan for students decided by a team. Teachers, administrators, parents and in a deaf child's case, teacher of the deaf and speech teacher form a team to recommend the best accommodations for the individual student (Cawthon et al., 2017). A quote found should be noted: "Under the guidelines of IDEA, along with parents, professionals with appropriate knowledge and expertise, develop IEPs to meet the unique educational needs of children diagnosed as disabled in one of the thirteen federal disability categories" (Moores, 2011, pg. 523). The quote reflects that students are not included in the meetings, despite being allowed. Findings reveal students are being excluded from conversations about their own education (Cawthon et al., 2017; Moores, 2011).

The IEP also sets the groundwork to provide reasonable accommodations. It is challenging for an IEP transition team to provide quality transition services and accommodations. Teachers of the Deaf are brought in as a resource to assist deaf students in schools. However, other teachers oftentimes do not feel prepared to work with students who are deaf/hard of hearing (D/HH). Findings in the literature show that professionals who are not

experienced working with D/HH students are challenged by IDEA mandates and following requirements (Moores, 2011; Yell et al., 2006; Turnbull, 2005; Cawthon et al., 2015).

D. Mainstreaming (Free and Appropriate Public Education under Least Restrictive Education)

Mainstreaming children with disabilities began with Free and Appropriate Public Education (FAPE), a requirement by IDEA. Every child would have the right to public education, including 13 categories of disabilities, including deafness (West et al., 2008). This requirement of inclusion for deaf students under the Least Restrictive Environment (LRE) continues to be controversial today. The LRE was considered as a general education classroom in a public school setting, while residential schools for the deaf was considered the most restrictive educational environment (Antia et al., 2009). There are concerns about D/HH students' access to classroom communication and appropriate accommodations in place in all the programs under LRE (Antia et al., 2009). The increasing numbers of mainstreaming D/HH students educated in public schools served as a challenge to the very same public schools that have never served a large number of students with various disabilities before. For instance, in 1990, almost three-fourths of all deaf children in the United States were mainstreamed, including for a few classes or just one class. Around 1,200 deaf students were enrolled in Chicago's public schools but 270 attended the state residential institution (Van Cleve, 2007). The influx of deaf students led to an urgency adjusting public schools' curriculum, services and ensuring teachers received the appropriate training in classrooms. Many schools were unprepared to handle the increased number of students with disabilities. (Moores, 2011; Hyatt et al., 2007; Cawthon et al., 2004; Large, 1980).

The questions about appropriate student placement arose from years of deaf students being sent to institutions. People questioned whether having students with disabilities placed with other deaf peers would be beneficial for everyone (Antia et al., 2009; Steffan, 2004).

Some researchers believed deaf children belonged to deaf schools, being recognized by the federal government as separate from other children with disabilities due to having a unique language and culture (Steffan, 2004; Van Cleve, 2007). Researchers including Cawthon found that deaf students were not usually educated in one single location.

The debate about mainstreaming can be traced to the roots of a movement led by Alexander Graham Bell[2]. His philosophy supported deaf children integrating with the hearing community and to use lipreading/speak verbally. Some critics would say A.G. Bell did considerable damage to deaf education through setting up day schools and as a hearing person, he believed his philosophy was absolutely the best choice for the deaf population. The Deaf community and many other critics did not support mainstreaming as it echoed Alexander Graham Bell's philosophy that deaf students would be surrounded by hearing students and teachers, ultimately, conforming to the hearing culture out of necessity (Van Cleve, 2007). But, the intention of mainstreaming under IDEA was for everyone. The law was created with the idea that every child would not be left out of quality education. This mandate included many different disabilities.

D/HH students' experience in the classroom settings and policy impact varied. Parents are faced with the insurmountable task to decide what is best for their child. That comes with many options from sending them to a Deaf school, use ASL, oralism or manualism, Total Communication, Cued Sign, sending them to a public school, use an interpreter among many

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[2] To this day, the A.G. Bell Association still promotes mainstreaming and oral education

other decisions. Oral instruction is known to be the alternative to manualism, having a total absence of sign language from the child's education. The method emphasizes on improving language acquisition and speech. Manualism encourages the use of sign language, while Total Communication is a combination of different methods, use of oral, and manual modes of communication. Cued speech is presenting first letter signals or cues with voice speech. This would help the users to distinguish vowel sounds that would look alike on the lips. This was design to overcome the barrier that too many words look alike when being lip-read (Large, 1980)

Additionally, parents face an uphill battle if they want to have an oral education for their child. For many deaf educators and educators without special training, to this day, believe oralism means mainstreaming without special help. The child that uses manual sign language receives more attention and support because he or she is more visibly handicapped than the oral child (Large, 1980). Many authors agree that an oralist child and a manualist child received markedly different educations in public schools (Cawthon, 2004; Moores, 2011; Van Cleve, 2007; Steffan, 2004).

To summarize, inclusion involves everyone. Programs must address teacher attitudes, relationships, student knowledge, curriculum, parents, extracurricular activities and many other elements in order to make mainstream education a success for every student (Antia et al., 2002). Authors found schools are not addressing all the elements that concern each student when evaluating their successes in school (Antia et al., 2002; Moores, 2011).

3.4 Observations:

Having two laws implemented at around the same time, with similar mandates would cause a disconnection between NCLB's focus on school-level accountability and IDEA's focus

on the educational experiences of individual students. IDEA and NCLB do not align perfectly, despite Margaret Spellings, the secretary of education announcing the opposite outcome (Eckes et al., 2009). Regulations do not address all areas in the laws and do not perfectly balance each other out. Many researchers believe NCLB's expectations are unrealistic for students with disabilities to match proficiency levels to general students. (Cawthon, 2007; Cawthon et al., 2004; Yell et al., 2007; Gaumer et al., 2013; Madaus et al., 2006). Many researchers believed deaf students are being negatively impacted by IDEA mandates and since deaf children are being categorized with other disabilities, their needs are lost within a larger system (Moores, 2011).

Review of teachings in science and math education for the deaf:

Table 6. Summary of Studies Reviewed

Authors	Year	Method	Researcher	Participants	Research purpose
Lang et al. (1982)	1982	Questionnaire sent to science teachers	Academic	Science teachers	Analyze training of science teachers, adequacy of curricula, and identify major needs in science education
Burch et al. (1982)	1982	Survey via letters to collect science curricula and curricula status of students 2-14 years old	Academic	Residential schools	Survey science education of deaf individuals in residential schools in the United States
Pagliaro (1998)	1998	Questionnaires sent to schools for the deaf and to teachers in those schools	Academic	Math teachers, administrators, deaf schools	To find information about curricula, and math program performance. Teacher questionnaires gathered data on background and teaching methods
Antia et al. (2009)	2009	Study	Academic	Deaf or hard of hearing students who attended general education classes	Reported academic status and progress over 5 year period of deaf and hard of hearing students

3.5 Science Education evaluations:

The articles were chosen according to their research topic and years that would coincide with IDEA and NCLB. The years for the five studies spans from 1982 to 2009 which will show how the results have changed over time. The studies analyzed science and math education, teacher experience, curriculum, and teaching methods. Subjects varied from residential deaf schools, D/HH students, teachers and administrators. A few methods for the subjects included questionnaires, surveys and results from various schools. Since the studies were chosen for the evolution of science/math education and student performance, the analysis started with the earliest of the batch.

Dennis Sunal and Daniel Burch conducted a study in 1982 surveying science education for the D/HH students in residential deaf schools. Their sample was 47 schools. 20 percent had no planned science programs. The schools that did have a science curriculum program, 60 percent used low-level student activity curriculum material, 57 percent used the material in the curriculum that was not modified for D/HH students. It was found at this time that the schools were not adequately modifying the curriculum and science education to best suit D/HH students. There were no commercially produced materials designed to meet the needs of D/HH students. One large issue found was language obstruction. The standardized curriculum had many vocabulary words that had no existing assigned sign. In programs with sign language involved, teachers would fingerspell or assign a sign to the vocab word. The students faced challenges when they encountered the same vocabulary word but under a different sign in a different class. The studies showed that for fourth-grade level, 63% of the vocabulary taught did not have a standard sign available. This implication was widespread. If all deaf schools had the same

problem, around 2/3 of deaf students in the United States are being taught minimally in science and math.

Another researcher, Harry Lang conducted research in the same year, 1982. He found a trend that science was neglected at many programs that served deaf students, and many science teachers did not have adequate training in science education. He used some of the information Burch discovered. Lang sent out a questionnaire used by 480 science teachers representing 326 school programs serving deaf students. His goal was finding major needs uncovered in science education for D/HH students, analyze teachers' education and training as well as identify science curricula. A whopping 73.6 percent of the respondents had no degree in science education. A conclusion emerged from this study that coincided with Sunal's study: lack of language-controlled materials. Teachers across the board supported the development of a k-12 curriculum that would focus on D/HH students' needs.

In 1998, Claudia Pagliaro conducted a study by sending a survey to administrators and faculty at schools for the Deaf relating to mathematics. Results showed that there has been some reform, such as problem-solving and using concrete materials. Pagliaro agreed with the other two researchers that reform is needed in the field of deaf education. Her sample pool included 66 schools, with a total of 195 questionnaires. Interestingly enough, as the study was conducted a decade after the other two, technology was included. The author saw a benefit in using technology as an instructional tool for math. Pagliaro found that teachers often have a lack of cohesion among each other, causing students to lose the connection between the level of math they currently learned and the next level with a different teacher. Therefore, teachers should work together to continue improving the school's math program. Pagliaro emphasized that the field of deaf education must recognize the importance of math knowledge.

A study conducted in 2009 by Shirin Antia analyzed D/HH students' academic progress. The study included 197 D/HH students with mild to profound hearing loss. The researcher received scores on standardized tests of math, reading and language writing for five years. Antia found that many students, as many as 69-81 percent of the average or above average in academic competence. Antia believes the success of their academic performance partly comes from more exposure to the general education curriculum than students educated in self-contained classrooms. The sample group, however, still remains a half Standard Deviation below the hearing norms. Students are now scoring higher in math than reading and writing, which is a trend that Pagliaro recognized would happen.

Recognizing the past issues that were discovered years ago, and determining whether these issues were resolved is critical. Modified curriculum for D/HH students is important, which the curriculum was not being modified. In 1982, 63% of vocabulary words in science did not have a standard sign and there was a general lack of training for teachers to work with D/HH students in science education (Burch et al., 1982). Most importantly, science was being neglected in schools for the favor of English, grammar and speech.

The last two tables, Table 7 and 8 summarize the findings in the literature review. Table 7 is categorized under each mandate with its references. Table 8 is categorized by authors- three studies of which had considerable findings while the fourth study was excluded due to mainly numerical research that did not yield as many findings as to the other three.

Table 7: Findings of literature review for NCLB/IDEA

Section	Findings	Authors
Accountability and Proficiency	1. Not a lot of data for students with disabilities, they are being categorized as a single group 2. Important to track documentation to measure performance growth in IEP as a result of academic support 3. Must test 95 percent of students in each subgroup 4. There is a large achievement gap between students with disabilities and non-disabled students. 5. Concerns with exam validity due to test modification 6. Researchers found deaf students are not achieving proficiency 7. Low proficiency in English and math	1. Cawthon, 2004 2. Madaus et al.,2011 Cawthon, 2007 Hyatt, 2007 3. Eckes et al., 2009 4. Eckes et al., 2009 Cawthon, 2007 5. Cawthon 2011 Moores, 2011 6. Moores, 2011 Cawthon, 2007 Antia et al., 2009 7. Eckes et al., 2009
Principles a) **Qualified Teachers** b) **Educational Methods** c) **IEP** d) **Mainstreaming**	• IDEA/NCLB have 6 principles • Goal is to attain better proficiency in mathematics • Qualified teachers in causing difficulty to fill positions which does more harm than good • Emphasis on speech, English and grammar • For IEP, students are excluded from conversations about their own education • FAPE mandated mainstreaming • Inclusion under LRE • Some researchers believed deaf students belong to residential deaf schools • Concern about D/HH access to classroom communication and appropriate accommodations • Many schools were unprepared to handle influx of students with disabilities	1. Turnbull, 2005 Steffan 2004 Cawthon, 2007 Eckes et al., 2009 Moores, 2011 2. Moores, 2011 3. Hyatt, 2007 4. Cawthon, 2007 Moores, 2011 5. Cawthon, 2015 Moores, 20011 6. West et al., 2008 7. Antia et al., 2009 8. Steffan 2004 Van Cleve, 2007 9. Antia et al., 2009 10. Moores, 2011 Hyatt, 2007 Cawthon, 2004 Large, 1980

Table 8: Findings for studies about science and math education

Author	Findings
Burch et al., (1982)	• Schools were not modifying curriculum and science education to suit D/HH students • No commercially produced materials • Language obstruction
Lang et al., (1982)	• Science was neglected at many programs that served the deaf • 73.6 % had no degree in science education • Lack of language-controlled materials
Pagliaro, (1998)	• Some reform, like problem solving and concrete materials • Lack of cohesion for teachers

4. History of Education Policies

4.1 Background

Learning the history of how deaf/hard of hearing children were educated is important in order to understand how and why they are in this educational system today. The observations involve societal perspectives in history and how they had a profound impact on schools. Therefore, there are many elements involved in special education, including societal attitudes and federal/state motivation to improve education for everyone. The term inclusion has a different meaning to each stakeholder. The increased integration of deaf students with hearing students leads to the question of whether 100 percent integration is actually entirely beneficial for the deaf students. Each student's needs in math and science vary and go against the educational institutions' penchant for utilitarian education with general education students (Hardman et al., 2008). Many deaf students require an individualized approach in science and math while the standard for classroom teachers is teaching multiple students at the same time. Each federal policy introduced in the 20th century is built upon each other through several amendments. The policies had a profound impact on schools and stakeholders, especially for children with disabilities.

There are many approaches to educating deaf students based on their educators' perspectives. Education leaders interpreted the meanings of deafness in several different ways, leading to many educational methods for the deaf. Until the 1860s, deafness was oftentimes described as a physical disability, or an affliction (Spaulding, 2015). People with hearing loss were often categorized with other disabilities despite their different educational and physical accommodations. The first residential school, The American Asylum for the Deaf and Dumb was founded in 1817 by an Evangelical Protestant Reformer, Thomas Gallaudet. Gallaudet and many

others supported sign language and thus, the Deaf community's language and culture were formed. This movement would later be known as Manualism (Spaulding, 2015, Large, 1980).

After the 1860s, a group of reformers opposed the philosophy of Manualism which supports the use of sign language. The group supported the use of lip reading and speech, later known as Oralism. The oral community strongly supported this reformation, striving to undo the manualism movement in their belief that it would help the Deaf to further assimilate with English speaking individuals. Supporters believed people who used sign language were mainly coexisting with one another, without trying to learn how to interact with the rest of the citizens. Many deaf people opposed the eradication of sign language but did not have any authority over their own educational system.

By World War I, 80 percent of deaf children were taught with the oralist method (Percy, 1989). It was easier for leaders of reform groups to impose their beliefs on the deaf through states as opposed to the national level. Prior to the late 19th century, states and local governments had a large role in elementary and secondary education (Percy, 1989). In the 1960s and 1970s, the oralist movement was questioned (Baynton, 1992). The rise in power of different reform groups reflected how much authority people without disabilities had over deaf education.

The reason for the sudden reduction in numbers of supporters for the oralist movement and number of institutions for deaf children in the 1960s and 1970s was caused by increased public policy efforts in the 1900s. After the First World War, people were exposed to more disabilities in their daily lives through veterans with combat injuries. Slowly, throughout the years, people were accepting disability and the responsibility it came with taking care of their loved ones with disabilities (Spaulding, 2015). The federal government attempted measures to save money and become more efficient through deinstitutionalization in the 1960s.

Deinstitutionalization caused a sharp rise in the number of community centers and independent living centers, which were being federally funded (Nielsen, 2012). The acceptance that people with disabilities could coexist with others, and more families taking care of their children with disabilities led to an urgent need to address the issues of public schools allowing students with disabilities to participate in education. Many of the students would formerly have been put in an institution or deaf school if applicable.

When paired, the societal beliefs and public policy efforts were very clear. When disability was viewed in a negative light, the public policy priorities were very low. When more parents and citizens voiced their concerns about educating the children with disabilities, Congress was faced with a task to mandate special education in schools.

Authors have discussed the superiority many people had when advocating for deaf education. The divide between visions is wide, most especially with how special education and Least Restrictive Environments should be operated. Attitudes take a tremendous part in people's visions (Kavale et al., 2000; Spaulding, 2015; Large,1980). Integrating students as required by state and federal education laws continues to be questions, for the negative aspects of integrating students with disabilities, to administrative and teacher concerns.

4.2 Public Policy efforts:

The 1950s and 1960s brought about many policy changes for people with disabilities. At this time, most states had laws for attendance in schools, but public schools still excluded students with disabilities. Widespread access only occurred through national policy implementation. Previously, it was at the states' discretion for education, since many

policymakers argued education was a constitutional right for states (Hardman et al., 2008). Therefore, federal policies in education did not occur until the 20th century.

The landmark supreme court case, *Brown vs. Board of Education* sparked a civil rights movement for African American students. Soon, parents of other minorities caught on. They insisted their children with disabilities should have a right to be in public schools with other students. Many parents sued states citing exclusion and inappropriate educational services violated students' rights to equal education (Katsiyannis et al., 2001).

The Supreme Court set a precedent that state-sanctioned segregation based on a person's characteristics was unconstitutional, and therefore, dual systems for education was unequal (Spaulding, 2015). The precedent included children with disabilities.

Congress was under pressure from parent groups representing children with disabilities. In response, politicians expanded funding of programs that assisted education for students with disabilities. The first step was Elementary and Secondary Education Act in 1965 which was only for children with disabilities in state-operated facilities (Reed, 1991). The Handicapped Children's Early Assistance Act in 1968 authorized 23 million dollars for experimental programs used as experimentations for education. The law later became Education for the Handicapped Act in 1970. The previous law then expanded to Education for All Handicapped Children's Act (EAHCA) in 1975 (Percy, 1989). The Act encompassed what the previous laws sought to do through "Free and Appropriate Public Education". The law failed to meet Congress' educational goals and students with disabilities were still not being educated under the standards of the laws (Valentino, 2006).

In response, the Education for All Handicapped Children's Act was modified to the Individuals with Disabilities Education Act in 1990. At that time, any criticism that rose was

focused on the burden the law would have on the educational system or the language of the Act. It was a law that made politicians look good, and it effectively ended the judicial debate on children with disabilities' constitutional right to public education (Large, 1980). The rush to pass the law led to having children with disabilities being categorized in one group, despite having many different needs and accommodation requirements.

Americans with Disabilities Act (ADA) was passed at around the same time as IDEA 1990. It was pivotal in protecting the civil rights of more than 50 million Americans with disabilities. This allowed new changes to occur in society's viewpoints, by requiring people to acknowledge that people with disabilities receive the same opportunities as everyone else. The law prohibited discrimination in various areas, including employment, state and local governments through services, programs and activities must be made accessible (Thompson, 2015). The ADA served as a law that fundamentally changed disability and society's perspective.

In 1997, IDEA was once again re-amended. FAPE was still in place, but with stricter standards of student achievement. This law would be the start of a push in standardized education. Later, the IDEA-97 expired in 2002, giving Congress time to re-evaluate and amend the law. Students, parents, the public and other stakeholders gave testimonies about what things should be modified in the IDEA. Congress decided to work on improving scores through increasing requirements, believing there was a direct correlation between improved educational outcomes and IEP development (Valentino, 2006). Since No Child Left Behind occurred at around the same time, it was an opportunity for Congress to merge the two laws so students with disabilities were included in the scope of No Child Left Behind.

Federal efforts to improve education for students with disabilities included increased incentives for states to voluntarily improve results through standard driven reform (Hardman et al., 2008). The standards-driven requirement would become the lodestone in multiple laws. However, the federal push resulted in an unequal response from states. There were two perspectives: there should not be federal involvement in locally controlled education and federal involvement was leveraged to improve their schools. The push for standards also lowered expectations for students with disabilities since they were excluded from national and state assessments (Hardman et al., 2008). Standardized assessments continued to grow, resulting in high stakes assessments today. In a high stakes environment, the assessments are used to impose consequences for students and teachers for failure to meet expectations (Hardman et al., 2008). The laws have evolved over the years based on how strongly the standardized education was being promoted by Congress.

These landmark educational acts opened a national conversation about students with disabilities and their education. The benefits of the law and further details were extensively discussed with experts and through testimonies before Congress. How people with disabilities earned opportunities and better education was based on societal and cultural changes.

4.3 Implementation Goals

The general consensus from primary documents of Congressional hearings reflected many people's lack of knowledge about deaf education. Most particularly, one statement supported the lack of knowledge about deaf education and reflected society's viewpoint at that time: "Deafness presents an inability to acquire the skills of the language. The language is basic to an individual's success socially, occupationally, and as a citizen" (Hearing, Ninety-first

Congress, second session on H.R. 18766, September 11, 1970). Over time, through constant

reauthorizations, Congress has made adjustments accordingly, from the review of the law's

performance and whether objectives were accomplished. In 2007, the belief was:

"Children with disabilities must overcome unique hurdles to get their education, but NCLB recognizes that in the vast majority of cases, doesn't mean these children can't achieve what their non-disabled peers achieve, only that they may need special help to achieve it"
 (Hearing, One hundred tenth Congress, first session, pg 2, March 29, 2007).

Comparing the two comments, it is very clear the perspective of special education has evolved.

4.4 Accountability and Proficiency

Congress contemplated how to use accountability systems to remedy educational

disparities, agreeing that there should be a better accountability system, sharing responsibility

with all stakeholders in the school system. They did not intend children with disabilities to

struggle with proficiency, "with regard to students with disabilities, NCLB affirms our belief that

a child should not be discounted simply because he or she does not learn at the same rate or in

the same manner as other students" (Hearing, One hundred tenth Congress, first session, pg 3,

March 29, 2007) In 1994, Congress took a strong stance with accountability:

"We must hold the entire governmental system, including legislation and federal, state and local education agencies, accountable for failing to fulfill the promise of partnership for the parents of schoolchildren with disabilities" (Hearing, One hundred third Congress, second session, pg 2 , March 17, 1994)

No Child Left Behind is responsible for the focus on accountability in schools, including

accountability for special education students. Congress did have reservations about including this

specific group of students but studied the possible impacts the law would have on students with

disabilities beforehand (Plain, 2004).

"Education for children with disabilities can be made more effective by having high expectations for such children and ensuring their access to the general education curriculum in the regular classroom, to the maximum effect possible" (Hardman et al., 2008, pg 7). Federal policy translates into a view that students with disabilities would need to learn alongside their non-disabled peers in order to succeed.

The result of the participation of students with disabilities in a standards-based curriculum program is still in question. Special education and public education's system are still conflicting. Special education operates to give each student an individualized education and developing methods that would best benefit the student. Public education is still based on an approach that teaching the greatest number of students is the best (Hardman et al., 2008).

Additionally, proficiency was designed to show achievement and progress from students there was concern about the inability to measure progress below proficiency since the system is so results-oriented (Hearing, One hundred tenth Congress, first session, pg 12, March 29, 2007)

Jane Rhyne, Ph.D., an assistant superintendent at the time of 2007, gave a prepared statement supported the basic concepts of NCLB but was concerned about ignoring the academic performance of significant numbers of children.

"States are allowed to ignore the academic performance of significant number of children. This state flexibility invites the flexibility of NCLB accountability system and allows some schools to escape portions of subgroup accountability" (Hearing, One hundred tenth Congress, first session, pg 7, March 29, 2007

IDEA's original goal was providing personalized educational plans that students benefit from. The goal evolved over time due to No Child Left Behind's influence for standardized education.

4.5 Principles

A. Qualified Teachers

In NCLB, Title I, Part A, Section 11 requires school districts to only hire qualified teachers to teach core academic subjects including special education. The definition of highly qualified teacher: 1) have a bachelor's degree or higher, 2) be fully state-certified, 3) teachers can demonstrate subject knowledge with college courses (Hearing, One hundred tenth Congress, first session, pg 22, March 29, 2007). The intentions were meaningful, as Congress wanted to ensure a strong educational program and increase opportunities for meaningful integrations of students with disabilities into productive general education classroom staffed with qualified teachers. In response, there were severe shortages of teachers for students with disabilities in middle and secondary grades. Syracuse and Rochester were cited to have the largest gaps in 2005-2006 (Hearing, One hundred tenth Congress, first session, pg 19, March 29, 2007).

The House of Representatives in 2003 passed legislation to revamp the 1975 Individuals with Disabilities Education Act to reduce paperwork burdens for special education teachers who were working to achieve NCLB's high standards, including allowing parents to select a three-year IEP rather than an annual one. The Department of Education also provided flexibility to teachers in rural school districts (Hearing, One hundred eighth Congress, second session, pg 9, April 21, 2004).

"Should consider financial incentives to attract and retain quality teachers…. and provide federally funded salary enhancements for teachers who achieve National Board Certification." Reg Weaver, the President of National Education Association testified that it was important to set a minimum standard of economic stability for teachers (Hearing, One hundred tenth Congress, first session, pg 59, March 13, 2007).

B. Educational Methods

The laws took on the belief that every child in US Schools will achieve a higher level of academic performance. Evidence-based practices are required in both laws but schools have been burdened with paperwork and regulations for compliance. This caused many professionals to become sidetracked from early intervention using research-based procedures. Increased inflexibility caused professionals inability to adjust instruction or policy since they are required to follow regulations. The model of compliance in both laws caused many schools and stakeholders such as teachers and administrators to become overly concerned with results (Yell et al., 2006).

In a prepared testimony by Rachel Quenemoen, to a question by Representative Susan Davis of California, it was observed that many schools and districts did not commit to evidence-based practices to ensure students succeed. Quenmoen asserted:

"Some teachers and educational professionals resisted actually teaching the students with disabilities challenging content and actually expecting them to learn it. Part of it is due to centuries of bias and pity towards people with disabilities".

In this testimony, it was acknowledged that many organizations still harbor those attitudes (Hearing, One hundred tenth Congress, first session, pg 88, March 29, 2007). Therefore, to reform this system would be a huge undertaking.

C. Individualized Education Program

Special Education took an approach that students needed to fail first before being targeted for special education intervention (Yell et al., 2006). The model is causing professionals to wait too long before students could receive benefit from special education. Therefore, in IDEIA, the

changes were made based on those two issues. The lawmakers wanted to improve the outcome of students with disabilities through making changes in the IEP process and merging NCLB with IDEA to make the compliance process easier for everyone involved. Congress and lawmakers hope to see improvement from teachers in focusing on the quality of students' special education rather than the procedural requirements of the law.

Many people gave testimony about enforcing IEP and the concerns they had about their children.

"You get the feeling, though, that even if you come up with a really good IEP that is individualized for that child, that the teacher takes the IEP, takes it to her file cabinet in her class and files it away" (Hearing, One hundred third Congress, second session, pg 60, March 17, 1994).

In a different testimony in 2007, students with disabilities are expected to achieve grade level academic content but should be supported with training for teachers and other staff to assist students to achieve that objective (Hearing, One hundred tenth Congress, first session, pg 33, March 29, 2007).

D. Mainstreaming (FAPE under Least Restrictive Education)

In the early 1970s, only 20 percent of children with disabilities were educated in schools. The committee recognized the importance of educational programs, assisting deaf adults to become contributors to the economy. Sixth or seventh-grade achievement was commonplace, but many participants in the committee agreed they should achieve a higher educational standard (Hearing, Ninety-first Congress, second session on H.R. 18766…September 11, 1970). Therefore, in 1975, Congress took action to pass Education for All Handicapped Children's Act after a discovery that over half of eight million children with disabilities did not receive educational services.

IDEA established mainstreamed education in the United States mainly through mandates and funding. In order for states to provide education for children with disabilities, grants were given. In return for the funding, states must comply with the requirements for IDEA and provide children between three and twenty-one years old a Free and Appropriate Public Education (FAPE). There were uncertainty about the definition of FAPE, as testified by the Commission on education for the deaf, Frank G. Bowe, Commission chairperson.

"Widespread misinterpretation of the "least restrictive environment" concept. Too often deaf children have been placed in improper educational settings because educational agencies have prioritized placement with nonhandicapped students in the "least restrictive environment" above placement which is most appropriate for the individual child. These priorities must be reversed and the Department of Education should emphasize appropriateness over least restrictive environment by issuing guidelines and standards for exceptions to the least restrictive environment requirements and a policy interpretation that states that removal from the regular classroom does not require compelling evidence." (Hearing, One hundredth Congress second session, pg 19, March 30, 1988).

The law never clarified the definition of FAPE in IDEA's reauthorizations, leaving the courts to interpret the term (Brizuela, 2011). In response, the courts mandated that schools provide individualized designed instruction and services resulting in educational benefit. The mandates evolved into ensuring that meaningful progress for each student could be measured (Hardman et al., 2008).

In the Supreme Court Case, *Board of Education v. Rowley*, the Supreme Court and the lower courts had different interpretations of appropriate education. However, the Supreme Court led a precedent to conduct a two-part inquiry in such cases: finding whether the states complied with the procedures in the IDEA and secondly, whether the IEP was reasonably calculated to give educational benefit (Brizuela, 2011). The Rowley standard was determining whether students are getting meaningful educational benefit from the IEP (Plain, 2004).

The most current Supreme Court decision, from the case of *Endrew vs. Douglas County School District (2017)* ruled that schools had an obligation to "enable a child to make progress appropriate in the light of the child's circumstances". The tenth circuit had determined a child's IEP is intended to provide "some educational" benefits or known as "merely more than *de minimis*". Therefore, the Supreme Court's decision led to a more demanding standard for IEP, being more appropriately ambitious and give the student a chance to meet challenging objectives (Prince et al., 2018).

When Congress passed IDEA, they were well aware of how expensive the law was going to be if they were to provide a custom education for each child with a disability. Nonetheless, the federal government promised to fund states to support them for provisions. The result in the upcoming years after implementation was disappointing. The government spent around thirty billion dollars annually. Nearly five million received services under IDEA but another four million students with disabilities did not receive the educational services they were promised. In fact, in 1990, fifteen years after the enactment of the law, one million students with disabilities continue to lack services in school settings (Goldman, 1994).

IDEA's goals evolved over time, from focusing on access to education for students with disabilities to schools being expected to improve the results of their education (Hardman et al., 2008). Congress had a very different perspective than the deaf community in terms of educational placement. IDEA 2004 clarified Congress' position on educational placement. Congress believed IDEA implementation was hampered by low expectations and insufficient focus on proven educational methods.

Table 9. Findings for Implementation Goals

Categories	Findings
Accountability and Proficiency	• Congress wanted to use accountability systems to fix educational disparities • Congress believed children with disabilities should not be ignored simply because he or she does not learn at the same rate as other students • 1994: "Hold the entire governmental system accountable" • Believe there should be high expectations for children with disabilities • Congress believes children with disabilities should learn alongside their non disabled peers to become successful. • Concerns about measuring progress below proficiency level
Principles a) Qualified teachers b) Educational methods c) IEP d) Mainstreaming	• Increased teacher requirements to have meaningful integrations of students with disabilities into productive general education classroom staffed with qualified teachers. • Recognition the requirements should be a little less strict • Leeway to rural schools for teacher requirements • "Should consider financial incentives to attract and retain quality teachers…. and provide federally funded salary enhancements for teachers who achieve National Board Certification." • Model of compliance caused schools to be overly concerned with results • Bias in educational institution and reform would be a huge undertaking • Congress and lawmakers hope to see improvement from teachers in focusing on the quality of students' special education rather than the procedural requirements of the law. • Concerns about enforcing IEPs • IEP should be followed up with training for teachers and staff to provide best possible support for the student • Controversy for LRE/Mainstreaming

5. Current Implementation

5.1 Interviews with school administrators, teachers and students

The results from this research study included both quantitative and qualitative data to show how much impact the laws have had on science education for D/HH students. The purpose of the research was to collect the perspectives of teachers and administrators who work with D/HH students. Each participant's interview transcript was coded for themes related to the topics of this study. Specific quotes were highlighted to answer the questions of how mandates for schools impacted science and math education.

Today, teachers who work with D/HH students continue to be language-based, focused on reading and writing. Subjects such as math, science and social studies remain secondary. Interview questions included:

- Can you tell me more about your experience working with deaf students in STEM courses?

- How much time do deaf students dedicate to focus on improving reading and writing?

- Do you think the IEP had a big impact on students' math and science skills?

- Do you think NCLB causes schools to focus their resources on certain subjects more than other subjects?

Questions used to help answer my thesis questions included: How did the policy mandates impact academic support for deaf students in high school? Did a change in academic support make a difference in accessibility for STEM education?

Table 10. Profile of Participants

	Deaf	Hearing
Students	2	0
Teachers	1	3
Administrator	1	1

5.2 Deaf Experience in STEM:

There were four Deaf participants in my study so they were asked about their science and math experience growing up. The first participant, a Professor at Rochester Institute of Technology, had extensive exposure to math and science as a part of daily life. His parents were involved in the scientific field as a pharmacist and a nurse. His brothers are both engineers. When he was in sixth grade, he did not have an interpreter at his public school, since it was before the ADA was passed. His public school did have a deaf program. He enjoyed math at that time, since his teacher had a very individualized approach. In high school, he had interpreters provided in physics and chemistry classes. However, his interpreters were Child of Deaf Adults (CODA) so they were not qualified to interpret in science and math courses. The Educational Interpreting Proficiency Assessment, a tool that evaluates skills of interpreters who work through elementary and secondary education, was not established until 1991.

The second Deaf participant, a Ph.D. candidate, went to a deaf residential school, and at that time, he was not interested in science and math. His mother was a psychologist so when he enrolled at Rochester Institute of Technology, he enrolled in the psychology program. He recognized that a lot of deaf individuals at NTID were quite behind with their language skills. He wanted to figure out the reason why, so eventually, he became a Ph.D. student in the biomedical

field. His experience in science was not great in high school. He asserted Physics was his only interesting science class. In biology, they mainly used power points.

The third Deaf participant, a recent college graduate, went to a deaf residential school in high school, which was four hours away from her home. She would stay at the residential school during the week and return home on the weekends. Her parents are not in the scientific field, and she graduated with a Criminal Justice Masters degree, therefore her studies are concentrated in the humanities field. Her experience at the residential school has been mainly positive when it came to science and math. She had one math teacher for all the classes, since her school was very small. Her class was around twenty-five students. If she needed to take classes her school did not offer, it would be at the public school across the street. From her experience, she believed there should be more staff well equipped with mathematics and science. At the dormitory, there was two staff for each floor of students, from elementary to high school. Only one person out of six staff was equipped to help with math and science assignments. "The other staff members were much older, so it has been many years since they've taken those courses".

The fourth participant, a school administrator at a residential school was born to a Teacher of the Deaf and a Doctor. He grew up with full access to sign language at home. He was born in Nova Scotia, Canada and moved to Boston. At that time in 1977, Massachusetts was one of the stronger states with deaf education. Initially, he attended a deaf school but it did not meet his parents' satisfaction, so he transferred to a public school. He did not have an interpreter growing up and remembered he only understood around 30 to 40 percent of the lectures in class through lip reading. When he went home afterward, his mother would write out concepts and practice, explain things to him. He preferred English and history compared to science and math, having never had someone to explain the concepts in great detail for science and math and help

him cultivate an interest in the field. His father was a doctor, and had a good amount of knowledge about science but if the participant asked questions, his father would simply answer without explaining why it was the answer.

5.3 Accountability and Proficiency

No Child Left Behind emphasizes accountability and started a new era of comparing schools with one another which affected their funding. Schools with better scores on average received better funding. Many people have different perspectives on what NCLB is really for. One participant, a professor at RIT believes people still need to figure out what the purpose of the law is for, whether to rank students or look at their overall progress? He believes there has not been enough training for teachers, leading to teachers becoming dissatisfied, believing the scores are a reflection that they need more training. The professor has been involved with assessment for over ten years and he has observed there are pros and cons to NCLB, as an assessment tool. One positive perspective of NCLB, as an assessment tool measures how students answer their questions, to explain the child's thinking when you get the score. The students also receive subscores to figure out where they are strong or not so strong in a specific area.

The emphasis on test scores has been detrimental to the educational system. It has no longer become an individualized education for everyone but a standardized education. According to one teacher of the deaf at a residential school in Rochester, the emphasis has been on exam scores, and the problem with that, it is limiting, and it is not showing the big picture of the student, their learning, development and progress. She believed exams have become the priority focus in schools.

No Child Left Behind has become a different law, Every Student Succeeds Act. Public schools can waive students with disabilities. Today, schools for the Deaf cannot waive any students. Therefore, students, who may be taking a different level of math or science than from their grade level, still need to take the exam created for their grade level. An administrator for the residential school in Rochester observed teachers are still playing catch up to prepare their students for these exams. Their students transfer in from a public school and can be behind in English and Mathematics which impacts their ability to learn science. If they're behind in the other two subjects, it is imperative to teach the students the topics first before introducing them to science. Teachers usually have to do individualized instruction for each student.

Accommodations on exams are important, according to an administrator at a residential school. The school follows rules relating to IEP and specific accommodations that can be provided. What he believes they struggle with specifically are English exams. The district tends to allow students to have ASL as a primary language but to take the English exam, the residential school wants to determine the student's exact skill in English not, being tested on their ASL skills. He believes several public schools have different perspectives on that accommodation.

5.4 Principles

A. Qualified Teachers

There are not many qualified teachers for math and science, especially when teaching deaf students. The strict qualifications for teachers did more harm than good for the number of teachers in the country (Steffan, 2004). One interview participant, a teacher at a residential school for the deaf is also a math teacher with a bachelor's in mathematics. It is her second year teaching at the residential school. According to her account, the school struggled to find a

science teacher that would satisfy the qualifications required under IDEA and NCLB. The school eventually hired a teacher that agreed to undergo the Masters of Science in Secondary Education in order to continue teaching. According to the teacher, she believed people are not attracted to the profession. "The pay has been related to the test scores their students receive. There is more stress on teachers for exams. People are now leaving the teaching profession and going somewhere else so it has been a struggle to fill positions."

According to one participant, a deaf professor at Rochester Institute of Technology believe that most teachers have been trained to focus on language and literacy. Language is applicable to every subject, so it is still important, but current teachers, especially in elementary school, oftentimes do not have the training how to teach math and sciences, which limits their ability to teach on a broader scale.

It has been a priority for leading institutions such as RIT and other researchers to lead the narrative for math and science education for the Deaf in the country. The professor is working with two schools for the Deaf to show elementary teachers how to incorporate language within math or science. He believes the same teaching methods have been handed down throughout the generations so there needs to be a new way of teaching. The standardized education that NCLB and IDEA are enforcing, is interfering.

One participant, an administrator at a deaf school in Rochester, NY, shared one challenge their school is working on, is the qualification of the educators. The school has three years of science, but trying to find someone with a science background and fluency in American Sign Language. Having someone with a certified background in science would be able to provide a high-quality program at the school.

B. Educational Methods

One person interviewed is a Deaf professor, but have experience teaching Deaf students at residential schools. He taught math at different levels and science classes such as physics, chemistry and biology. From his experience, students had varied backgrounds and interests, so he had to figure out how to make the lessons interesting for everyone, such as including hands-on activities and problem-solving exercises.

As research by Sunal and Burch showed, the students will meet the challenges when they encounter the same vocabulary word but under a different sign in a different class (Burch et al., 1982). Students bring a variety of different language skills in the classroom. Some students transferred from other schools or had different teachers in science.

"For example, they would teach fractions, and would use one particular sign, and I prefer to use a different sign than the sign they learned previously. Using an initialized F also looks like the number nine. He thought, using a generalized classified could show that it was a fraction and could change the shape of the hand to show that it's a smaller denominator, or a smaller numerator and use the same hand classifier to show if it was proper or improper… it was a good opportunity to talk about language in the classroom".

Another example arose in a different interview … "the term, Pi would be signed as if it was Pie"….The concept didn't get through to the participant until much later, when he realized it was Pi not Pie. The concept was not there because the interpreter did not expand on that term."

The second teacher is hearing, but teaches at a residential school as a teacher of the deaf and a math teacher. She currently teaches high school math, everything from algebra, geometry, statistics and calculus. At her school, the staff wants to make sure students are developing certain vocabulary proficiency. Hearing students could pick up vocabulary while deaf students don't

have the auditory access to listening for words. When students transfer from other schools, sometimes they are missing foundational concepts and information they needed. For math, she evaluates their conceptual knowledge in mathematics and tries to figure out how to best address those needs to fill in the gap of the foundations they have missed.

She also brought up vocabulary, ensuring her students develop certain vocabulary proficiency, like hearing students. The hearing students hear words constantly and deaf students do not have access to the auditory channel. They have to expand a little more on the vocabulary and repeatedly show it in the teaching so students can learn the new words.

The two teachers who taught at residential schools have a very individualized approach when it comes to teaching math or science. Their classrooms are very small, which allows them to work with each student and try different approaches. One teacher will observe her students and she will see a few signs that students used and she would use the signs.

One teacher of the deaf who works with BOCES discussed providing support with concept development and retention with her deaf students at a public school. Primarily, she works on math concepts that are language-based and she believes that retention is an issue since it is often hard for students to remember what they have learned if they have less access than their hearing peers to the language of instruction. She works on addressing retention in consult with teachers. Teachers believe that if students have an interpreter, they should have the same access as the rest of the students and the TOD disagrees with this belief. She works on a lot of math problems with her students, teaching them concepts and work on the language in word problems. She noticed her students get overwhelmed with vocabulary like, quadratic functions, polynomials, difference of perfect squares so she found math videos and he would then teach it back to her.

The school administrator at the residential school believes they could do more to introduce STEM concepts in their classrooms. Teachers themselves have some experience in STEM and suggested they could work together to ensure their curriculum overlaps each other and introduce STEM in English or History class.

C. IEP

The IEP was viewed favorably by many participants in this research study. One participant emphasized it really depends on who is involved. There would be plenty of people who are limited in their knowledge or more oppressive with their approach which can do more harm.

Participants shared that at their schools, students were encouraged to become involved in the IEP process from the age of 14. From their experience, it was a process to help students to think about their priorities and what classes they wanted to take. The process should be for the student, not how the professionals decide what is best for the student.

One participant, the professor at RIT discussed that the IEP process should be an empowering experience for the students. There are some residential schools that encourage students to run the IEP meetings. He has observed in some meetings, professionals discuss test scores which can be very number based, rather than discussing how the student could improve and what the student really wants from his/her own education. The student took this test with many different people and therefore, it is not an individualized approach.

Another participant, the math teacher at a residential school discussed how the IEP can be impactful for any subject regarding test accommodations. Some students get extended test time, another student has exams translated into sign language, and some other people have access to

calculators. IEP makes a good impact on math in the classroom by ensuring accommodations to assist deaf students to succeed in the subject.

One participant who went to a residential school disagreed that he received accommodations. "It felt more like a public school, but they were all just teachers who could sign". However, he shared that at his school, there was a huge emphasis on the IEP process. In April, students had a week off because of the IEP process. But, typically, students would go on vacation and their parents would take care of the process. So, when he became an upperclassman, the school changed it to the week after school was done, so everyone could become more involved with the IEP process.

One participant is an administrator, in which he shared that New York started encouraging principals and special ed directors to get fully trained and learn how to run IEPs. He observed that parents and students' perspectives do not align so at meetings, they learn what their differences are and developing a plan on what is best for the student.

Another participant, an administrator at a public-school replied students are mandated to be part of their transition planning, as well as their parents in NYS regulations. Some studies did not include students as part of the IEP process so there is a gap in how involved students are in this process across the country.

D. Mainstreaming:

Free and Appropriate Public Education (FAPE) in Least Restrictive Setting (LRE)

Participants like the Math teacher/Teacher of the Deaf at the residential school recognize the impact the mandate had on schools and students. She observed in the last 10 to 20 years the number of students who attend deaf schools decreased and it may be relevant to the policies. Parents have perceptions with the policies, thinking a mainstream environment is very inclusive.

She believed the laws like these tend to simplify a complicated issue since every student is unique and has individual needs, and they do not have one method that is appropriate for everyone.

The administrator at a residential school agreed LRE was a good intention, promoting full access to education, but according to the federal government, the least restrictive environment would be a public school, and the most restrictive environment would be a residential school. The participant believed Deaf people are not getting the full benefit of education. Many Deaf people's primary language is ASL, and one objective of LRE is access to a full education. It comes in a full package, emotional, social and educational growth.

A Teacher of the Deaf at a public school believes every student is individual along with the families for whether mainstreaming is the best for them. Some of her students call themselves "individuals with hearing aids", rather than "deaf" or "hard of hearing" which is an interesting label, showing how far removed her students are from the culture and community. The teacher of the deaf says her students do not require too much assistance in the class other than making sure everyone receiving the appropriate accommodations and that their FMs are working.

A deaf participant missed days at her Middle School when both interpreters were absent, since the school was unable to find another interpreter. The student missed days of school because accommodations were not being met. She moved towns, in order to receive the benefits another school had. That is not what the lawmakers had in mind for the least restrictive environment.

Every child had a right to education but for the parents, it proved to be an unreasonable burden for them to move towns in order to provide accommodations for their daughter in a Deaf school introduces the long-term argument about least restrictive environments. According to

IDEA, the most restrictive environment would be a residential school, but here, it challenges the notion of how restrictive it could be by having teachers being on the same page with students about language. If the instruction is supposed to be very language-based, Deaf students have a right to equal access to language. Interpreters cannot always provide equal access in public schools without the appropriate support from other staff such as teachers.

5.5 Time spent in STEM compared to other courses:

One residential school typically spends 80 minutes every day in their ELA courses, focusing on reading and writing, as well as social studies which also have a strong writing component. Math has been allotted eighty minutes every other day. For speech therapy, it depends on the individual but on average, it's ninety minutes a week, three thirty-minute sessions per week. The speech teacher will sometimes play a support role in the classroom.

At one participant's residential school, it takes a year and a half for each level of math. The lessons for math classes are more visual. Students should not be taking notes when the teacher is signing, so she gives them time to write notes and it becomes a consecutive process. Since it takes the students a year and a half, in their senior year, they do not have a math class so many students decide to take electives such as personal finance.

At a residential school, according to the administrator, it is 80 minutes per day for science. The students are preparing for the Regents exam, a state-mandated exam, but at the same time, students are also behind on some courses. The students are balancing science, labs, math, English and other courses, while at the same time, they are pulled out of class for speech and other training. Parents want their children to work on their English and speech skills. The participant

believes students should have had enough time to learn English and math to become successful rather than play catch up in high school.

5.6 STEM Enrichment

Part of the students' learning experience is learning more about STEM outside of the classroom. One participant, an administrator at a residential school is working on a five-year plan involving STEM, through expanding the current STEM programs and become more involved in competitions. This school is recognizing that STEM is part of the priority to have Deaf students become more involved with the field.

One participant promotes Pi Day celebration at her school, where students play math games and have projects for the afternoon. Her school had a math competition which helped expose more deaf students to different areas of math and science.

One participant is an administrator at a public school, his remarks on STEM enrichment was: "STEM opportunities exist for all students. For students that are deaf or hard of hearing, we need to continue to find ways to program in inclusive settings with the appropriate accommodations to support access."

From interviews with participants, it seems that Deaf schools are recognizing the importance to introduce Deaf students to STEM as they are well versed in how students are typically behind language-wise due to late development, but STEM is very visual and can add a component to their language development.

Other public schools are approaching STEM enrichment by providing better accommodations, which seems to be through interpreters and other accommodations based on the student's needs. "In a public-school setting, we typically have to access support from BOCES

connected to inclusive programming." The administrator expressed most teachers need support when working with students who are deaf and therefore, there is no formal training for those teachers in public schools nor for interpreters in science and math courses. If there should be an improvement in STEM enrichment for deaf students in a public-school setting, it should start with training for science and math teachers, as well as for interpreters.

Table 11 highlights the findings collected from interviews with participants:

Table 11. Findings collected from interviews

Categories	Findings
Deaf Experience in STEM	• Accommodations and enrichment play a pivotal role in capturing interest in science/math • Individualized approach is extremely beneficial for participants • Participants noticed their instructors needed to be trained more in science/math
Accountability and Proficiency	• Different perspectives of accountability • Teachers can feel the pressure that they need more training • Deaf schools are now included in standardized exams • Emphasis on test scores is limiting and have become a priority focus in schools • Teachers are trying to prepare their students to take the exams, appropriate for their grade level • Teachers are recognizing that language is extremely important in leading to a better understanding of math and science • To help their students do well on their exams, the participants all have emphasized individualized teaching to help develop their skills • Accommodations is important, but should be within reason and accurately measure students' skills. Schools have different perspectives on what is an appropriate accommodation for an exam
Principles e) Qualified teachers f) Educational methods g) IEP h) Mainstreaming	• Not many qualified teachers available for math and science that are equipped with teaching and working with deaf students • Need for better incentives for teachers, such as qualifications are too demanding • Pay has been related to testing scores their students receive, more stress on teachers for exams • Many teachers have been focused on language and literacy. Current teachers oftentimes do not have the training to teach math and sciences • Priority for institutions to lead the narrative for math and science education for the Deaf in the country • One participant is teaching elementary teachers how to incorporate language within math and science • General consensus that the mandates can be disruptive for teachers • Very positive outlook on IEP • Students are encouraged to become involved in the IEP process from the age of 14 • Positive training on running IEPs in New York State due to initiatives for principals and special ed directors to get trained
STEM Enrichment	• Very active effort with STEM enrichment • More math and science competitions • Finding ways to involve more inclusion for science and math opportunities

6. Conclusion

6.1 Findings

The purpose of this study was to determine how the two laws, No Child Left Behind and Individuals with Disabilities Education Act impacted STEM education for D/HH students. The three questions asked were: What were the impacts of IDEA and NCLB on science education for D/HH students? How do policy mandates impact academic support for deaf students in schools? Does better academic support make a difference in student performance for STEM education?

The impacts of IDEA and NCLB on science education were explored through categories used throughout the study, categories also found within the policies themselves: Accountability and Proficiency, Principles (which includes Qualified Teachers, Educational Methods, Individualized Education Program and Mainstreaming). The charts below show a comparison of the findings which will later be explained.

The policy mandates had a profound impact on the United States academic system, which is explored through the categories, how each mandate impacted and changed an aspect of the education system.

Interviews and findings from the literature review and the historical chapter show discussions about better academic support leading to an improvement in student performance for STEM education.

I argue that through the study and research, the compliance, and results-driven mandates hindered more students than it benefited them. From interviewing participants to analyzing the policies, it is clear that deaf students are being expected to achieve benchmarks in their educational journey. However, the inconsistencies in public schools' accommodations and early intervention services, as well as Deaf schools' curriculum and different approach of teaching, are

causing students difficulty to work on their skills when transferring from one school to another. It is very clear that the professionals are working hard, faced with need for language development and a very individualized approach to student education.

The second finding is that there is a wide variation in D/HH students' curriculum. One Deaf school completes each level of instruction for science and math by the year, while another Deaf school completes instruction for each level in 1.5 years. This can prove a challenge when attending a university (such as RIT/NTID, where students come from different backgrounds).

The third finding from my research is that that overall, science and math education has not improved. The findings in the literature are from several years ago, however, leaving ample opportunity to improve and work on language obstruction in math/science terminology, and lack of cohesion from teachers. Teachers are still challenged with not having enough training or science background.

The fourth finding from interviewing participants is that progress in STEM enrichment for students is possible. Administrators and teachers are very aware at the importance of STEM and how more exposure to science and math activities outside of their core classes can lead to improvement in understanding the material and develop further interest in science and math.

Table 12: Chart of Literature Review Findings and Science Findings

Literature Review	Findings
Accountability and Proficiency	• Not a lot of data for students with disabilities, they are being categorized as a single group • Important to track documentation to measure performance growth in IEP as a result of academic support • Must test 95 percent of students in each subgroup • There is a large achievement gap between students with disabilities and non-disabled students. • Concerns with exam validity due to test modification • Researchers found deaf students are not achieving proficiency • Low proficiency in English and math

Principles
 	
  a. **Qualified**
 	
    Teachers
 	
  b. **Educational**
 	
    Methods
 	
  c. **IEP**
 	
  d. **Mainstreaming**
	• IDEA/NCLB have 6 principles
	• Goal is to attain better proficiency in mathematics
	• Qualified teachers in causing difficulty to fill positions which does more harm than good
	• Emphasis on speech, English and grammar
	• For IEP, students are excluded from conversations about their own education
	• FAPE mandated mainstreaming
	• Inclusion under LRE
	• Some researchers believed deaf students belong to residential deaf schools
	• Concern about D/HH access to classroom communication and appropriate accommodations
	• Many schools were unprepared to handle influx of students with disabilities

Science Findings from **Lit Review**	• Schools were not modifying curriculum and science education to suit D/HH students • No commercially produced materials • Language obstruction • Science was neglected at many programs that served the deaf • 73.6 % had no degree in science education • Lack of language-controlled materials • Some reform, like problem solving and concrete materials • Lack of cohesion for teachers
Findings for science **from Current** **Implementation**	• Accommodations and enrichment play a pivotal role in capturing interest in science/math • Individualized approach is extremely beneficial for participants • Participants noticed their instructors needed to be trained more in science/math • Very active effort with STEM enrichment • More math and science competitions • Finding ways to involve more inclusion for science and math opportunities

Table 13: Findings for Historical Chapter and Findings for Current Implementations

	Findings for Historical Chapter	Findings for Current Implementations
Accountability and Proficiency	• Congress wanted to use accountability systems to fix educational disparities • Congress believed children with disabilities should not be ignored simply because he or she does not learn at the same rate as other students • 1994: "Hold the entire governmental system accountable" • Believe there should be high expectations for children with disabilities • Congress believes children with disabilities should learn alongside their non-disabled peers to become successful. • Concerns about measuring progress below proficiency level	• Different perspectives of accountability • Teachers can feel the pressure that they need more training • Deaf schools are now included in standardized exams • Emphasis on test scores is limiting and have become a priority focus in schools • Teachers are trying to prepare their students to take the exams, appropriate for their grade level • Teachers are recognizing that language is extremely important in leading to a better understanding of math and science • To help their students do well on their exams, the participants all have emphasized individualized teaching to help develop their skills • Accommodations is important but should be within reason and accurately measure students' skills. Schools have different perspectives on what is an appropriate accommodation for an exam
Principles a. **Qualified teachers** b. **Educational methods** c. **IEP** d. **Mainstreaming**	• Increased teacher requirements to have meaningful integrations of students with disabilities into productive general education classroom staffed with qualified teachers. • Recognition the requirements should be a little less strict • Leeway to rural schools for teacher requirements • "Should consider financial incentives to attract and retain quality teachers…. and provide federally funded salary enhancements for teachers who achieve National Board Certification." • Model of compliance caused schools to be overly concerned with results • Bias in educational institution and reform would be a huge undertaking • Congress and lawmakers hope to see improvement from teachers in focusing on the quality of students' special education rather than the procedural requirements of the law. • Concerns about enforcing IEPs • IEP should be followed up with training for teachers and staff to provide best possible support for the student	• Not many qualified teachers available for math and science that are equipped with teaching and working with deaf students • Need for better incentives for teachers, such as qualifications are too demanding • Pay has been related to testing scores their students receive, more stress on teachers for exams • Many teachers have been focused on language and literacy. Current teachers oftentimes do not have the training to teach math and sciences • Priority for institutions to lead the narrative for math and science education for the Deaf in the country • One participant is teaching elementary teachers how to incorporate language within math and science • General consensus that the mandates can be disruptive for teachers • Very positive outlook on IEP • Students are encouraged to become involved in the IEP process from the age of 14 • Positive training on running IEPs in New York State due to initiatives for principals and special ed directors to get trained

6.2 Accountability and Proficiency

Originally, Congress wanted to use accountability systems to fix educational disparities and therefore heavily depended on assessment scores to measure the performance of students across the country, quoting "holding the entire governmental system accountable". Their attempt was well-intentioned but involved too many variables. They took on a positive attitude that children with disabilities should not be ignored simply because he or she does not learn at the same rate as other students. Believing they could help students with disabilities, they set high expectations for them to meet. The high expectations can be beneficial for the students with disabilities, but have taken on assumptions and a perspective that children with disabilities should learn alongside their non-disabled peers to become successful. Does the high expectations equate having students become closely similar to their non-disabled peers?

Findings from my literature review, congressional hearings and interviews have showed the high expectations and support is not as beneficial as the government would like. Since they wanted to use the accountability system to fix educational disparities, and include students with disabilities, they did not consider the fact that they would lose data for students with disabilities since they were categorized as a single group (with many different disabilities). It would take many more years until Every Student Succeeds Act for D/HH students to be tested under their own disability.

Ultimately, there is a large achievement gap between students with disabilities and non-disabled peers, especially a low proficiency in English and Math. The low proficiency impacts every school that educates D/HH students. Teachers feel the pressure to help their students improve. Interviews with participants reveal that teachers and administrators are all

acknowledging that language is extremely important in leading to a better understanding of math and science.

6.3 Principles

A. Qualified teachers

Congress originally believed having qualified teachers could enhance integrations of students with disabilities into productive general education classrooms. The mandate has negatively impacted the science/math community for the deaf. Deaf schools are having a difficult time finding qualified math and science teachers, with the background in either and knowledge of American Sign Language. Interviews with participants show they believe this is a general disrespect of teachers from the federal government, from low pay to unrealistic expectations of keeping up with the burden of paperwork and documentations for assessments. They also feel they are not receiving enough training to become prepared to assist students with new assessments. However, some efforts are being made, compared to when the literature review was conducted in 1980s, such as training teachers to incorporate language in science and math, and leading institutions are paving the way for new opportunities for D/HH students in math and science.

B. Educational methods

The Individualized Educational Program's approach to tailored education is at odds with the educational system's utilitarian approach and standardized education. In public schools, D/HH students receive individualized assistance from their itinerant teachers. In residential schools, an individualized approach is very common. From interviews with participants, many

participants have emphasized the importance of this individualized approach. It is very important for deaf students in math and science due to terminology and learning concepts. Many different students may have varying knowledge about each unit in class and teachers try to match their knowledge and build from there. This is the reason why one residential school has math for 1.5 years rather than the standard 1 year.

C. IEP

The Individualized Educational Plan was favorably viewed by participants in my study as an opportunity for D/HH students to explore their options. The deaf community holds the perspective that the students should be empowered to make educational decisions. Students in public schools are theoretically encouraged in public schools for students to become involved in their meetings but the research shows that the information is not being relayed to them.

The IEP is extremely helpful for teachers to determine how to work with each student and what skills they need to work on. The federal government's intent for IEP matches and has accomplished this goal. While there are several legal changes with the IEP such as providing reasonable accommodations, it has helped parents, teachers and students to decide what is the best course of action for the students' education.

D. Mainstreaming

There are many different perspectives about mainstreaming in public schools according to Free and Appropriate Public Education under Least Restrictive Environment. While the federal government believes it is beneficial for students with disabilities to learn alongside their non-disabled peers, members of the Deaf community, including a few participants from my

study believe it is up to the student to decide what is best for themselves. As many students' primary language is ASL, they are not receiving the least restrictive education through public school where it is more likely the student would have only an interpreter. However, mainstreaming has brought benefits including having access to skilled math and science teachers, more course offerings and for Deaf schools, ability to send their students to public school for a few courses, including advanced math and science classes.

6.4 Implications of the Study:

The implication of this study shows that there is a need to continue to research into methods to improve science and math education for the deaf. There is an inconsistency in the method of teaching due to the deaf population being divided between in residential and public schools. Public schools in each state are a bit more consistent with the levels of science and math students need to follow. Deaf schools also follow the state education curriculum, but both serve different methods of education. Public schools are much more audio-based in their curriculum rather than being visual. Being visual in schools has only become a recent trend that is being hampered by teachers from older generations that have followed the same method of teaching. From studies in the 1980s, a need for a sign language vocabulary for mathematics and scientific terms was revealed. There was also no commercially produced material for Deaf/HH students for math and science courses. There is also a language obstruction when it comes to learning STEM material. Unfortunately, those issues persisted in interviews of many participants, around forty years later. Further research needs to be conducted to support science and math curriculum for deaf and hard of hearing students on a large scale.   The laws, NCLB and IDEA are not taking into consideration of different institutions other than public schools, and the different ways of

instruction that could be used in math and science. The mandates may encourage teachers to follow a research-based instruction but many teachers are not trained to teach students with disabilities in math and science. There is still an expectation for everyone else to keep up with the standard- a standard that non-disabled students are setting.

6.5 Future Research Considerations:

Future research should take into consideration the perspective of teachers and administrators, as well as students on a larger scale based on science and math instruction. The sample size in this study was small, and may not accurately reflect the conclusions one may draw from a larger set of participants. The administrators and teachers are following the mandates, which impact their instruction and decision-making process for their curriculum. The students interviewed at public schools and Deaf schools would also offer valuable insight into the satisfaction level of their curriculum and accommodations provided. The study could also be a comparative case study, to compare public schools to Deaf schools and BOCES. This will assist with determining the differences in all three's educational approaches in math and science, along with measuring the quality of accommodations provided in all three school systems.

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8. Appendix

Questions in my thesis:
- How do the policy mandates and budget impact academic support in high schools for deaf/hard of hearing students? Does a change in academic support make a difference in accessibility for STEM education?

Questions to ask teacher:
- Can you tell me more about your experience working with deaf students for STEM courses?
- Are deaf students usually focused on improving writing and reading?
- Deaf students have been shown to be equally interested in STEM field in high school, according to research. Do you think they are usually able to explore their interests or are they emphasized to focus more on other things? What could schools do to encourage deaf students to explore their options in studying STEM?
- Do you think IEP can be one size fits all? If so, do you think this has a tremendous impact on the students' math and science skills and the assistance they are receiving?
- For IDEA, they have mandates including transition planning, IEP and evaluations/assessments. Do you believe teachers and staff are equipped to make decisions for the student? Should the student be involved in his/her own IEP process?
- Do you believe math and science teachers are generally equipped to work with deaf students?
- NCLB causes schools to become results oriented for proficiency in different subjects. Do you think this causes some schools to focus their resources on certain subjects more than other subjects?

Questions for Teachers of the Deaf
- How did you decide to become a Teacher for the Deaf?
- Can you tell me more about Teachers of the Deaf? What are their responsibilities?
- How many deaf students do you have?
- Can you tell me more about your experience working with deaf students for STEM courses?
- The goal for IDEA and NCLB is requiring schools to become more inclusive. Did you see any direct impacts of the policies on your students?
  - For example, do you see more students dividing their time between RSD and a public high school? (This applies to FAPE, Free and Appropriate Public Education)
- How much time do deaf students dedicate to focus on improving reading and writing?
- Deaf students have been shown to be equally interested in STEM field in high school according to research. Do you think they are usually able to explore their interests or are they encouraged to focus on other subjects?
- What do you personally think from your experience, that the school and families can do to encourage deaf students to explore their options studying STEM?
- Do you think the IEP has had a big impact on students' math and science skills?
- Do you think students should be involved in their own IEP process?