THE SCIENCE OF THE NO CHILD LEFT BEHIND ACT OF 2001 AND ITS EFFECTS ON SCIENCE EDUCATION: *THE SCIENCE IN SUCCESSFUL SCIENCE TEACHING*

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This paper is dedicated to my mother,
who is my biggest fan, supporter,
and continues to be the seamstress of my spirit and heart.

This paper is also dedicated to:

Mimi and my dad, who are always with me.
Grandpa Ardoline, who said, "Someday you will go to HWS to become a teacher."
Jan D. who is a wonderful role model for being thoughtful and having heart.
Jamee S. who kept me grounded and focused,
and continues to be the tailor of my essence.
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Michael B. who truly had a 'beautiful mind'.
Finally, to Zoey, Mandy, Amore, Checkers, Buddy, and Jacques,
who re-ignites my soul, my smile, and my heart, everyday.

~Mary K. Ardoline March 17, 2009

Abstract

This position paper investigated the social policy, No Child Left Behind of 2001 (NCLB), its diversified trickled-down effects, and how using the correctly implemented strategies, NCLB could have more effective and successful results. Specifically, the goal was to explore how improving or making NCLB policies more explicit, may improve subject areas' achievement scores, but more importantly in the area of Science. Science was the sole learning content area of examination of this paper, more specifically elementary Science. Thus, this paper provided effective strategies that not only met the policy demands of NCLB, but also could increase students' opportunities in fulfilling the Science content learning standards. This paper examined examples of effective learning and teaching strategies that could satisfy the Adequate Yearly Scores for Science, and be executed in all Science discipline areas, at all grade levels. This writer hoped that these suggested alternatives will alleviate the failed attempts of past educational policies, where no child will be left behind, specifically in Science.

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Introduction

In attempting to understand the history and background as well as the effectiveness of the No Child Left Behind Laws, inaugurated under the Bush Presidency, it is important to realize that this educational reform was itself part of a broader movement in American history towards continually grappling with how best to educate its citizens. It could be argued, in fact, that historically, American educational reforms have fallen short of their shared goals of excellence for our students. In striving to perfect our public educational system, we have had some of the most talented and creative thinkers of the past four hundred years, from different disciplines, beliefs, and backgrounds, vacillating back and forth on what works best in the classroom and how students learn the best. Policy decisions have ranged from being centralized to decentralized, to currently being somewhere in between. Questions remain as to who should be accountable for making the tough decisions about such pertinent issues as standards, testing, assessments, and accountability?

This paper examines these paradoxes and questions. It explores the history of schools and education reform, and follows the trends, pitfalls, and modest achievements that have occurred in educational policies over the last four hundred years. What events, policies, and people influenced the establishment of the current No Child Left Behind (hereafter referred to as "NCLB") legislation? As part of this investigation, this paper will also discuss an overview of NCLB, including its key components. In addition, we will investigate the strengths and the shortcomings of this educational reform. As will be shown, many of its shortcomings are due to the vagueness in the Act's actual language, and partly due to some glaring oversights and omissions, specifically in the area of Science standards.

While the NCLB legislation, as it is currently written, makes relatively precise directives

for Math and ELA (English Language Arts), the field of Science seemed to be included in it almost as an afterthought. Why is Science so important? As is made pointedly clear throughout this paper, Science is a crucial area for young people to master in order to be able to understand how the world, in its physical and material realms, works and indeed, how to promote its very survival. With such pressing scientific and political issues as global warming, the greenhouse effect, population crippling diseases, the diminishment of natural resources including the rainforests and fossil fuel, and the increase of landfills, to name just a few crucial areas, it seems that Science should to be at the forefront of any national educational reform/policy. However, as the reader will learn, teaching Science can be an Achilles' heel to many teachers and educators. Teaching Science is more cumbersome in terms of time, manpower, resources, funding, creativity, and space and is therefore too often given short shrift in children's education and in the NCLB legislation itself.

This paper will take the position that there are effective teaching methods that can be applied in every classroom, at every grade level. These teaching/learning strategies are very effective when teaching Science in the elementary levels, but are versatile enough to be modified to be used in the higher grade levels. In addition, the earlier those students are taught to be a *Science thinker*, the more likely they are going to become *stronger Science thinkers* throughout their academic and adult lives. It is like planting a seed in poor soil, and never giving it water or sunlight. The seed has little to no chance for flourishing or growth. However, the seed will have a better opportunity to grow if it is provided with these essential components. As stated above, we are in desperate need of having more people in this world who have a better understanding and appreciation of Science and all that it entails.

Nevertheless, educators today still insist that our students learn about the world through

textbooks and lectures. We know that each student learns differently and therefore, solely basing curriculums on these teaching strategies are ineffective. Would you want a doctor to operate on you if the only experience he or she has had with surgery was through a textbook? Furthermore, where would our medical technology be today without the innovative ideas of those who thought to inquire, investigate, theorize, explore, and/or demonstrate, etc?

In light of President Bush's policy, "No Child Left Behind," teachers and school officials are under pressure to ensure that every child has the opportunity for academic success. This paper will provide specific effective teaching strategies and methods that may provide a framework for teachers on how to more successfully teach Science. This will increase the schools' opportunities to satisfy the Adequate Year Progress reports, which is NCLB's main form of monitoring accountability and providing assessment for assuring that the required learning standards are being met. This writer believes that students will have personal and academic success when curriculum, especially Science curriculum, incorporates such teaching/learning strategies as thematic units, Multi-sensory/Multiple Intelligent learning activities, and inquiry-based thinking. The benefits of developing curriculum using these strategies encourage children to think *outside the box.* I will make many suggestions and give original illustrations of lesson plans and curriculum plotting that incorporates these key teaching strategies that will hopefully be more successful in ensuring that no child will be left behind.

Chapter One:

The History of American Education and Reform: A Brief History Spanning From the Latin Grammar School to Goals 2000

Introduction

Some of the best advice ever given was that past events are good predictors for future ones. In analyzing the history of American education and how it has evolved over time, it seems best to start at the beginning, and then follow the building blocks of policies as they were added and sometimes removed, as the American educational system was developed and had started to take form. To have a greater appreciation of the status of education, it is beneficial to briefly examine the numerous transformations over the last 400 years or so. Pioneer thinkers and policymakers, whose backgrounds derive from both education and society, have influenced the history of American education and reform. The exploration of the most important developments in the field of education continues until the most recent reform is reached. This backdrop, in turn, forms the context by which an understanding begins to raise about the No Child Left Behind legislation, what its underlying assumptions are about children and how they learn.

The 1600 and 1700's

The earliest attempts at public education in American society occurred in the first settlements that were established in North America in the 1600s. The European settlers had assimilated the school systems of their homelands into their settlements within the North American colonies. In 1635, Benjamin Sym established the first free school in Virginia (Sass, 2008; Cooke, 1883, p.168). Initially, these schools were *free* in the sense that students were taught lessons that were free from both the church's and England's (the King's) influences

(Cooke, 1883, pp. 168-1790). Later it will be discussed that the idea of *free* also meant that the schools were funded publicly and therefore, cost nothing for the students to attend.

In addition, the Latin Grammar School opened in Boston, Massachusetts. The Roxbury Latin Grammar school was the first endowed grammar school that was established for the sons of the higher classes, whose future pursuits included "leadership positions in the church, state, and courts" (Miller, 2004; Barnard, 1863, p.529). The first college in the United States was founded in Newton, Massachusetts, now known as Cambridge, Massachusetts. In 1636, Harvard College became the first institution of higher learning, and by 1642 offered nine Bachelor of Arts degrees (Sass, 2008; Brubacher and Rudy, 1997, p. 21).

The 1700's was a time of growth, but only in the territories that were established by the European settlers. In these areas, societal development was apparent, as was evidenced with the creation of public schooling, which gave the poor some educational advantages (Barnard, 1863, p. 532). As Gerald L. Gutek (2008), a historian of early American education, has noted:

> They established a two-track school system in which the lower socioeconomic classes attended primary vernacular schools and upper class males attended separate preparatory schools and colleges (Gutek. 2008).

The primary goal of the early curriculum was literacy (Wagoner and Haarlow, 2008). Around 1785, students used a set of books called, *A Grammatical Institute of the English Language*, written by Noah Webster (Sass, 2008; Wagoner and Haarlow, 2008). This set consisted of three books. The first, *The Elementary Spelling-book* (also known as the Blue-Black Speller) which dissects the alphabet (letter by letter) by pronunciation, sounds, diphthong, usage, and script. The second, a *grammar book,* which attempts to teach "proficiency" and the precise "construction" of Grammar of the English language. The third was a *reader,* which included

four pertinent rules on Reading and Speaking, such as paying the "strictest attention on to accent, emphasis, and cadence" (Webster, 1908, pp. 8-16); Webster, 1804, p.3; Webster, 1804, pp. 2-5). These three volumes were the first version of American textbooks (Sass, 2008; Wagoner and Haarlow, 2008).

The 1800's: The Common Movement and The Committee of Ten

During the 1800's, there was the Common Movement, which resulted in an increase in public or free schools, offering free elementary education available to everyone. Schools became a two-track school system, which prepared the two different classes for their future social roles (Gutek, 2008). Thomas Jefferson referred to these two different learning tracks as being for "the laboring and the learned" (Sass, 2008). While the lower class was provided with the requisite skills to have the minimal social graces, their futures would most likely consist of a life of working on a farm or as a laborer. The upper class was being prepared to become future leaders and predominantly business owners. Jefferson was a big supporter of "civic literacy," where individuals work at becoming more morally and socially sound members, who execute their civic obligations within their day-to-day lives (Wagoner and Haarlow, 2008).

> Projecting a theme that would echo throughout the common school movement in the next century, Jefferson conceived of elementary schooling as basic education for citizenship; it was to be a public investment in the possibility of self-government and human happiness at both the individual and social levels (Wagoner and Haarlow, 2008).

By the beginning of the 1800's, the schools became the responsibility of each state, instead of the federal government. In 1821, the first public high school was opened in Boston Massachusetts (Sass, 2008). In addition, in Massachusetts, the first State Board of Education

was created in 1837, naming Horace Mann their Secretary (Gutek, 2008).

Horace Mann was known as the "Father of the Common School" (Wagoner and Haarlow, 2008). He was the first Secretary of the State Board of Education in Massachusetts for twelve years. During those years, Mann achieved many successful accomplishments, such as campaigning for better teachers, teaching materials, and school committees; establishing free libraries; fighting for and acquiring an increase in state aid for public schools; becoming an editor of the "Common School Journal"; and arguing for businesses to be taxed to help support public education (North Carolina State University, 2008). He was also instrumental in the passing of the 1852 State Law on school attendance, which by 1885 sixteen states had implemented. By 1918, all the states had implemented the compulsory-attendance law (Sass, 2008). Horace Mann believed that every child had a right to a public education, and that it was the State's responsibility to see that it was received. In addition, he believed that it was society's responsibility to support the schools through taxation, because they would benefit from having a more educated society (North Carolina State University, 2008). Prior to this period, schools were co-funded by parents and the local communities, including businesses. During this period, the responsibility in retrieving and allocating funding for the formally known *free* schools, which were now being referred to as *public* schools, shifted to the states, and moreover, from the taxation collected by the local governments (Macmullen, 2008).

In 1839, Horace Mann started the first "Normal School for Teachers" in Lexington, Massachusetts to provide better training for teachers to teach past the elementary levels. As Ducharme and Ducharme (2008), two scholars of early educational reforms in the United States noted, "Normal Schools prided themselves on their thorough, cohesive and "scientific" curriculum. They would provide a norm for all teachers (hence the term Normal School) that

would assure a level of quality generally unavailable previously."

By the end of the 1800's, there was a big push for graduating students to continue with their education and go to college. The problem was that many of the graduating seniors were unable to pass college entrance exams or were under-prepared for the basic coursework of core classes. The Committee on Secondary Social Studies, also known as the Committee of Ten, identified a need for "a college-oriented high school curriculum" (Sass, 2008). On December 4, 1893, James H. Baker, the President of the University of Colorado, signed the Committee of Ten's report, which would become the United States' first major national education reform. This historic meeting of The Committee of Ten was made up of educators and professionals from every academic discipline, from all over the country. The Committee of Ten explored eleven main questions (Appendix 1.0) in their quest to improve the educational system within the United States. It is interesting to read those eleven questions, because one gains an insight into the Committee's frame of mind, what their goals were, and their attitudes towards education at that time.

The Committee of Ten made many landmark decisions regarding schools and education. The Committee decided that students would spend two additional years in high school (four years total), and during these years, students would learn subjects such as "algebra, geometry, natural sciences, a concentration on English composition, and foreign languages" (National Education Association, 1894, pp. 34-40). The Committee decided which subject was pertinent for a student to learn in high school; to what degree of knowledge a student should learn about a specific subject; and how much of his or her high school years he or she would spend learning that subject. The Committee also determined when the students needed to be introduced to specific subjects, in the elementary levels (National Education Association, 1894, pp. 142-150).

They considered which information was important for students to learn, depending on which part of the country they lived in (National Education Association, 1894, pp. 34-40).

In addition, by the addition of secondary schools, students would be better prepared for college; and to meet the growing demands of industrialization. These significant changes in commerce during the early twentieth century, attributed to the training of the youth so they would be able to partake in the business, commercial, and professional world ahead of them (Boston University School of Education, 1909, p.38).

The Committee of Ten also suggested that colleges should schedule their entrance examinations either closer to the beginning or the end of the school year (National Education Association, 1894, pp. 34-40). Ironically, the first Scholastic Aptitude Test or SAT would not be administered for another thirty-three years later, in 1926 (Sass, 2008). Finally, the Committee of Ten identified that for these recommended changes to be successfully executed, elementary and secondary schools needed to acquire more highly trained teachers (National Education Association, 1894, pp. 158-161). The balance of and battle over setting standards, control, curriculum development, accountability, and knowledge based testing would continue to be a perplexing dilemma for educators and legislators, well into the next millennium.

The 1900's: Movements, Reformation, and Great Thinkers

The next benchmark in the evolution of education reform occurred twenty-six years later. In 1919, the "Progressive Movement" was started by the Progressive Education Association, which was influenced by John Dewey's book, Democracy and Education: an Introduction to the Philosophy of Education (Schugurensky and Aguirre, 2002; Sass, 2008). Dewey wanted to see the traditional educational system replaced with a system that encompassed four main themes,

which included mental testing, child-centered education, fitting education around the needs of society, and making it the responsibility of schools to aid in the changing of society itself (Dewey, 1899, pp. 30-35). According to Schugurensky and Aguirre, two scholars who have written extensively on this Reform Movement, Dewey theorized that:

> ...the ideas of child-centered education [included] social reconstructionism, active citizen participation in all spheres of life, and democratization of all public institutions. Progressive educators believed that a new education program, based on the development of cooperative social skills, critical thinking and democratic behaviors, could play a pivotal role in transforming a society of greed, individualism, waste and corruption for one based on compassion, humanism and equality (Schugurensky and Aguirre, 2002).

Dewey believed that schools should produce individuals who would benefit and strengthen society's overall structure, and by training minds to think and judge, instead of memorizing and studying, this could be possible (Dewey, 1899, pp. 30-35). In sum, the premise of John Dewey's theories and the Progressive Movement was that learning should be based on previous experiences. In addition, learning should be a gradual process, which included opportunities for revising, adapting, experimenting, verifying, and reconstructing (Schugurensky and Aguirre, 2002).

In addition to John Dewey, the 20th Century produced many other innovative thinkers and theorists who wrote on the topic of education and education reform, and who explored the effects of teaching and learning on the cognitive and behavioral development of children. For example, in 1926, The Child's Conception of the World by Jean Piaget was published (Sass, 2008). Piaget studied the cognitive development of children, and his theory was referred to as "cognitive constructivism." He believed that children developed cognitively in stages. Piaget identified four

stages of cognitive development. The sensori-motor (Birth - 2 years) stage is when the child "differentiates self from objects"; starts to identify the cause and effect relation he or she has on his or her environment; and that objects exist, even when out of sight. The pre-operational (2-7 years) stage is when a child "learns to use language and to represent objects by images and words"; he or she remains "egocentric" in relation to his or her environment; and groups things by one similar characteristic. The concrete operational (7-11 years) stage is when a child "can think logically about objects and events"; can group objects by individual, differing characteristics; and "achieves conservation of number, mass, and weight". Finally, the formal operational (11 years and up) stage is when a child "can think logically about abstract propositions and test hypotheses systemically" and "becomes concerned with the hypothetical, the future, and ideological problems" (Atherton, 2005). The stages and their correlating ages are not set in stone. It is possible for a child to advance into the next cognitive development stage, at an earlier age. Piaget's cognitive development theory has been used to develop teaching/learning curriculum by determining what level of learning the students are cognitively able to achieve, based on the age/stage that the group of children are in.

During the 1900's, theorists struggled back and forth on which was the best approach to apply to lesson planning, learning, and the classroom. For example, Piaget was a supporter of the cognitive approach. However, in the 1950's, Burrhus Frederic (B.F.) Skinner developed his operant conditioning (or instrumental) theory, which was based on an individual's behavior or behaviorism. This theory emphasized that behavior can be modified by using reinforcement, and it was integrated into classroom management and lesson plans in schools across the country (Sass, 2008). Skinner's operant conditioning theory was derived from the simple principles of cause and effect. However, his theory involved three significant and related parts: stimulus,

reaction (positive or negative), and response to the reaction (positive or negative). It was a way of modifying behavior by using either positive or negative reinforcement. Skinner's operant conditioning can be very effective in behavior modification, and can be very beneficial for teaching and learning experiences (Huitt and Hummel, 1997).

One current application of operant conditioning being used in schools is the grading system. If a student studied and passed his or her test, then the good grade is positive reinforcement, which could lead to a higher GPA, scholarships, entrance into a good college, parental approval, etc., all examples of positive reinforcements. Skinner believed that positive begot positive. Therefore, the positive behavior or thinking would continue in the presence of positive reinforcement. On the other hand, if that same student did not study, and failed the test, that student would receive a failing grade (negative reinforcement). A failing grade could lead to being held after school, being held back a grade level, punishment by parents, or dropping out of school, all negative reinforcements. Skinner believed that in the presence of a negative reinforcement, the behavior should be positively corrected/modified. When the positive behavior is identified, then that behavior should be encouraged to continue through praises and/or rewards (Huitt and Hummel, 1997).

Throughout the 1900's, national educational reforms were strongly influenced by the popular thinkers of that era, such as Dewey, Piaget, Skinner, Bruner, and Rogers. In addition, educational reform were highly influenced by the social issues affecting youth and their families, including increasing inequality in American society and the life opportunities of those in the lower and working class students' families to make it in a changing economy.

In the early 1960's, newly appointed President Lyndon Johnson, "created an ambitious legislative agenda", referred to as the Great Society Movement. During this Movement, many

landmark social programs and policies were created that help further his "War on Poverty", and improved the overall social structure and well being of the day-to-day lives of the average, working-class, working-poor, and impoverished Americans. These programs/policies included Job Corps, Volunteers in Service to America (VISTA), and two vital healthcare programs that still serve American citizens at need today, Medicaid, and Medicare (Hutchison, 2005, p. 108).

In addition, President Johnson declared a "War on Poverty", and launched a "comprehensive child development program" known as the Head Start program, which was established under the Elementary and Secondary Education Act (Alexandria, 2005). The Elementary and Secondary Education Act "was passed on April 9, 1965," and the Act's goal was to allocate large funds to aid the special educational needs of low-income families; to support agencies in areas that were densely populated by low-income families; and to initiate Title I, Bilingual education and other educational programs (Schugurensky and Aguirre, 2002; Sass, 2008).

As a former teacher himself, President Johnson identified the fact that nearly half of the country's poor population consisted of children. Johnson believed that early intervention programs, especially for a child from a low-income family, could positively affect a child's development, and could greatly affect a child's future socio-emotional and cognitive development (Alexandria, 2005). As a result of his efforts at passing legislation directed to the needs of low income children, there are now currently 525 Head Start programs across the country serving approximately "38,000 infants, toddlers, and pregnant women." The original goals of the Head Start program are still steadfast after all these years. The once half day, eight week summer program, has grown into a full day, year-round program, that provides such services as medical, food, school, pubic services, parenting classes and support groups

(Alexandria, 2005). Early Head Start Programs have become one of our nation's most successful preschool programs.

In the mid 1960's, the ideology on teaching and learning shifted from behaviorism back to cognitive constructivism. Jerome Bruner, a psychologist and theorist of learning, also studied cognitive development. Bruner's theory of "cognitive growth" differed from Piaget's, in the sense that Bruner believed that cognitive development was strongly linked to "environmental and experiential factors" (Smith, 2002). In his influential book The Process of Learning, Bruner believed that learning should not be just a "mastery of facts and techniques." It should also be a means to gain a full understanding of ideas, so that they could be related to and applied to other ideas, in different contexts. Bruner's "readiness to learn" referred to the idea that students could be taught subjects that were thought to be too difficult, but in fact were possible to learn if a student was provided with the right cues and motivation to learn. The difference was how the information was presented to them. The subject matter had to be presented in an intellectual manner that would be comprehensible at their level of development and intellect.

This idea of developmentally appropriate levels of learning had an important influence on educational reforms, specifically in the creation of the "spiral curriculum." The theory is as the curriculum proceeds the learning object or main idea is developed from a concept that is relatable to the students. As new ideas are introduced, they are related to or built upon the original, until the student has successfully achieved full comprehension of the learning objective (Smith, 2002). By using a spiral curriculum, a student learns new information based on his or her previous knowledge of related or similar information, and using his or her intuition and analytical thinking to identify the similarities between the concepts. It is a way to bridge or relate different information together. This bridge would then expand as their ability to interpret

and digest information does, and thus, connections are made between the varying information and are built, reinforced, and mastered. In essence, Bruner was one of the first developmental/cognitive theorists to introduce analytical thinking into the realm of learning and cognitive development (Smith, 2002).

In 1969, another standard for teaching and learning was introduced by Herbert R. Kohl's book, The Open Classroom, called Open Education. Open education is based on a holistic approach to learning, where classrooms are child-centered and industrious (Sass, 2008). Though sometimes viewed as being chaotic, lack of unclear objectives, and traditional structure and accountability, there were many good points to open education. According to Charles Rathbone and Lydia Smith (2009), educational researchers and contributors to Education Encyclopedia online, "open education defied empirical evaluations" for many reasons. It supported collaborative learning; "student participation in planning and in setting goals"; involved a more "evolving" or progress curriculum; focused on the bigger picture of the academic/learning objective outcomes; child-centered including the "emotional and social needs of learning"; hands-on approach to learning (which as will be discussed later, has been proven to be a highly effective method of learning), and that there should be "a reciprocal relationship between school and community" (something that is one of NCLB key points, which will be discussed later). John Dewey's and Jean Piaget's *Progressive* theories supported this same ideal of having a process of "learning to think through the solution of real problems by means of active inquiry and experience, not by memorization and recitation" (Rathbone and Smith (2009); Dworkin, 1959 p. 20). Open education is still successfully implemented in alternative educational institutions today, such as some Montessori and Charter Schools, across the United States.

Open Education was born out of the humanist perspective of education, which supported

a student's "curiosity", "self-direction and independence", "creativity", "responsibility for what they learned", and "interest in the arts". The humanist perspective was reflective of the relatively self-directed culture and mentality of the 1960's (Huitt, 2001). Carl Rogers was a theorist and supporter of the humanist perspective. Roger's "Facilitative Teaching" was based on providing a learning environment that was positive, supportive, sensitive, and harmonious towards their students (Huitt, 2001). Kohl's and Roger's theories took their inspiration from the humanistic perspective, and similarities could be found between both Kohl's and Roger's approaches (Appendix 1.1).

On December 8 1975, Newsweek magazine published their infamous and highly controversial cover story, "Why Johnny Can't Read" (Elgin, 1976, p. 28). In that article, the author stated that:

> ...a school preaching that one form of language is as good as another; that at the age of 5 anyone who is not deaf or idiotic has gained a full mastery of his language; that we must not try to correct or improve language, but must leave it alone; that the only language activity worthy of the name is speech on the colloquial, slangy, even illiterate plane; that writing is a secondary, unimportant activity (Elgin, 1976, p. 30).

What did Newsweek attribute to being the reason why Johnny could not read? The author made several claims, including that the students' primary example for speaking was the "simplistic" dialect they heard from television; that students were being taught primarily through structural linguistics versus transformational linguistics; the decline in the use of Sentence Diagramming/Trees; and finally "the teaching of Standard English to speakers of a nonstandard dialect is said to make such speakers *bilingual*" (Elgin, 1976, pp. 34-35).

Newsweek's 1975 article identified many reasons why the National rates of literacy were

poor, especially for the graduating seniors. This resulted in the development of the "back-to-basics movement." This new movement in national education reform was a shift from the child-centered, open learning classrooms of the 1960's to the teacher directed instruction classrooms of the late 1970's and early 1980's. As an avid researcher of this era, Charles Weingartner's (1977) subjective summary of the Back-to-Basics Movement may seem somewhat cynical. However, it gave the reader the overall goals of Movement (Appendix 1.2), which was another benchmark in the progress of America's education reform (pp. 39-44).

Though Weingartner was not a supporter of the new shift toward a more structured educational environment, Madeline Hunter was. In 1982, Madeline C. Hunter's book, Mastery Teaching, discussed her Direct Instruction Teaching Model (Sass, 2008). Currently, Hunter's Model is still being integrated into training curriculum used by teaching colleges. The teacher centered Model is based on a *seven-step* sequential instructional plan, which Hunter believed should be incorporated into the planning of every teaching lesson. These planning and instruction steps include: objectives (what are they going to learn?); standards (what educational goals are the students supposed to accomplish through the lesson?); anticipatory set (the introduction or the "hook" to get the students interested); teaching (input, modeling, and checking for understanding); guided practice (a related activity for the students to work on under the teacher's guidance); closure (what was learned? Answering questions the students may have or a summation of key points of the lesson.); and independent practice (i.e. independent or group projects, and homework) (Hunter, 1986, pp. 172-179).

Even with the superb efforts of thinkers like Madeline Hunter, educationally speaking, by the 1980's we were a *Nation at Risk*. In April of 1983, the National Committee on Excellence in Education "published an alarming federal report entitled *A Nation at Risk*" (U.S. Department of

Education, 1999). In this attention grabbing and alarming report, the Committee collected astonishing evidence of the intensifying risks for our nation's schools (Appendix 1.3).

With the trends leaning towards a stronger technological background, graduating seniors needed to become more knowledgeable about computers. The National Committee on Excellence in Education called for creating a "Learning Society," where every student, from elementary on, would be given learning opportunities that would "stretch their minds to full capacity." This new generation of a Learning Society would also be more knowledgeable about the world around them and how things work within that world. The National Committee on Excellence in Education believed that the future of America depended on producing these worldly, technologically perceptive, and extremely literate citizens (U.S. Department of Education, 1999). The *Nation at Risk* report proposed that this could be accomplished if there were a stronger "set of academic basics for high graduates; higher standards for universities; a longer school year and/or day;" sliding scale pay based on the quality of teachers; and more community involvement (Orlich, 2000, p. 469).

In the past, American schools were not always producing morally, socially, and intellectually sound individuals. Many young people lacked good overall habits. It was almost certain that with the demands of an unstable economy, they were not being given the kind of intellectual and social tools they would need to succeed in an increasingly competitive and specialized workplace (Sizer, 1984, p. 206). Theodore Sizer believed that many of the changes within the nation's educational system have not led to favorable outcomes and he agreed that our nation's educational system was lacking in many of the areas identified in the *Nation At Risk* report (1992, p. 35 & p. 206).

Sizer believed that the schools needed to acknowledge that every student learned

differently, at a different rate, and may need extra assistance in learning (Sizer, 1992, p.34). In a sense, Sizer believed that schools need to admit that all children are different. Therefore, a traditional and rigid curriculum needed to be replaced with curriculum that supported students' individuality. Schools and their teachers needed to adopt more creative methods in order to reach students with diverse needs, and become more accountable for the academic fate of their students (Sizer, 1992, p.50).

For example, students in the inner city schools were suffering academically, which had been reflected in their relatively high dropout and low graduation rates. Why was this more prevalent in these demographics? First, their schools were poor in terms of facilities, workforce, resources, and funding. Second, these students were faced with poorly structured academic programming that was focused around "low-level, fragmented curricula" and finally, there was evidence of poor morale among faculty members (Tobin, 2001, p.41). Sizer also believed that students from all demographics wanted to meet the basic requirements in order to receive their high school diplomas (Sizer, 1984, p.163). As Sizer observed, "students know that only minimum engagement is required to make it through high school... ...and taking risks for students is not required" (Sizer, 1984, p.163).

By 1994, a new law was established that was intended to increase the requirements that students needed to achieve to make it through high school (Sizer, 1984, p.163). On March 31, 1994, the "Goals 2000: Educate America Act" became a law (U.S. Department of Education, "Goals 2000: History", 1998). According to longtime teacher and educational author, Susan Ohanian, Goals 2000 was the "offspring of A Nation at Risk," where students were defined as "human capital and the teaching/learning compact was a protected monopoly offering goods and services. " Ohanian also described the relationship between teachers and the communities they

served as that of "buyers and sellers," under the Goals' legislation (Ohanian, 2000).

Like Sizer's beliefs about educational reform, Goals 2000's key principles were also based on the fundamental idea that all students can learn. To that end, there was a large need for community involvement in developing strategies for system-wide improvement. These improvement strategies must be coordinated, understandable, and developed, at the local level. In addition, there was specific language in the Report to the effect that "lasting improvements depend on school-based leadership;" and "simultaneous top-down and bottom-up reform is necessary" (U.S. Department of Education, "Goals 2000: History", 1998). According to the U.S. Department of Education, Goals 2000 was:

> "The first federal education initiative specifically designed to help States and communities to initiate, improve, and coordinate their own reform efforts, Goals 2000 provides the leverage and support necessary to improve strategic education planning. Through a process of broad-based involvement, State and local educational agencies (SEAs and LEAs) that are awarded Goals 2000 funds are required to develop and implement comprehensive education improvement plans that describe strategies for improving teaching and learning for all students (U.S. Department of Education, "Goals 2000: History", 1998). In addition, state and local implementation of Goals 2000 is focused on ensuring that all children meet high academic standards. This emphasis on result is embodied in changes in instructional and institutional systems, curriculum and instruction, professional development, assessment and accountability, school and leadership organization and parental and community involvement, that are all aligned to content and performance standards. Because Goals 2000 represents the effective implementation of standards-based reform, the two are inextricably linked. Therefore,

the success of Goals 2000 must be tied to State progress in implementing standards-based reform and its respective elements (U.S. Department of Education, "Goals 2000: Implementing...", 1998).

According to the U.S. Department of Education, improvements were being observed in schools under the Goals 2000 reform. However, improvements still needed to be made. The schools still needed to close achievement gaps and meet the higher learning standards, while ensuring they were reaching each student and their individual learning style. Goals 2000 had a humanist feel to it, in that it was more student-centered, but it also needed the commitment of the community or "*village*" for it to be successful and to coordinate with its efforts. Goals 2000 wanted the development of content, curriculum, assessment, performance standards, instruction, and the schools' accountability to become a collaborative effort made by a combination of the state and local levels, including educators and the community (parents) (U.S. Department of Education, "Goals 2000: Continuing..." 1998).

Goals 2000 also expected further "professional development and preservice education" for teachers. There were support and professional allotments for teachers to continue to receive educational development, which was less disruptive to their teaching time and more cohesive with their overall schedules and that of their immediate colleagues. In addition, educational institutions would be rewarded for raising their standards professional training, development, and achievement (U.S. Department of Education, 1998).

This push towards producing better-trained and highly qualified educators, to meet higher learning and performance, assessments and standards, was quite contrary to anything that had been seen before in our nation's educational system. According to Diane Ravitch's 2000 book, Left Back: A Century of Failed School Reforms, previous school administrators preferred

students to be taught in the most organized and least controversial manner. Similar to Sizer, Ravitch identified the need for a clear, structured set of standards for American education and increased requirements for graduating. Ravitch also identified the historical pattern of how education reform had been geared more to the increasing demands of the job market (economy), while dismissing the idea of post-secondary opportunities that needed to be changed (pp.80-92).

According to Ravitch, in the past business owners wanted a system that produced individuals who had the basic skills needed to be productive workers. Educators also seemed more concerned with providing society with more productive/skilled members (Ravitch, 2000, p.80 & p.92). Just a few short years ago, the U.S. General Accounting Office reported that 50% of all the students graduating from high school had "no marketable skills" (Flick and Lederman, 2002, p.4). These new adults were faced with poor job opportunities that were low paying, with no benefits, poor work hours, and were physically demanding. This made it almost impossible for them to be self-sufficient. However, throughout the 20th Century, there was an ongoing debate involving utility versus knowledge (Ravitch, 2000, p.26). On one side, many experts wanted education to be a building block for a person to become a productive member of one's society. On the other side, experts argued that knowledge is power, and that intelligence makes for a more productive community member. In this sense, a student would have more of an option of whether to pursue post-secondary education or training, such as college or a trade school (Ravitch, 2000, pp. 26-29).

Historically, when it came to school politics, the parents, teachers, and principals have not been viewed as powerful players, as the legislators and school boards were. In most school districts across the country, the schools were being maintained with conventional (or traditional) methods. Teachers were there to teach the students, manage the classrooms, and offer guidance

to the students. The federal government via the state government through the local school districts was ultimately monitoring schools. In other words, students in school X spent their days moving from class to class, in a monotonous existence of memorizing facts and listening to lectures and note taking. Students were essentially treated like a herd of cattle, where they were fed information in the troughs of America's contemporary educational system, which offered a narrow selection of by-products and fillers. In the past, it seemed that our schools were failing more and more at producing *Grade A* anything (Ravitch, 2000, p. 106).

Ravitch believed that the shift from being "marketable" to college educated had to be made, because again, "knowledge is power" (Ravitch, 2000, pp. 26-29). Commenting on Ravitch's position, Sass noted that Ravitch:

> ...criticizes progressive educational policies and argues for a more traditional, academically-oriented education. Her views, which are reminiscent of the "back to the basics" movement of the late 1970s and 1980s, are representative of the current conservative trend in education and the nation at large (Sass, 2008).

Would it be safe to assume that Ravitch would view Goals 2000 as a bit untraditional and needlessly too unconventional?

In conclusion, in revisiting the history of educational reform of the United States, there is a continual theme of the need to educate students to be productive citizens for a democratic society. While different theories draw on different understandings of human nature and how best students learn, there is always a sense that educational reform should be tied to the larger question of how to encourage an educated citizenry, and one who can participate in both the market and the economy as well as in civil society. There have also been shifts in who was thought to be part of this educated public, and we are now at the stage in our educational reform

of trying to make every child part of this American project in an increasingly globalized and competitive world.

The pinnacle of past manifestations of educational reform that tried to educate all of America's children was the "Goals 2000" legislation. One major difference between Goals 2000 and the educational movements of the past was that Goals 2000 placed a stronger emphasis on assessment, accountability, student evaluation, and student performance, and how these factored into future "corrective action" and "continuous improvements," pertaining to the educational system as a whole.

However, as this paper moves forward, there will be an understanding of the ways in which the emphasis on "accountability" and "assessments" has played out in classrooms and school across the country, and a critical assessment of what problems have been identified with implementing this newest educational reform. The brief history of educational reform which has been outlined in this first chapter should serve as a cautionary story, however, both in terms of trying to identify what makes for the best possible educational system and what social and political stumbling blocks have plagued these early myriad attempts to create a successful educational reform.

Chapter Two:

The Science Behind the No Child Left Behind Act of 2001

New Millennium, New Reform: The No Child Left Behind Act of 2001

Prior to the new millennium, the United States' educational system had seen movements and reforms come and go, without much success or longevity. As previously discussed, the success of Goals 2000 was based on assessment, accountability, and applying the results from the students' performance achievements to develop and expand upon future educational improvements. Unfortunately, it never gained the momentum and notoriety that its successor would. By 2001, President George W. Bush had abandoned Goals 2000, and proposed his own national educational reform that was based on almost identical principles as that of Goal 2000's objectives. On January 08, 2002, President Bush's "No Child Left Behind Act of 2001," also now known by its initials, "NCLB," became a law (Public Education Network, 2006). NCLB is based on four key areas that include "stronger accountability for results, more freedom for states and communities, proven education methods, and more choices for parents" (U.S. Department of Education, July 2004).

The No Child Left Behind Act granted each State the authority to develop their own standards and each State would then be held accountable for those standards. This policy is supposed to specifically target students with disabilities as well as students who are economically disadvantaged, minority groups, in low-achieving schools, and students who are limited in speaking English. In the past, these students usually fell through the gaps of the educational system, because their limitations made it difficult to be academically successful within this system of high strict standards that allowed little margin for error. However, with the

new standards, schools are required to measure for both quality and quantity of the students' successes, to assess that *all* students are learning (U.S. Department of Education, September 2002; Paige, 2002, pp. 708-713). This legislation initially proposed the following objectives:

a. By 2005, all children will be taught by highly qualified teachers, who demonstrate subject matter knowledge for each course they teach;

b. States create their own standards for what a child should know and learn for all grades;

c. Standards must be developed in math and reading immediately. Standards must also be developed for science by the 2005-06 school year;

d. With standards in place, states must test every student's progress toward those standards by using tests that are aligned with the standards. Beginning in the 2002-03 school year, schools must administer tests in each of three grade spans: grades 3-5, grades 6-9, and grades 10-12 in all schools. Beginning in the 2005-06 school year, tests must be administered every year in grades 3 through 8 in math and reading. Beginning in the 2007-08 school year, science achievement must also be tested;

e. Each state, school district, and school will be expected to make adequate yearly progress toward meeting state standards. This progress will be measured for all students by sorting test results for students who are economically disadvantaged, from racial or ethnic minority groups, have disabilities, or have limited English proficiency;

f. School and district performance will be publicly reported in district and state report cards. Individual school results will be on the district report cards;

g. If the district or school continually fails to make adequate progress toward the standards, then they will be held accountable (U.S. Department of Education, May 2003).

Accountability is a way to ensure that all schools are providing adequate and

reasonable learning experiences that effectively satisfy the states' learning standards/objectives (Mathis, 2003, pp. 685-686). In addition, schools will not only be held accountable for their standards, but they will also have to develop their own assessments to demonstrate quality and quantity of the students' academic successes, via their school's report card or their Adequate Yearly Progress (AYP) reports (U.S. Department of Education, September 2002).

The schools' AYP report reflects how close the schools' assessments are to satisfactorily achieving their state's standards. The schools' funding is based on their AYP. This is an achievement initiative for schools (Donlevy, 2002, p. 258). The concept of AYP was fairly new during the late 1990's. What is AYP? As part of a report published by the New York State Education Department (2003), "Attachment C" described the "Twelve Most Important Things to Know About Adequate Yearly Progress (AYP)." These include what the goal of NCLB is; the definition of AYP in relation to NLCB; and how proficiency, performance, and the measurement are considered and determined for the AYP. There are AYPs for both the schools and entire district (including the specialized subject areas); the "requirement for AYP for disaggregated groups (including an emphasis on groups that need extra services pertaining to learning English Language Arts or ELA); the "rewards and consequences" of meeting or failing to meet the AYP; and where educators and school administrators can receive further information on the state's AYP requirements (New York State Education Department, 2003).

Under NCLB's policy, determinations that schools that were being *left* behind, were based on their AYP's. According to the U.S. Department of Education (January 2001),

> School districts and schools that fail to make adequate yearly progress (AYP) toward statewide proficiency goals will, over time, be subject to improvement, corrective action, and restructuring measures aimed at getting them back on course to meet State standards.

> Schools that meet or exceed AYP objectives or close achievement gaps will be eligible for State Academic Achievement Awards... ...For students attending persistently failing schools (those that have failed to meet State standards for at least 3 of the 4 preceding years), LEAs must permit low-income students to use Title I funds to obtain supplemental educational services from the public- or private-sector provider selected by the students and their parents... ...Schools that want to avoid losing students—along with the portion of their annual budgets typically associated with those students—will have to improve or, if they fail to make AYP for 5 years, run the risk of reconstitution under a restructuring plan.

President Bush's No Child Left Behind (NCLB) Act of 2001 was described as "a sweeping overhaul of federal efforts to support elementary and secondary education in the United States" (U.S. Department of Education, September 2002). As stated above, NCLB was developed around four main components: Higher "accountability" for academic success; greater "flexibility" with the use of federal funds at the local levels; more academic options for students from "disadvantaged" backgrounds; and finally, having quality teachers using "teaching methods" that work. The big picture is that schools have had the academic bar raised for them by the NCLB Act. Specifically, schools were now being held more accountable for their students' overall achievement and performance scores, which are formulated into the states' AYP (U.S. Department of Education, September 2002). The schools' AYP reflects the outcome of their assessments, which is factored in locally and statewide. Each state is responsible for having their own requirements for how assessments are developed and conducted. For example, New York State's regulations on assessments are designed to:

> Provide a uniform measure of student achievement across all districts, all schools, and all classrooms.
>
> State tests assess the extent to which students have achieved the learning standards in a content area.
>
> Are important indicators of student achievement of the learning standards.
>
> Are used to understand individual student needs in conjunction with other appropriate measures.
>
> Drive necessary changes in curriculum and classroom instruction.
>
> (New York State Education Department, August, 2008)

This legislation allows for more "flexibility and local control" for each state and the school districts within the states. According to education writer Judith Rajala (2003), who has written frequently on the benefits of NCLB, NCLB's greater flexibility and local control mean that:

> The act offers districts powerful tools to provide the best education to all children, especially those most in need, by cutting federal red tape; reducing the number of federal education programs; and creating larger, more flexible programs that place decision making at the local level (Rajala, 2003, p. 31).

The main purpose for greater flexibility and local control is to increase the decision-making jurisdiction at the local and state levels where educators and school administrators are more aware of what their students need to meet or exceed their AYP. Meanwhile, being held accountable to the expectations and consequences established and regulated at the federal level, via the NCLB policy. The trade off it that the states will have more freedom to spend their earned federal funding as they see fit, including buying new technological learning aids, facility

improvements, increasing teacher salaries, recruiting new, well trained teachers, and improving teacher training and professional development (U.S. Department of Education, 2001).

Furthermore, schools that succeed in demonstrating students' achievements and closing the achievement gap will be rewarded with grants and No Child Left Behind School Rewards. However, if the schools fail "to meet their performance objectives and demonstrate results in academic achievements," then they will have their federal funding reduced, which could lead to re-staffing, state takeovers, and school restructuring (U.S. Department of Education, 2001, & Donlevy, 2002, p. 259).

In addition, parents are given more choice and control over their child's academic progress. If a student continues to fail to meet the state's new academic standards for two consecutive years, then the parent(s) will have the option of sending their child to another public school, including charter schools, located within their district. The student's district will have to provide the transportation for that student to the other educational institution. Parents with students in schools, who have failed state assessments for three or more years, will be entitled to receive additional academic support services, such as tutoring, after school services, and summer school. This will force schools who have failed in the past, to place more emphasis on what works to improve student academic performance and successes. If they lose their students, then they will lose their funding, because according to Ohio's Representative, John Boehner, "money follows the child" (U.S. Department of Education, September 2002 & 2005, pp. 6-7). Schools receive funding per student attending.

In 2002, it was projected that New York State was going to be allocated $4 billion dollars for education, which was an increase of $926 million dollars (U.S. Department of Education, September 2002). This funding was designated to help schools in poorer districts (i.e. dense

urban areas) to be able to provide a comparable quality of education to that being offered in the richer districts. The poorer school districts could improve safety by doing renovations. They could also afford to pay good teachers, and improve teacher development in order to have good teachers available to teach in their districts. Schools across the state could afford to pay for materials and devices that would provide a richer learning experience.

The Implications of NCLB

As national educational policy writer Alice C. Lewis remarked about NCLB, "undeniably, the right issues are on the table. No one would seriously argue against working to ensure that all students are attending successful schools, are taught by competent teachers and are assessed fairly" (2002, p. 4). It is plausible to think that the majority would agree with Lewis's statement. The intentions behind this largely encompassing legislation appear to be forthright and proactive. However, there are some questionable drawbacks to the No Child Left Behind Act. In Terri Schwartzbeck's (2003) article, "The Ins and Outs of Implementing NCLB (Federal Dateline)," the author reviewed the No Child Left Behind Act of 2001, and voiced the following concerns: "what does a statewide accountability system look like? How is it going to differ from–or be the same as–what states have today" (2003, p. 47)? If anyone takes the time to read the entire legislation, then one would notice that the Act does not specifically state how accountability is going to be measured. NCLB leaves the assessment and accountability determinations to the individual states. This raises the question, however, of how the government will be able to account for the many variables of each state's assessments? As Schwartzbeck stated, "the result of using different methods of statistical testing will be school systems across state lines held accountable for the performance of wildly varying subgroups,"

not to mention sizes (2003, p. 47).

Another critic of NCLB, June Kronhotz, stated that NCLB also requires assessments to be given every three years, versus every four years, for both the primary and intermediate levels. These required assessments are to ensure that the standards are being met. Stringent standards can have multiple adverse effects. For example, they may widen the already enlarged performance gaps between the various groups of students (MacDonald, 2003, pp. 82-83). Lawrence Hardy (2003), an Associate Editor of American School Board Journal, states that the government's or states' standardized testing not only expands the achievement gaps, but there is also evidence of a large gap between the "revenues and expenses," amongst the schools and districts (Hardy, 2003, p. 18). In addition, somewhere in the middle of all this, the states and districts still have to ensure that "all students get a quality education they need to enable them to take advantage of the new economy's opportunities" (Walsh, 2002, p. 11).

However, the quality of education may also be a casualty from the NCLB reform. One teacher, Wendy Darling, has pointed out that NCLB emphasizes students' achievement scores more than the actual learning experiences (Darling, 2002, p. 15). Under NCLB, the states are going to feel more pressure to have their students pass states' assessments, in order to secure more funding from the federal government. This pressure trickles down into the individual school districts. This can only amplify the pressure on teachers to teach to the test (Kronhotz, 2003, p. A4; MacDonald, 2003, pp. 82-83). Moreover, teaching to the test can lead to the sacrifice of learning environments that are full of creativity, intrigue, content, and inquiry, among other enriching learning experiences (MacDonald, 2003, pp. 82-83). How will the teachers of today and tomorrow be able to deal with this turmoil?

Furthermore, teachers will also be expected to advance their training to become more

course specialized, such as having a stronger background in Science (depending on whether they are primary or secondary), while developing new curriculums based on research proven teaching methods. Under the *No Child Left Behind Act of 2001*, Section 1112 Local Educational Agency Plans, Plan Provisions (b) section (a) paragraphs (ii) and (iii), this states that local educational agencies are:

> "To assist in diagnosis, teaching, and learning in the classroom in ways that best enable low-achieving children served under this part to meet State student achievement academic standards and do well in the local curriculum." In addition, "each state will be held accountable for the academic achievements of each of their students. In doing so, the states will be responsible for developing their own annual assessments that must demonstrate high achievements in Reading, Math, and Science. Moreover, each State will be responsible for providing annual report cards that show "comparative information on the quality of schools" and students academic achievements, specifically in Reading, Math, and Science" (U.S. Department of Education, 2001).

Under the discussion of improving teacher quality, Lewis stated that NCLB poorly defines what they mean by a "qualified" teacher and anyone can pass a test of *content*. However, having an understanding of content is not the same thing as having an enriched knowledge of the content area, because without this depth of knowledge, creativity is most likely forfeited. In addition, NCLB also fails to specify where the responsibility falls for how teachers are to be trained in order to actively interpret and/or implement scientifically based research into their daily lesson plans (Lewis, 2002, p.4). Is it the responsibility of the teaching colleges? Is it the responsibility of the individual teachers to take professional development courses that includes this information? If so, then who provides for these courses and who pays for them?

Additionally, William Mathis (2003), who has written on this issue, discussed the problem of what happens if the teachers did not do their jobs and the students would not learn. Does this then mean that the school would go on the list of low achieving schools (pp. 684-685)? As previously discussed, if the school was on the list for more than three years, then the taxpayers of that district and/or the school itself would have to forgo funding for academics and allocate that money for tutoring, transportation to ship students to other schools, and intensive after school programs, etc. It requires many financial resources for these schools to make the improvements needed to get themselves out of the cross hairs of the NCLB imposed consequences. However, NCLB does not provide substantial financial incentives for these schools, which have identified their needs and improvements, but are in great need of a financial boost to begin to make those positive changes happen. It would appear that NCLB is really supporting the schools that are already thriving.

What about these so-called "target" schools? How will they ever be able to recover, especially when their demographics include poor and/or overcrowded inner city areas? These schools are the most *at-need* for financial help and improvements. Ironically, these schools have a higher percentage (per capita) of disadvantaged students, and serving these students is one of the main objectives of the No Child Left Behind Act (Mathis, 2003, pp. 680-683). As Mathis stated, "the effect will be to take money from those schools and those communities that need it most and transfer it to "successful" schools" (2003, pp. 680-683). The higher achieving schools are located in areas that have more of an influential political voice due to their already existing extensive resources.

To summarize, Susan Sclafani, a prior counselor to the Secretary of Education, wrote:

"No school system lacks the desire to do right by their students. They are

> underperforming because they don't know how to do it differently. What happens over time is that underperformance erodes their morale; it erodes the teachers' belief that school performance is in their control, and they start saying, well I was very successful with the students I used to have, so it must be the students" (Sclafani, 2003, p. 45).

NCLB: Scientifically Based Research

Additionally, Title II, Part A, of the No Child Left Behind legislation calls for states' accountability that all children are to be taught by effective teachers using "research-based" practices (U.S. Department of Education, 2006). This legislation mandates that proven educational methods that are funded by the No Child Left Behind Act, must be proven to *work* through Scientifically Based Research or SBR (Beghetto, 2003). According the U.S. Department of Education:

> Ineffective teaching practices and unproven education theories are among the chief reasons children fall behind and teachers get frustrated. As a solution, the U.S. Department of Education recommends that a there needs to be a demand that instructional practices be evidence-based, and direct funding so only the best ideas with proven results are introduced into the classroom (U.S. Department of Education, April 2003).

Furthermore, "reliable research" or "research based practice" is composed of five essential components, including the scientific method used; the capability of being replicated; the ability to be generalized about; that it meets arduous standards; and the results of different studies arrive at the same conclusion (U.S. Department of Education, April 2003).

The Education Commission of the States (2008) defines Scientifically Based Research as

"research that involves the application of rigorous, systematic and objective procedures to obtain reliable and valid knowledge relevant to education activities and programs." Also known as "what works" in terms of effective teaching that is demonstrated by students' academic successes (Education Commission of the States, 2008).

In Margaret Trybus's opinion (2007), a reputable firm of independent researchers who follow a strict research protocol using an empirical method of an experimental design must perform Scientifically Based Research. The results must be valid, reliable, and be able to be reproduced exactly, and if retested (pp. 5-7), the SBR must:

> Rely on measurements that produce valid data across evaluators and observers; and
>
> Be accepted by a peer-reviewed journal or a panel of experts through a very rigorous scientific review.
>
> OR
>
> Pose significant questions that can be investigated empirically.
>
> Link research to relevant theory. Use methods that permit direct investigation of the question.
>
> Provide a coherent and explicit chain of reasoning.
>
> Replicate and generalize across studies.
>
> Disclose research to encourage professional scrutiny and critique. (Trybus, 2007, pp. 5-6)

Section 9101(37) of the Elementary and Secondary Education Act of 1965, also known as ESEA, as amended by NCLB, defines Scientifically Based Research (SBR) as "research that involves the application of rigorous, systematic, and objective procedures to obtain reliable and valid knowledge relevant to education activities and programs" (U.S. Department of Education,

2006). SBR provides reliable evidence and results that can be duplicated. It is not seen as a "trend," but as a tried and true practice that is proven to be effective and to *work* in the classroom (U.S. Department of Education, September 2003). Teachers must use only research-based teaching methods and the school must reject unproven "fads," i.e. textbooks and *chalk and talk* (U.S. Department of Education, February 2002).

However, there are some legitimate concerns with having the NCLB mandating SBR as being such an intricate component of the American educational system. According to Frederick Hess and Michael Petrilli (2006), authors of No Child Left Behind: Primer:

> The phrase "scientifically based research" appears more than 100 times throughout the No Child Left Behind Act and is applied to policies addressing reading programs, teacher training, drug prevention and school safety, and a range of other topics. Scientifically based research has no title or program of its own, but it is woven into the fabric of virtually every program in the law. As a result, this emphasis has potentially far-reaching consequences for both daily classroom practice and academic research related to education. In addition, by making the federal government a more active partner in determining what specific instructional methods should be approved for classroom use, NCLB also sets a new precedent of federal involvement in curriculum and instruction (Hess and Petrilli, 2006, p.94).

SBR focuses on very narrow ranges of performance and standards. These experimental designs fail to factor in numerous variables that are present in all schools. The SBR's data and conclusions are generalizations. They provide a one-size fit all research, to teach the masses. According to Liston, Whitcomb, and Borko (2007), SBR leaves no room for teachers' professional experiences and judgments, which may lead to teachers' resistance. Why would

they not resist a one-size fits all mandated plan of action for how they are to plan their curriculum? They are on the front line, day-to-day, and have a strong sense of how their students are struggling with the given material. A teacher's knowledge and experience could never be replicated in an educational experimental design. Therefore, one could assume that teachers would have difficulty accepting a teaching practice/theory that was a product of a quasi-experimental design, and having to implement it into practice.

If teachers had to interpret the research and/or data, it would be overwhelming, if not a completely a different language; especially if it was beyond the scope of any previous training they may have had (Liston et al., 2007, pp. 100-101). Liston et al. have suggested that in order for teachers to learn more about this new educational design, they would have to pursue additional professional training, and the states would have to mandate teaching colleges to incorporate understanding and interpreting SBR, into their teaching certification programs (2007, pp. 105-106). "Currently, knowledge of research design is not heavily emphasized in many discussions of the knowledge base for teaching" (Liston, et al., 2007, p. 105).

To conclude, it is interesting to note that Liston et al. recommends that educational reforms of the future should do away with mandating curriculum being evolved from SBR. Instead, the authors' believe that change and reform should be placed back onto the teachers. Specifically, Liston et al. recommend that:

> The field needs a coherent policy agenda that simultaneously addresses higher standards for all preparation routes, rigorous performance assessments for teacher candidates, improving the funding levels of teacher preparation to reflect the true costs of high quality preparation, incentives to recruit and retain candidates willing to teach in hard-to-teach areas, more rigorous evaluations of teachers in their initial years, and improvements

to the working conditions, particularly for beginning teachers (Liston et al., 2007, p. 105).

Following the same logic as that of Liston and colleagues, if teachers were better trained or qualified in administering their own assessments for each of their students, then it would be possible for teachers to identify the specific needs of their students. In turn, they could align the states' standards with their lesson plans, while using the most effective teaching methodology that would best suit the various learners' (meeting the students' previously identified needs) in their classes (Paige, 2002, pp. 711-712). It would be possible, in short, to do away with the SBR altogether. As a result, it would potentially free up funding that could be used in other areas, such as previously discussed, including as a financial boost for the poorer schools/districts, whose future seems to be set in a needless vicious cycle of "needs" and "consequences."

The NCLB Act of 2001 focuses on four main components: accountability, flexibility and local control; more parental choice; and increased quality of teacher/education (SBR). As previously discussed, NCLB has many strengths and was developed with good intentions for a better educational system for our children. It was established around the premise that all children will learn. However, it does have some challenges. For example, NCLB focuses its funding and support for educational programs that include English Language Arts (ELA), English as a Second Language (ESL), Math, and programs that target students from disadvantaged demographics. However, one of the major downfalls of NCLB is that the legislation is very weak on supportive measures for improving Science education and Science based programs in schools. The next chapter will investigate where NCLB misses the mark for Science Education, what academic improvements are needed, and why Science education is so crucial for our students, communities and our increasingly technological world.

Chapter Three:

The Correlation between NCLB and Science Education

"The most critical need of all...People are alarmed and thinking about Science, and perhaps this alarm could be turned toward a constructive result." President Dwight D. Eisenhower (Tenebaum, 2008)

Introduction

In the previous chapters, we learned the history of schools, education, and education reform. Over the last two hundred years, education was largely influenced by the demands of society. The actual education or learning environment component was secondary. Schools were to build productive members of the society. Colleges were viewed as a luxury for the wealthy or extremely intelligent. However, there was a significant shift in the 1960's when the public university systems flourished, the community college systems were established and spread across the country, and much of the cities' universities made their colleges accessible, without stringent admissions requirements. A college education could be attainable by the masses, due to major developments in student loan and grant programs.

The trends in education reform changed, when it become obvious that schools were failing to produce well educated young adults. This ushered in a period when completing a secondary education was not enough. Students, from all demographics, needed to further their education in college. However, they were not educationally ready for college. In other words, their previous education failed to provide them the skills they needed to pass entrance exams or be successful when taking basic college course levels.

We also have discussed previous national educational reforms in the past that tried to successfully address these issues. The latest, the No Child Left Behind Act of 2001, seems to be the most thorough reform of them all. However as discussed in the last chapter, it had

weaknesses in certain areas, such as Science education. We have seen that the introduction of new requirements in the elementary school system to revise the science curriculum as mandated by the No Child Left Behind legislation was based, in part, on a combination of revised thinking in general on how students learn best, combined with a political mandate to quantify the process of educating American children.

In this chapter, we will explore why science and scientific thinking arguably holds more relevance than ever for our nation's and the world's health and survival. This will include a brief review how science has been defined, as well as how science has impacted human history. In addition, the focus will shift to specifically the question of how the science curriculum was revised, based on the NCLB, and what more does NCLB need to support a stronger Science education in our schools? Specifically, what are NCLB strengths and weaknesses, and what are some plausible suggestions/modifications to make it more proactive in terms of students' success in Science education?

The Importance of Science and Being a Strong Scientific Thinker: A Brief Review

In general, the importance of science and scientific thinking has become increasingly meaningful as we enter the new millennium. In terms of science as a quintessential reality, it is clear that, by simply looking around one's room, there is ample evidence of the ways in which science is an intricate part of the very fabric of our everyday lives. For example, if one took a minute, and looks around the room it immediately becomes apparent that there are innumerable things related to Science. A watch on a wrist, a computer on a desk, the cars that pass by on the street, a tree providing shade on the grassy lawn outside; all of these are arguably part and parcel of the world of Science. It is in our homes, our neighborhoods, and our workplaces. However,

most of us take it for granted. Even if we do appreciate it, we probably do not understand it, or even find the time to do so. That may well be because Science can be intimidating. Equations, graphs, chemistry, DNA, and centrifugal force; all these can make even the most intelligent person become overwhelmed. This is not to imply that we, as a society, need to have a full understanding of everything there is to know about Science. However, it is important to not shy away from it, but to obtain a certain level of appreciation for it.

In fact, as we see, it is not even the end of the first decade of the new millennium and the economy and society are already unstable, in part due to vast scientific and technological changes that are critical for us to understand. Furthermore, we are witnessing serious Science related consequences from the previous century, in terms of our planet and ecosystem. Global Warming or the *greenhouse effect* has resulted in the reduction of polar caps, the depletion of the rain forest, the increase of the UVA and UVB rays, and indigenous animals, such as the polar bears, dying off because their natural habitat is literally melting away. We need strong Science thinkers to analyze and develop feasible and cost effective plans that could be accepted by the masses that would either slow Global Warming down, or if possible, reverse its damaging effects.

Another large concern we have related to Science is fossil fuel and the limited amount we have access to. On any given night, one can tune into one of the major cable stations, and he or she will hear some analyst discuss how the U.S. has a lot of fuel in its reserves, but it will not last forever. Some believe that we should be tapping into it now, while others believe that we should be looking for new drilling sites. Preferably, there is a third option, and this is where a strong educational background in the Sciences would be imperative. We need to develop an alternate source for fuel. It would have to be cleaner, better for the environment, safe, and have minimal

impact on the Global Warming problem.

A final example of why it is important to produce strong Science thinkers is that it would be good for our economy. In terms of NAFTA (North American Free Trade Agreement), there needs to be a better policy, plan, or strategy on how to bring the thousands of overseas contracted accounts back to the United States; where a policy like NAFTA would become obsolete or stringently reduced. We need to have the technology to build more state-of-the-art manufacturing facilities, where workers are safer, and the overhead cost can be reduced. It is important that something is done that supports and encourages the return of these jobs and accounts back to the U.S. to avoid future economic and environmental issues, such as contamination of pet food and toys made with lead based paint.

The Statistics

In the 2005-2006 school year, there were 96,143 public schools across the United States, and there were approximately 3,000,000 teachers educating approximately 48,500,000 students (Garoogian, 2006, p. 1440). Comparatively, in New York State there were 4,672 public schools, with approximately 210,000 teachers, educating 2,815,581 students (Institute of Education Sciences, 2006).

In 2005, a sample of 300,000 4th and 8th graders was selected to calculate the National average Science scores. The results showed that:

> At grade 4, the average Science score was higher in 2005 than in earlier years. The percentage of students performing at or above the *Basic* achievement level increased from 63 percent in 1996 and 2000 to 68 percent in 2005. Twenty-nine percent performed at or above the *Proficient* level.

At grade 8, there was no overall improvement. In 2005, 59 percent of students scored at or above the *Basic* level. Twenty-nine percent performed at or above the *Proficient* level (Grigg, Lauko,& Brockway, 2006).

According to The National Assessment of Educational Progress, in 2000 New York State's 4th graders scored better than the national average in Science. In 2000, 40% of New York's 4th graders were at the Basic level and 23% were at the proficient level. There was no data presented for New York 4th graders in 1996. In 1996, New York State's 8th graders scored just slightly behind the National average, and in 2000 they scored dead even with the National average. In 1996, 30% of New York's 8th graders were at the Basic level and 24% were at the proficient level. In 2000, 32% of New York's 8th graders were at the Basic level and 27% were at the proficient level. Statewide, the students in the 8th grade showed a slight increase in Science achievement since 1996 (IES National Center for Education Statistics, 2006). As previously discussed, one of NCLB's weak points is that it does not support the leaps and bounds Science education needs to improve scientific literacy in our schools.

What these statistics indicate is that, taken together, students nationwide as well as in New York State demonstrates some serious deficiencies in the area of science. This is turn provides the backdrop as well for why the NCLB legislation specifically included a mandate to overhaul the science education in this country. Before we turn directly to how NCLB attempted to integrate a revised science curriculum, it may first be helpful to briefly review a working definition of Science, as well as how Science has inaugurated some of the most important developments in world history.

What is Science?

According to the Merriam-Webster Online Dictionary (2008), the definitions of Science are:

- knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method
- such knowledge or such a system of knowledge concerned with the physical world and its phenomena : natural science
- a system or method reconciling practical ends

The study of science has been documented for almost as long as man has been a communal biped. The Ancient Egyptians believed in The Memphite Theology, which was written like a sonnet. It described the human anatomy as being closely related to things they found in nature, such as trees, plants, and animals (Allen, 1998, pp.43-44).

During the course of following centuries, Science thinkers and pioneers continued to explore, theorize, experiment, expand, and evolve their thinking of the vast areas that encompassed the subject of Science. Long forgotten were the ideals that included a tree limb, which was a scientific metaphor for a human arm. The greatest accomplishments and contributions to the field of Science happened during a span of almost three hundred years, referred to as the Scientific Revolution. Between the late 1400s and the mid 1700s, some of the greatest Science thinkers such as Isaac Newton, Francis Bacon, Galileo Galilei, and Nicolas Copernicus were making historic discoveries in the field of science (Halsall, 1997).

After the Scientific Revolution, science theories and discoveries continued to occur for the next two hundred years, almost at the speed of light. Lives were changed, mentally and physically, by these discoveries. How food was produced, manufactured, and stored had

changed. Medical breakthroughs saved lives, and even prevented some illnesses from occurring. Mental illness, which was once thought of as a person being possessed, was now being treated as a medical condition, and a person could regain a quality of life. In the past, one had to wait a week or so for correspondence from a loved one on another continent. Within the last century, correspondence can now happen with a click of a mouse. In addition, not only can one "talk" to his or her loved one as if he or she was sitting in the same room, but one can actually see his or her loved one live (in living color). All these were made possible because of Science and strong Science thinkers, such as Benjamin Franklin, Louis Pasteur, Charles Darwin, Jonas Salk, Albert Einstein, Marie Currie, Sigmund Freud, Stephen Wozniak, etc. (Halsall, 1997).

Although the immense field of Science and Technology education was growing all around the world, it had reached a disappointing plateau in the U.S. schools. On November 3, 1957, the Soviet Union successfully launched their first missile, Sputnik, into space. This was only a few months prior to the U.S. launching of their first rocket, the Jupiter-C, on January 31, 1958. However, when the Soviet Union beat the United States in the race to space, this caused President Eisenhower and his Scientific Advisory Committee to review the situation. Eisenhower's Committee feared that, in the midst of the Cold War with the Soviet Union, the launching of Sputnik made the Soviet Union appear to be superior in the areas of mathematics and science, and that they were at least 10 years ahead of the U.S. in those areas (Tenebaum, 2008).

In order to catch up to the Soviet Union, Eisenhower knew that our schools needed to produce students who had a stronger Science background. According to David Tenebaum (2008), a Science historian, Sputnik did not initiate the debate in the United States about the quality of schooling, but it did fuel the movement for curriculum reform. In 1958, the National

Defense Education Act (NDEA) was passed. This law allocated one billion dollars for "college student loans, scholarships, and scientific equipment for public and private schools (Tenebaum, 2008). This law emphasized an increase and improvement of Science education standards at all academic levels. NDEA was unprecedented. Before this, education in the United States was largely left to state and local authorities (Tenebaum, 2008).

NCLB: Science Standards

As previously discussed, under the No Child Left Behind Act of 2001, schools are now held more accountable for the academic performance of their students, thus raising the overall bar in education. The Act clearly specifies that, "Federal funding will be targeted to support programs and teaching methods that improve student learning and achievement" (U.S. Department of Education, September 2002).

There are twenty-eight programs within the Department of Education and eighty-seven programs throughout the United States Government that provide funding and support for teacher training (U.S. Department of Education, 2006). This policy not only demands having better-trained teachers, it also demands that eventually *all* teachers will have to have stronger backgrounds in Science. The NCLB Act recommends that the states need to provide training courses throughout the school year and summer to help increase teachers' proficiency in Reading, Math, and Science. In addition, the Act recommends that all teaching colleges should amend their training programs in order to produce more teachers with stronger Science backgrounds and teaching skills (U.S. Department Education, February 2002).

The No Child Left Behind Act of 2001 requires the states to have more teachers who are highly trained and experienced in Science (U.S. Department Education, February 2002).

How is this supposed to be accomplished? For example, New York State's Science standards are lumped together with Math and Technology. There is not a lot of special attention to the development of Science specific skills. According to the New State Academy for Teaching and Learning, there are seven general standards for Math, Science, and Technology or MST. They include Analysis, Inquiry, and Design; information systems; Mathematics; Science; Technology; interconnectedness: common themes; and interdisciplinary problem solving (Appendix 2.0) (New York State Education Department, September 2008). Each grade/skill level, elementary, intermediate, and commencement, has their own set of achievement/proficiency objectives for each of the seven MST learning standards. For example, each level is expected to master their designated learning objectives for *Physical Setting,* as described under NYS Learning Standard 4 for MST (New York State Education Department, 2001). At the commencement level, the learning objectives are subdivided into more complex areas of Science, such as Earth Science and Physics.

As previously discussed, NCLB imposes accountability through assessments on the states, in order for the states to continue to receive crucial federally funded initiatives and rewards. In New York State, the assessments used to test science proficiency are State regulated standardized exams. In other words, every student takes the same exam. Students are tested for Science proficiency at the elementary level with the Science Elementary Science Program Evaluation Test (SESPET) during the fourth grade; and for the intermediate level, with the Intermediate Level Science assessment during the eighth grade. Before a student can graduate, he or she must prove that he or she meets New York State's Science standards by passing the Living Environment Physical Setting; Earth Science Physical Setting; Chemistry Physical Setting; and the Physics' examinations (New York State Education Department, August 2008).

Science: Left Behind?

As stated previously, science is an all-encompassing subject. Science involves English Language Arts (ELA, which includes reading and writing), math, art, technology, and social studies. As will be discussed in this position paper, many experts believe in the benefits of teaching/learning good science *skills* early on. Students are more likely to link the continuity among the other diverse disciplines, identify the consistency of information processing, and relate their academics to the real world. Students, who are taught to be strong scientific thinkers, have higher self-esteem and self-confidence. They are more resourceful and successful throughout life. They are able to generate their own answers, and formulate creative solutions when encountered with a problem-solving situation. Individuals who are *strong thinkers* are less likely to cave to peer pressure, partake in deviant behavior, and remain within negative societal imposed roles.

When certain key elements are present within a learning environment, students, spanning across a diverse gambit of needs, will have more opportunities to be successful, which can complement NCLB's learning objectives. Educators, at all levels, can facilitate the students' success with science. In the next chapter of this paper, specific teaching strategies that are proven to be effective and can be applied to successfully teach science to any student, will be explored. Furthermore, students will have personal and academic successes and have less chances of being *left behind.*

By 2005, the No Child Left Behind Act of 2001 proposed a requirement that the states were to would have more teachers that were highly conversant and experienced in Math and Science (U.S. Department of Education, February 2002). The policy proposed that:

No Child Left Behind creates Math and Science Partnerships to rally every sector of

society to work with schools to increase math and science excellence.

The National Science Foundation and the U.S. Department of Education will provide an estimated $1 billion over five years for results-oriented partnerships between local districts and universities and colleges.

Partnerships will also invite businesses, science centers, museums, and community organizations to unite with schools to improve achievement.

The program also rewards states for increasing participation of students in advanced math and science course and for increasing the passing rates on Advanced Placement exams.

To ensure accountability, the Partnerships must report annually to the U.S. Secretary of Education on progress in meeting their set objectives, aligned to state standards.

(U.S. Department of Education, February 2002)

According to Raymond Bandlow (2001), a researcher in U.S. education, reforms in the past have included going back to the basics, decentralizing governmental control, creating charter schools, dispensing vouchers, upgrading teacher-training, and making graduation standards more intense. Bandlow also identified the revamping of reading programs, the reduction of class size, the addition of a class period to the school day, tracking students by ability, and what he refers to as other methods of *piecemeal reform* (pp. 69 & 71).

There has been a dire need for teachers who are competent and effective in teaching Science. In President Bush's legislation, No Child Left Behind, the policy states, "America's schools are not producing the science excellence required for global economic leadership and homeland security" (U.S Department of Education, February 2002). It is pertinent that schools need to "fill the nation's classrooms with teachers who are knowledgeable and experienced in Math and Science" (U.S Department of Education, February 2002).

Bandlow recommends that instead of mandatory national standards using scientifically based research curriculum materials for Science, the standards should ensure that teachers have more in-depth Science backgrounds. Furthermore, the government can force textbook publishers to develop more organized and meaningful textbooks that provide more subject quality and not quantity (Bandlow, 2001, p.72). Students need to be taught at a deeper level of understanding, rather than a superficial one, which is oftentimes the result of a vast range of topics teachers try to squeeze in year-to-year (Bandlow, 2001, p.70). Bandlow also recommends that for a deeper understanding, students need to be taught topics that are interrelated, which can be built upon as the years pass. Just reviewing topics, year after year, is a waste of valuable instruction time (Bandlow, 2001, p.71). "Standards must be organized by school year for coherence and consistency" (Bandlow, 2001, p. 71).

Around the turn of the century, there was significant proof, according to the National Assessment of Educational Progress, that our students were poorly proficient in the understanding of Science. Furthermore, their overall success of learning the Science *basics* were negatively reflected in their Science achievement scores. In addition, in a world that is becoming more technologically demanding, these students are at a great disadvantage (Anonymous, February 2002, p. 2 & Moreno, 1999, p. 569). Michigan Representative Vernon J. Ehlers, observed that, "the best long-term solution is to improve education in the sciences", which would result in "...better preparing students for careers in technical fields" (Anonymous, Summer 2000, p. 26). Furthermore, we do not need every student to go on to college to become physicists. However, we need to produce more Science literate individuals who are able to read the articles, vote responsibly on Science related issues, and have a basic understanding of some technology (Jemison, 2000, p. 3).

According to Jeffrey Weld, a Ph.D. candidate of Science Education at the University of Iowa (1997), students in research-supported classrooms cooperate, collaborate, and challenge each other en-route to conceptualization of ideas. Meanwhile, questioning their own beliefs, essentially a first step in modifying their interpretation of the world (p. 15).

How can this be done? Weld believes that there needs to be more of a push for Science literacy (1997, p. 14). "Scientifically literate adults who are experienced at posing and framing questions, discussing strategies, acting upon reasonable hunches, and communicating results to build a consensus are valuable contributors to society" (Weld, 1997, p. 15). This would involve a drastic shift from the "content-driven approach", lecturing, reading from a text, memorizing, and verifying through labs; to shared problem solving: questioning, investigating, and discussing scientific phenomenon. Furthermore, the "content-driven approach" does not produce strong, scientific thinkers. Students should be able to arrive at their own conclusions. This aids students to have *ownership* in their own learning (Weld, 1997, pp. 14-15).

Science is very multifaceted. It encompasses many things from nature, to molecules, to combustible engines, to psychology, to computers, etc.. Science in itself can be used as a method of learning, and it is a way of being objective and subjective all in one. Science is a frame of mind, and can be used as a way of training one's mind to automatically problem solve, to see the forest through the trees, per se. If taught correctly, then students can effectively analyze a problem, make a hypothesis, test it, conclude from it, and test their conclusions for consistency. If they were able to successfully practice this process enough, then it would become second nature to them. Once they have mastered this process or way of thinking, they can apply these skills to other aspects (academic and nonacademic) of their lives, such as conflict resolution, peer pressure, and other moral judgments, etc. All children need Science knowledge

and an understanding of scientific ways of thinking in order to function in a communication age (Bohning et al., 1999, p. 143).

NCLB and Science Education

In President Bush's No Child Left Behind Act of 2001, there are provisions for Science education advancements, as discussed above. NCLB discusses partnerships with Science related businesses and organizations to work with the schools in enhancing their Science programs. NCLB also wants teachers to develop their curriculum from data collected through SBRs. Initiatives were also established for teachers with strong Science backgrounds; schools whose AYP reports show improvements/progress; for having students in advanced science classes; and an increase in passing rates in Advances Placement exams (U.S. Department of Education, February 2002).

These are great provisions, but more improvements needs to be made. The No Child Left Behind Act of 2001 is not descriptive enough in what improvements should be made in order to improve Science education. Simply collaborating with Science *professionals* from the community is not enough and can be problematic. Who has the time? Teachers at the elementary level, for example, already are responsible for curriculum development for other subject areas. When would these collaboration meetings take place? During planning time, during the time teachers spend with students working one on one, or during the times when the teachers are suppose to fulfill their other faculty obligations?

In addition, according to the legislation, the Mathematics and Science Partnerships (MSP) (Title II, Part B), are to design programs for grades Kindergarten through eight. What about the secondary grades? At the secondary level, students are learning more intense and

specialized Science subjects. Furthermore, NCLB does not specifically mandate that lessons involving MSP must be developed through SRB. NCLB does recommend that school districts recruit "science and engineering majors into teaching." How will these individuals be trained and certified to teach? According to NCLB, these Science and engineering majors will receive their teaching training through distance learning and mentoring programs. It seems that these individuals would be at a major disadvantage. They would miss out on the learning (including the various effective teaching methods), training, and guided hands-on experience that can only be obtained while working with a teaching university (U.S. Department of Education, October 2002). In addition, seasoned teachers are being encouraged and rewarded to pursue further professional/educational development, under NCLB.

NCLB has established initiatives and rewards for schools and teachers who have a strong background in Science. However, there has been some concern that there has been a decrease in Science teachers to "handle the higher enrollment rate and replace the aging teacher force" (Bohning et al., 1999, p.143). Science can be an intimidating subject. It takes a lot of thinking, inquiring, patience, reasoning, planning, and studying. Combined with having to teach all those skills to students, this can be a very daunting task for already over burdened teachers. According to Bohning, teachers have a legitimate anxiety about teaching Science, especially new teachers. In addition, the more intense and detailed the content, the more anxious the response the teachers had towards teaching Science. The researchers found a high rate of career changes for first year teachers. According to Bohning et al., "it is the responsibility of the university educators to integrate contemporary views of teaching science into preparation programs of prospective teachers" (1999, pp. 143-148). If teachers have concerns or anxieties about teaching Science, then it will reflect in infrequent and inadequate classroom instruction. In turn, these concerns

can transfer to the students, and carry on with the students throughout their academics lives (Bohning, 1999, pp. 146-47). In addition, Science literacy, including the understanding and application of Science, should begin in the earliest grades. Students should also be taken beyond recall and abstract, and work with more concrete evidence and scientific information gained through experiments and inquiry (Gallagher, 2000, pp. 310-312).

Is it possible that our government also has anxieties and concerns about Science? NCLB's plan of how to get the United States' educational system on track towards educational supremacy, and the provisions it has made pertaining to Science, have been previously discussed. However, there are a lot of undefined areas (or the areas left behind) in the law. Under NCLB, the states are responsible for establishing their own standards, assessments, and AYP reports pertaining to Science. All the federal government requires is that each state has each of these factors in place, report their Science AYPs, and that the states' scores must reflect growth and/or improvement. This can lead to variance and unfair comparisons among the states. It would be more pragmatic to have a nationwide set of Science standards, assessments, and AYP reporting procedures. This would help maintain consistency and reliability of SBR from state to state, which will be discussed later.

NCLB also does not specifically outline what is expected of teachers as far as teaching certifications and educational/career development. It just recommends that there will be rewards and initiatives for teachers, schools, and universities, if they improve their Science training endeavors, placements, hiring, and mentoring. In addition, teacher quality also varies state to state. Why does New York have to be one of the toughest states to receive a teaching certification? "States are indeed obligated under NCLB to ensure that teacher qualifications are distributed equitably" (Learning Point Associates, Quick Key 8, 2007). Why don't all states

integrate the same or very similar, strict standards and qualifications as that of New York State? Why cannot governmental educational reforms such as NCLB, make more uniform, nationwide standards, where their expectations are clearly outlined? NCLB identifies a direct correlation . Why not offer more specific and feasible solutions that can produce and put better quality teachers in our schools? NCLB does not make clear, "exactly which set of teacher qualities and qualifications subsequently raises student achievement and narrows achievement gaps" (Learning Point Associates, 2007).

As stated above, NCLB does not specifically mandate the use of SBR in developing Science curriculum. The legislation provides an overall general recommendation that learning curriculum should be developed by SBR. However, SBRs can often be more problematic than beneficial. Anyone who has taken a basic research class at the undergraduate level knows how regimented, controlled, and precise a research study must be. The slightest change in one variable can invalidate the entire research. By imposing SBR on curriculum development, though a proactive idea, will only compound already over vexed teachers. Furthermore, who will be held accountable for a Science curriculum that does not match or work with your classes?

The most obvious issue is that what may work with one group, may not necessarily work for another. Children are the most uncontrollable subjects to study/research. There is a plethora of unknown variables. A Science curriculum for a class of approximately twenty-five, which may have worked in a small rural town for the last five years, may not be as successful in another rural classroom of twenty-five students. Why? The differing variables could include income, gender ratio, number of single parents, religious beliefs, environmental factors, and an increase in behavioral problems, etc. This is not to say that at its core, the research behind the curriculum is not useful. It just seems very implausible that an SBR cannot be implemented without some

sort of professional wisdom. Going back to my previous example, the teacher in the second rural class may have to adjust the curriculum to fit the specifics of his or her class and their underlying factors and influences.

According to Public Law 107–110, No Child Left Behind does not specifically state who is designated to perform the scientifically based research. For example, under 115 STAT. 1439, Sec.1605 (3):

> ...describe how the local educational agency or consortium will provide technical assistance and support for the effective implementation of the comprehensive school reforms based on scientifically based research and effective practices selected by such schools (National Clearinghouse for English Language Acquisition, 2002).

A Scientifically Based Research or SBR can be a result of a program used in a school, which has had consistent positive outcomes in students' achievements. SBR can also be administered by an independent testing/research firm. Either way, it still needs to meet the NCLB's qualifications. However, another issue is that experiments may reflect a kind of researcher bias. It is common that a researcher wants the research to reflect the desired results, especially if this is an independent firm hoping to make a profit. SBR's results are supposed to be reliable and duplicable upon retesting, but again, students do not make the best control groups (Learning Point Associates, Quick Key 7, 2007).

One should also consider if the SBR was based on a quasi-experiment or full scientific experiment. The researcher might obtain results that are more accurate if he or she uses a full scientific experiment versus a quasi-experiment, because the subjects used were randomly chosen. This allows for more unbiased, real results, and it will have the highest probability for the widest representation of the targeted group. Using a quasi-experiment, a researcher can

narrow down the subject group, which may also sway results in one way more so than another. It is important that upon receiving these reports and data, that information is included.

Finally, SRB is supposed to be scrutinized and retested for reliability and validity. Who does this? NCLB omits this very pertinent information. Is it the agency/firm or school district in which the research was performed? There seems to be too many questions and concerns with proposed solutions of this legislation. NCLB gets an A_+ for identifying the problems with our nation's educational system, but gets a C- for its remedies of the problems.

NCLB needs to use more specific language on how teachers will become more qualified, and map out a national set of standards for teaching certifications for elementary and secondary levels. There needs to be a clear, precise set of standards, assessments, an AYP reporting system that is nationwide, and a better guarantee that the funding for MSP will ensure student achievement in Science education. In addition, Science teachers are also responsible for effectively integrating technology into their curriculum, which means that their continued training in Science will also include technology. If NCLB is going to make it through the next administration, this law needs to get off the fence and make a precise, clearly written language on some of these issues.

To summarize, research shows that not all students learn the same, and this will be discussed more in the next chapter. If we know this, then why try to teach students using cookie cutter methods? It seems very improbable to administer a curriculum from SBR, from beginning to end, without one instance of professional wisdom intervening. Instead of SBRs, what if teachers submitted their completed curriculums to educational professionals for suggestions, standards updates, and other modifications/recommendations? SBR cannot replace all the experience that every teacher gains, with all the students taught, in every classroom, across the

nation.

In the next chapter, we will discuss how valuable teachable moments are in a classroom. In addition, it will be discussed further that NCLB's idea of *what works* does not have to base on research alone, but on the experience of teachers and great theorists who have dedicated their lives to studying the various developmental schema of children. The next chapter will explain and give evidence to that by integrating these *theories* into their teaching styles/methods and curriculum, teachers can be very successful at reaching and teaching their students, and their students' differing individual learning styles and needs. All children have the right to learn. All children can learn. All children learn differently.

Chapter Four:

The Science of Successfully Teaching Science

Chinese Proverb: "Tell me and I'll forget;
Show me and I may remember;
Involve me and I'll understand."

Introduction

As we have seen in the preceding chapters, The No Child Left Behind Act of 2001 has been criticized on a number of fronts. One of the problems that have been identified is that, as it is presently written, it is too vague in its language. A second problem is that, as it now stands, it imposes too much responsibility on the states to enact the legislation without enough resources, which in turn puts too much pressure on individual schools to raise the test scores without enough material support. A third problem, which relates to the first two issues, is that, as it has been initially crafted, there is no unified, systematic standards which have been set up which would measure all schools uniformly. Instead, each state has been left to come up with their own learning standards, which are arguably widely divergent one from the other. A national policy would aid in alleviating any of these variances among the states' in terms of their standards. At the federal level, the general educational standards' policies could be established. In turn, the individual States would be responsible to translate these standards to what best *fit* the demographics of their target population.

It would be possible to have a National Standardization of Educational expectations or Learning Standards. However, to address the inconsistencies of states' testing, assessment measurements, and AYPs, the federal government could include standardized these, as well as a comprehensive nationwide standards system. Again, this does not mean that there would not be some kind of allowances made for differences based on demographics of the varying target

population of the students. In addition, in all likelihood, there would be a range of standard deviation of achievement rates among the States and districts. Nevertheless, by having some kind of national learning standards system, the pressure on individual schools to come up with their own interpretation of the vague language of the legislation would be eliminated. Essentially, all the students in the US would learn the same material, in the same grade levels, but be taught the material in different contexts and in diversified, demographically relatable lessons.

To summarize, while there is a need, then, for both standardization in terms of measures by which to judge all students that are nationally agreed upon and recognized, as well as some kind of standardization in terms of the material that will be learned and subsequently tested on, this does not mean to imply that there should be only one uniform way of teaching these students this standardized curriculum. This is where individuation comes into play. Though it may well be important to have some kind of universal content and universal measure of evaluating whether that content has been learned, it is equally important to advocate for a variety of learning strategies to implement the national core curriculum.

As we move forward, then, in trying to revise and implement the goals of the legislation, a seemingly simple, yet key question may be asked: what is the best way to teach students science? Moreover, perhaps more importantly, who decides how students may best learn the material? The focus of this chapter will try to address this central question, by exploring the designs comprehensive learning programs and environments for teachers to help them implement the goals of NCLB. At the same time, this chapter will also evaluate the efficacy of these various models, and will return to the fundamental question of what might be the most appropriate and successful strategies for teaching science to young people? What has worked,

and what was the basis of this success? Are the independent groups that perform SBRs really on the pulse of contemporary American Education?

For example, one research group, The Institute for the Advancement of Research in Education (IARE) has developed a software line that correlates with many of the States' learning requirements, called "Inspiration." Inspiration has different software programs that were developed to complement teachers' curriculum, and is available by individual subject and grade level. IARE promises to provide students with all the resources and information they will need to meet the proficiency standards for each subject, by each grade level. Through SBR, IARE bases their programs on developed visual lessons that increase "thinking and learning skills such as organizing and communicating ideas; seeing patterns and relationships; and categorizing ideas", which research proves increases information retention (The Institute of the Advancement of Research in Education, 2008).

As we have seen in earlier chapters, one of the problems SBR curriculums is that, once they are put into a live classroom context, they are less effective than their initial design would suggest. Even though the research and design of the curriculum was tested over a period of five years, there is no guarantee that is going to hold up in every classroom, across the country. Thus, while these curriculums had the advantage of trying to standardize the content that all students would learn, they fell short in terms of the question of how best to implement that curriculum, based on specific learning needs and styles.

One argument that can be made is that what is missing from these earlier attempts at designing a standardized curriculum is that there was not enough input from teachers, who were themselves grounded in their classroom experiences. These teachers have the irreplaceable advantage of *knowing* the students from their colleagues and working in the same school as their

students, past and present. It would seem more pragmatic for legislators and policymakers, i.e. NCLB, to draw on the insights of teachers, who can provide an endless source of knowledge and strategies for implementation of this standardized curriculum.

as a vehicle for successful implementation of curriculum. When I was working towards my teaching certifications, I had to complete many hours a week in actual classroom, doing observations. Every semester that followed, I was given more responsibilities in the classroom while completing my weekly hours, in terms of direct student teaching. At the same time, I also had college classes to attend as part of my degree program, but in retrospect, it was the hands-on experience, working with an actual teacher, that made the learning experience more enriching for me. I do not think that I could have had the same training or learning experience if it was done in a classroom only, or by a regimented curriculum that expected me to learn to teach by a script or a playbook like a football coach would use.

This chapter is going to explore effective teaching strategies that have the most potential in terms of successfully implementing a core Science curriculum. These strategies are arguably effective because they align with students' natural mental and physical development; they are versatile and can be adapted to multiple learning styles and intelligences. Most importantly, these learning/teaching strategies can be implemented when teaching Science. The NCLB legislation has arguably been least successful when it comes to the subject of Science, compared to the more in-depth provisions for ELA and even Math. This relative lack of attention and success in Science may be because Science is perceived in some respects as more difficult to teach. Yet, as I have tried to demonstrate in earlier chapters, there is more need for creative scientific thinking than ever, given the challenges that we as a nation, and even planet, face.

The focus of the rest of the chapter will consist of itself a kind of thought experiment and a concerted effort to "think outside of the box." I will draw on my various prior readings in the area of effective teaching strategies to engage in a creative exploration of some of the "best practices" that master teachers have come up with to make learning a more enriching experience. The goal of this chapter is to also model some of the ways that a core curriculum can be taught, by drawing on a number of successful teaching strategies that have arisen in the wake of earlier critiques of traditional teaching methods.

Imagination and Learning: An Informal Discussion

I would like to begin this section with a brief thought experiment. Think back to when you were a child. Do you remember the day the deliverymen delivered your mother's new refrigerator? This was an exciting time in any child's life. Who cares about the new *refrigerator*, you were probably more excited about the *box* it came in. You would spend hours those first few days playing inside it, because that simple box became your clubhouse, spaceship, or somewhere to have teatime with you dolls. However, you soon became bored with it. The *box* did not have that much potential, because after all it was just a *box*. How much fun can you have with four walls and a ceiling, in a space smaller than your dog's house? Playing in it became confining and monotonous.

Now take those same feelings, and think about what it was really like to be in elementary school. Think about being in a classroom, a *box* the size of your garage, sitting among five or six straight rows, reading word for word from your Science textbook. Your only salvation was if you sat near the window, because at least could pass the time daydreaming out the window, wishing you were in a car that passed by. Maybe if you were in that car you could go to a local

apple orchard and see firsthand how an apple tree grows from a seed and where cider comes from; versus reading about it in your two dimensional textbook.

Let us switch gears here. Take sixty seconds and make a list for all the possible uses for a tire. Looking over your list, you would have to agree that a tire is a versatile object. I was asked to do this as a *brainstorming* and *creativity* exercise in one of my teaching classes in college. Most of the students were able to list at least five ideas: Sandbox, swing, obstacle course, playground tunnel, and a flowerbox. I, on the other hand, was able to come up with at least seventeen ideas. Here is my list:

Playground tunnel	Swing	Flowerbox
Mosquito breeding ground	Buffers for a dock	Obstacle course
Ladder (linked together by chains)	Something to roll down a hill in	
Compost for food	Weight for tarps (popularly used at farms)	
Grounded for horse pen	Grounded and processed for athletic tracks	
Recycled into newer tires	Buffers at race tracks	Sandbox
Something to bounce on	Weed deterrents around trees/landscaping	

My point is that students need to be able to expand one's mind past its own limitations. Everything is not just black or white, but many shades of gray. I believe that *this* is a key component in learning, one that can be nurtured by a teacher who has incorporated this practice into his or her own style of teaching. However, a teacher who remains limited within his or her own creativity will have similarly limited success with their students. Simply put: creativity generates creativity.

How is this accomplished? Legislators, Boards of Education, Superintendents, Principals, and teachers should shift their focus around such teaching strategies as "chalk and talk," "round robin," and "two-dimensional textbooks." They should be replaced with strategies such as "multi-sensory," implementing thematic units, and inquiry-based thinking. Learning should be interesting, thought provoking, continuous, pertinent, relatable and something that can

be built upon. These practices are what develop diverse and strong thinkers, thinkers whose minds, learning, and imaginations/creativity extend beyond the classroom.

Creativity and imagination are key components in learning such subjects as Science. Therefore, they should be cultivated and encouraged to grow throughout a student's various academic experiences. Rubrics, for example, are becoming a popular measuring tool for assessment/grading. Would students not get more out of a learning experience if they could also be evaluated for their creativity and/or creative interpretations of the material, in addition to their standard demonstrations of knowledge?

Thematic Units: It is All Elementary

The first step before trying to teach anyone anything is to gain his or her attention by sparking his or her interests. Common sense tells that if a child is interested, then he or she will learn; and not only will he or she learn, but want to learn and enjoy learning. Engagement is one of the most important keys to learning. By engaging a student, one is encouraging him or her to become an active learner. Teachers can engage their students by relating what the students find as interesting to what they want the students to learn. Students learn best, when they can relate to or find purpose in what they are learning. However, engaging students can be a difficult task (Sizer, 1992, p.163). Previous teaching strategies, such as "chalk and talk" and textbook centered lessons have failed because they do not grab the students' attention or provoke their interests. Learning becomes work, boring and painstaking. However, students who can recognize there is a purpose are more likely to engage themselves into learning (Sizer, 1992, p. 108).

Think back to when you were in school. Remember this dreadful phrase: "Okay class.

Get out your Science books. Open to page 110. We are going to read the next 20 pages about centrifugal force." Be honest. What you really heard from the *"Okay class..."* to the end of that lesson was *"Blah, Blah, and Blah"*.

However, in a parallel universe:

"Okay class. We are going to spend the next couple of days, working with different colored objects. Today, we are going to glob four different colors of paint in the center of a piece of white board. Let's put the white board on a pottery wheel and see what happens." " Why do you think this happened?" " When we are done we will write about our findings in our journals." " How many colors do we have again?" Let's count them together." " What are the names of these colors?" " What other things are yellow?" " How many things can you name that are yellow?" " Where do you find bananas?" " Let's be authors and write a book about different things that are yellow."

The above illustration depicts a thematic unit (or a curriculum) centered on colors. Students are taught the names of colors in Kindergarten. Most students, however, know the names of colors even before Kindergarten. Colors are all around us. Colors are something that students are familiar with and have a lot of intuitive knowledge about. Their previous knowledge on the subject gives them something to build from. Furthermore, colors are a topic that students can easily identify with (Barrentine, 1999, p. 277). When students are able to relate to a topic, they feel confident and thus, more willing to learn (Randle, 1997, p. 85). Thematic units, such as colors, help bring these objectives into light, and helps students to feel successful.

Thematic units are not only beneficial for triggering the students' interests, but can also be a way to connect various subject areas (Barrentine, 1999, p. 276). In conventional classroom teaching, mastery is usually viewed in terms of mastery of discrete "subjects" (Sizer, 1992, p.

80). This does not allow room for individual creativity. Educators like Theodore Sizer believe that subjects are very rarely interrelated in a conventional classroom setting, and thus only provide fragments of somewhat useful knowledge for the students (p. 81). In his view, schools should instead identify their main goals as "education of the intellect" and "an education in character" (Sizer, 1992, p. 84). In his reading, the traditional curriculum or subjects are irrelevant, because in most cases, they do very little for character building or the education of the intellect. Connecting the various subject's matters, however, and seeing how they are tied to individual and collective human action, on the other hand, can help to realize these dual goals.

Thematic teaching has been defined as "...involving planning and implementing cross-disciplinary, developmentally appropriate learning opportunities... ...that causes children to interact, inquire, experiment, problem solve, read, and write" (Barrentine, 1999, p. 277). Thematic teaching has also been believed to encourage high-order thinking (Van Deusen and Brandt, 1997, p. 21). Higher order thinking included critical thinking, analyzing information, and problem solving information. The more intensive the high-order thinking, the more motivation and participation is needed from the learner (Krathwohl, Bloom, and Masia, 1968, p. 77). If this is performed in an environment where the presentation of the information has minimal distractions and interference, and one where open communication can occur, where ideas can flow between students and the teacher, then students will be more willing to receive new information (Krathwohl et al., 1968, p. 78).

Clues are important in learning and reinforcement of the information (Krathwohl et al., 1968, p. 61). According to Krathwohl et al. (1968), using the word "right" is an effective response and teachers should keep feelings to themselves. Instead, teachers should be encouraged to use more proactive and objective responses that promote students' confidence as a

learner (p. 61). The goal here is to develop a plan that encourages students to be stronger thinkers. Strong thinkers are able to analyze, synthesize, and evaluate ideas and problems effectively (Krathwohl et al., 1968, pp. 19-21).

Thematic units not only appeal to the students' interests, maintain a continuous flow among subjects, and encourage higher-order thinking, but they also help students to make a link between what they know and what they are learning, to the outside world (Randle, 1997, p. 85). This is very important. It is also just as important when developing a thematic unit to keep the age and academic level of targeted students in mind. Furthermore, the theme should be relevant to the students' background.

For example, how successful would a teacher be to teach a curriculum around the theme of Farm *Life* to a class of inner-city students? How does farm life pertain to the students' everyday lives? How would they be able to relate to it if most of them have most likely never seen or even been on a farm? A teacher would be more successful in developing an integrated curriculum or thematic unit around a zoo, circus, or a carnival, things that may be readily available or occur in the students' geographic location. "All students can remember relevant information better than irrelevant information, and using thematic units and activating prior knowledge can make learning more meaningful" (Watson and Houtz,2002, pp. 269-270).

In conclusion, with the advancements in technology, computers and more specifically the internet, **thematic units** can transport lesson plans and the students in completely new dimensions, with deeply enriched learning experiences. According to Toriskie and Hall (1999):

> Creating ***thematic*** unit is easy using the wealth of information on the Internet. Start with a topic that students like and weave it into whatever concepts and skills that the curriculum requires. Watch the students take off into researching and learning even

> more than you expect, and loving every minute of it. The reason for this burst of student enthusiasm is intuitively -- that ***thematic*** units help students learn. These units accomplish this feat by providing a mental framework to which students can attach new learning and concepts. In addition, ***thematic*** units are an obvious departure from the drudgery of plodding through a text or workbook (p.58).

Maybe it could be possible for a class in an urban neighborhood to witness what farm life entailed? Alternatively, it also could be possible for a class in a rural area could learn about the hustle and bustle of the city-life, almost firsthand?

The Lessons of the Multi-Sensory and Multiple Intelligences Approaches: Successfully Responding to Individual Learning Styles

In part two of our thought experiment, imagine that we have now developed a theme that has our students intrigued, and implemented a curriculum that integrates various subjects. The students are enjoying our thematic unit because it is something they are able to pull from their own background knowledge. They can also apply it to their own "worlds." They are feeling confident. Learning has smooth transitioning from one subject to another without the disruption of changing "gears," or becoming overwhelmed from various unrelated facts trying to be digested in the same six-hour day.

The next step is to ensure that every student can "get it." In other words, is every student given the opportunity to learn? How is this done? First, we have to accept the fact that lecturing alone is an ineffective teaching strategy (Baker and Beisel, 2001, pp. 28-29). Students do not want to hear about colorful things, they also want to see them too. Second, we have to get away from using textbooks as the 'primary survival tools" for our curriculums. Fifty-nine percent of

teachers still use textbooks as the basic pillar of their lessons (Huber and Moore, 2001, pp. 33). Students do not want to just to observe the colorful flowers. Why can they not smell and touch them too? Children instinctively use all their senses to discover and explore things in the world around them (except in school?). For example, infants love to look at objects and grip them in their hands (which after awhile goes right to their mouths). They love rattles for the noises they make. Look at the toys and activity centers developed for babies. They have objects and gadgets that appeal to all the senses. They stimulate the baby's curiosity and exploration (and motor skills). These devices are the baby's first learning tools, and they are multi-sensory.

Most importantly, teachers have to identify and teach by the belief that not every student *learns* the same way (Collinson, 2000, p. 42). Our brains process things in their own way. The brain draws on many different associations when processing information (Scott, 2000, pp. 328). Some people process information better through audio perception, some through visual, and others through tactile; and some through a combination of all three. Therefore, everyone has his or her own way (strength) in learning new information or learning style. A learning style is how an individual gains, interprets, internalizes, stores, and recalls information (Collinson, 2000, p. 42). On the average, "children retain 24 percent of what they hear, 40 percent of what they see, and 70 percent of what they learn through multi-sensory experiences" (Collett, 1991, p. 42).

We have five senses: Seeing, hearing, touching, tasting, and smelling. Multi-sensory learning is a learning style that primarily uses three out of the five main senses: *Seeing* (visual), *Hearing* (auditory), and *Touching* (tactile or kinesthetic). Most teachers put more emphasis on visual and auditory components of learning in their lessons. However, "tactile stimuli can be used to focus attention on and illustrate auditory concepts through concrete experiences" (Miller, 2002, p.5). Furthermore, "physically manipulating objects assists children in focusing their

attention, memorizing information, and developing the capacity for abstract thought" within kinesthetic activities (Miller, 2002, p.5). Multi-sensory learning has also been known to improve a student's motivation to learn, efficiency of learning, and heightens a student's access to learning (Tomlinson, 2002, p. 25). Multi-sensory learning is a key teaching strategy for working with students with disabilities and "at-risk" students (Miller, 2002, p. 4). However, I believe that every child, no matter their academic or ability level, can potentially benefit from multi-sensory enriched curriculums.

Children intuitively use all their senses to investigate, experiment, discover, and explore issues within their everyday lives (Staley, 1997, p. 240). There are benefits for giving a student the opportunity to learn within the learning style he or she is most comfortable with and will most likely succeed from using. First, the lesson will be more meaningful in the sense that the students will better retain and internalize the information. In most cases, multi-sensory lessons give the students firsthand experience of the knowledge. A teacher can explain what centrifugal force is. The auditory learners may get it. The students can read about it, and the visual learners will probably have an understanding of what it is. However, if the teacher provides a number of hands-on activities, then everyone (visual, audio, and tactile learners) should gain an understanding of what centrifugal force is.

Another example of the positive benefits of multi-sensory teaching can be found in the area of simple addition and subtraction. When I was in elementary school, for example, I was given a number line to use for the first couple of weeks to get the concepts of adding and subtracting. After that, I was expected to memorize it. Flashcards became my best friend. Luckily for me, I did not any have problems with memorizing numerical operations. Today, Lego-like blocks are used in the early elementary grades to aide students with adding and

subtracting. Our students are very fortunate, because they are being taught the numerical operations (how adding and subtracting really works) with these manipulatives. However, this seems to be the exception to the rule. We will only provide multi-sensory-like lessons for some things; and everything else has to be memorized. In addition, we only seem to acknowledge this need for multi-sensory learning styles at the primary levels. After that, students are on their own.

A second benefit of multi-sensory lessons is that they can build confidence in the learner. When the students "get it," they feel good about what they are doing, and more importantly, they feel good about themselves. Sizer (1992) suggests that a student should be allowed to "exhibit his or her mastery" of his or her knowledge and skills (p. 63). This includes allowing the student to have more input in class, over what they are learning and how they are learning it. Personalizing the overall learning experience allows students to exhibit their mastery over their own learning (Sizer, 1992, p. 67).

Similar to the multi-sensory theory is Howard Gardner's Multiple Intelligences approach. Howard Gardner also believes that students process information differently, and thus, they learn by different modalities. There are nine "intelligences" in his theory:

Linguistic. Ability to understand and use spoken and written communication. Ideal vocation: poet.

Logical-mathematical. Ability to understand and use logic and numerical symbols and operations. Ideal vocation: computer programmer.

Musical. Ability to understand and use such concepts as rhythm, pitch, melody, and harmony. Ideal vocation: composer.

Spatial. Ability to orient and manipulate three-dimensional space. Ideal vocation: architect.

Bodily-kinesthetic. Ability to coordinate physical movement. Ideal vocation: athlete.

Naturalistic. Ability to distinguish and categorize objects or phenomena in nature, ideal vocation: zoologist.

Interpersonal. Ability to understand and interact well with other people. Ideal vocation: politician; salesperson.

Intrapersonal. Ability to understand and use one's thoughts, feelings, preferences, and interests. Ideal vocation: autobiographer; entrepreneur. (Although high intrapersonal intelligence should help in almost any job because of its role in self-regulation, few paid positions reward a person solely for knowing himself or herself well.)

Existential. Ability to contemplate phenomena or questions beyond sensory data, such as the infinite and infinitesimal. Ideal vocation: cosmologist; philosopher.

(Moran, Kornhaber & Gardner, 2006)

Gardner's multiple intelligences approach does not require each lesson to incorporate all nine of the *intelligences* in one activity, but with a very resourceful and creative educator, all could be demonstrated in any classroom. Some *intelligences* are just naturally present in everyday classrooms, i.e. interpersonal, bodily-kinesthetic, and linguistic.

In addition, Gardner believed that the more that are present in a learning activity, the more likely different learners would have an opportunity to learn, or have more opportunities to experience or have "access to the material". The multiple intelligences approach aides in building active learners through enriched learning activities that appeal to the diverse strengths and weaknesses of each student (Moran, Kornhaber & Gardner, 2006). Finally, multi-sensory lessons and multiple intelligences lessons, especially ones that include manipulatives, encourage social interaction. These learning experiences usually involve interaction between students and

teacher, and students with students. This interaction also involves cooperation, communication, and conflict resolution (Berk, 1999, p. 52).

If we think about it, when a child is in Kindergarten, he or she is exposed to primarily multi-sensory activities within their daily lessons. Here is an example of a lesson on learning shapes (let us pretend that there are shapes in front of you, including three circles, a square, a rectangle, and a triangle): "Take the following shapes and make different objects out of them at your desk. When you have finished, turn to a neighbor, show them what you made, and tell what shapes you used to make it." The students may construct an ice cream cone, a dumbbell, a train engine, etc.

The students are seeing the shapes, hearing the names of the shapes, and touching the dimensions of the shapes. Most students, especially predominantly tactile learners, would enjoy touching the shapes if the shapes were cut out from carpet, textured material, or wallpaper. This lesson appeals to the students' different senses/intelligences.

Why is it that after Kindergarten, teachers begin to steer away from multi-sensory and multiple intelligences lessons to more predominant ones that involve lectures and textbooks? We know that students have their own styles of learning. We also know that students have more academic successes when engaged in activities that engage their differing learning styles. If this is the case, why are educators still insisting in form fitting students into the same learning molds? One could argue that multi-sensory or multiple intelligences lessons require more planning time. Along the same lines, they also may not be as cost effective as textbooks in the long run. Some of the old school teachers may not want to change their curriculums. Whereas, new teachers may feel that a less involved curriculum their first year will allow for a smoother transition. Furthermore, the schools may be outdated and thus, cannot accommodate the equipment needed

for these lessons, like a pottery wheel.

I agree that these multiple stimulating lessons may take more time initially. However, if a teacher could be guaranteed with a far higher success rate, then is it not worth the extra time? As far as the cost, there are thousands of books published that turn ordinary household items into rainy day activities (surf through the Barnes and Noble's website). Some schools may not be able to afford a pottery wheel or even have the space to accommodate one. However, colored yo-yos or a bucket with colored ping-pong balls in it can also help the students to "get it". Furthermore, when students "get it," then the possibilities start to become endless.

Inquiry Based Thinking: Question Everything

The old cliché states that curiosity killed the cat. Humans, by nature, are very curious, even though we do not like to admit it. As a side note, historically, we have seen that humans are creative by nature too. Furthermore, it has been out of our curiosity that some of best creative innovations have been born, such as fire, the wheel, the telephone, etc.

Unfortunately, for the most part, we are deterred from being inquisitive. Think back to when you were a child, what was the infamous response we would all get when questioning our parental figures? "Because I said so!" Even in school, teachers frequently used the explanation of:"Because that is just the way it is." Some teachers even felt threatened when they were asked a legitimate academic question. Perhaps their reaction stemmed from a sense that they needed to protect their positions as authority figures. Looking back, maybe they simply did not know the answers. As a student, though, it surely would have been preferable if they would have said, "Let me make sure. I'll get back to you." No one has superior astuteness.

Another old cliché says, "The only dumb question is one that is never asked." Inquiry-

based thinking is a very powerful mental tool. The idea of "inquiry" has been defined in many ways. Inquiry is "a quest for meaning that requires one to perform certain mental operations in order to make experience understandable" (Vanfossen and Shiveley, 1997, p. 71). Inquiry is also thought of a way to pose a productive question and to investigate an answer (Huber and Moore, 2001, p. 33). In this sense, Inquiry can be viewed as "the process by which one goes about rationally resolving doubt" (Vanfossen and Shiveley, 1997, p. 71). Inquiry can also be "the act or instance of seeking truth, information, or knowledge about something" (Marginally, 1998, p. 164). Finally, inquiry is also defined as developing "deep understanding of content and the ability to think critically" (Pratt and Hackett, 1998, p. 20).

Out of all these definitions, I believe the last two definitions best supports my goal. Inquiry-based thinking is intended to pose questions, to think critically, to explore, and to gain a deeper understanding about something. I believe that given the right environment for opportunities, modeling, and encouragement, students can exercise both forms of inquiry-based thinking. They should not be expected to master it early on, but they should at least be introduced to it.

Students in the elementary grades are basically fed information. These curriculums "box" up much of the individualized thinking or need for original ideas. For the most part, education has been structured in such a way where students are moved along on academic conveyor belts, within the great educational manufacturing plant.

As an alternative to this traditional model of content design and delivery, Inquiry-based thinking can be accomplished through many student-centered teaching strategies that encourage inductive thinking (Wise, 1996, p. 337). I will discuss three types of inquiry-based teaching strategies. First, **modeling** is a simple way for a teacher to teach his or her students to think

critically. A teacher can talk through her rationale aloud to model for the students how he or she is processing a situation. For example, "I wonder what will happen to the globs of paint when I turn on the pottery wheel." Along the same lines, a teacher can model inquiry-based thinking by asking the students specific open-ended questions. For example, "What is the difference between a circle and a square?" "Why did the paint splatter out when we turned on the pottery wheel?" "What other kinds of things would spread out like the paint did?" This can help the students to discover for themselves what possible answers there might be.

Similar to modeling, Theodore Sizer (1984) highly recommends **coaching** as a method of teaching. Coaching encourages engagement to take place between teachers and students and can nurture trust between them. Students learn to trust that the criticism they receive is constructive, and to trust that there is purpose behind the lessons taught by their teachers. Thus, students who can recognize that there is a purpose are more likely to engage in learning (Sizer, 1984, p. 108). Getting to know a student can prove as beneficial for the teachers. Sizer believes that one essential component in engaging a student is to teach around what the student thinks is interesting (1984, p. 108). Students learn best when they can relate to what they are learning.

A second strategy for encouraging inquiry-based thinking among students is K-W-L (what do you **K**now? what do you **W**ant to know? what have you **L**earned?) (Coleman, Thiessen, Wilson, Arey, and Barrow, 1999, p. 28). Know-Want-Learned is a teacher-led learning exercise that helps students to begin to ask in-depth, unusual, and creative questions. With the K-W-L strategy, a teacher would use a chart to illustrate the deductive thinking process. For example, let us go back to the centrifugal force and the pottery wheel. In the first column under the "**K**", the teacher would ask the students to list everything they know about the paint and the pottery wheel. In the second column, the "**W**" column, the teacher would ask the

students to list questions about what they wanted to know and learn from this experiment. In the "**L**" column, the teacher, with the aid of the students, would write in the answers to the "**W**" questions in relation to the results of the experiment (Dever and Hobbs, 1998, p. 8). K-W-L is also very useful in testing and confirming theories, such as being used in scientific research or experiments (Sampson, 2002, pp. 528 - 532).

The K-W-L strategy helps students to "build an understanding from their own actions upon objects and by telling stories about what they did and what they found out" (Coleman et al., 1999, p. 29). This type of strategy allows students to build off their own background knowledge through inquiry. With practice, K-W-L becomes a tool they can use in the real world (Dever and Hobbs, 1998, p. 11).

This exercise can be used when teaching any subject. For example, K-W-L can be implemented during a Reading lesson. Before the class begins reading a story, the teacher can solicit what the students know about a certain character in the story. The teacher can ask the students what they want to know about this certain character based on the jacket of the book or illustrations within the story. Finally, the teacher can discuss with the students the "main idea" of the story and how it satisfied the inquiries they generated on their own (Dever and Hobbs, 1998, p. 10).

Similarly to K-W-L is another inquiry strategy called **Think-Aloud**. According to Patricia Cooper, an assistant professor of Early Childhood and Literacy at New York University, Think-Aloud is a strategy where "young children may attempt to comply with the teacher's request, it is difficult to believe they are accurately reporting on their thought processes when they do. The fact is, children under seven or eight are just learning to articulate what they are thinking about". The teacher verbally demonstrates his or her thought processes aloud,

illustrating to the students how he or she came to his or her conclusion. What questions is the teacher asking him or her when trying to arrive to the answer or solution. In turn, students demonstrate their thought processes by articulating what they are thinking. It is then that the teacher can influence the students' ideas towards one direction or another. **Think-Aloud** also involves the elements of the teaching strategies of **modeling and coaching**. It is an open forum, where students learn to talk and inquire through problem/question, and as Cooper stated, this is a strategy that can be implemented with students as young as seven or eight. If one can teach an infant sign language before he or she masters speech, perhaps then a child could learn the Think-Aloud strategy even younger (Cooper, 2009, pp. 178-187).

The final strategy to be discussed is called **hands-on** or "minds-on" activities. Hands-on learning is quite popular for tactile and visual learners, because it allows a lesson to go beyond two-dimensional learning to multi-sensory stimulation (Olaf and Vanosdall, 2002, pp. 601-605). Hands-on lessons also encourage and incorporate inquiry-based thinking (Huber and Moore, 2001, p. 33). Students learn by doing (Lockwood, 1998, p. 6). Students gain a certain feeling of ownership towards the lesson during hands-on activities, and thus, they start to wonder what will happen next. Hands-on lessons also encourage social interaction among students. Working together, the students can debate ideas and theories (Huber and Moore, 2001, pp. 32-35). In this way, they can informally inspire each other to develop more in-depth, inquiry-based thinking.

Sizer suggests that students learn by using the information they are taught (1992, pp. 86-87). They will learn by having the following techniques integrated throughout their entire curriculum: Conversation, collaboration with teachers and other students, and through interesting and engaging activities (Sizer, 1992, p. 91). Furthermore, **brainstorming** also allows for opportunities for inquiry-based thinking (Huber and Moore, 2001, p. 32). Brainstorming is

another simple mind expanding exercise that can be performed during most lessons. Brainstorming is also is good way to introduce a lesson. Soliciting the student's previous knowledge on a topic gets them interested (or hooked) and allows them to feel ownership towards the lesson that follows.

In the introductory section of this chapter, I discussed a brainstorming activity exploring various uses of tires that I did as a teaching student. I would like to apply this topic to a hypothetical lesson. A fifth grade class is doing a unit called *Save the Planet.* The class starts with a lesson on recycling. The teacher decides that the class as a whole will write a story about a boy who finds a tire. This boy is unsure of what to do with this tire. The class develops a list (brainstorming) of reasons why the boy should not throw the tire in the trash. The class will then brainstorm a list of things the boy could use the tire for. The teacher will bring in an old tire to help with this exercise. When the list is complete, each student will pick a usage for the tire from the brainstormed list, and that student will be responsible for writing that page of the story. Each student will also be able to design his or her own page's illustration and can either draw, paint, or make a collage.

In this example, the teacher is leading the inquiry-based exercise by initiating the brainstorming process. The teacher has the vantage point of engaging the students during the brainstorming, by prompting the students to think about the different usages for the tire, beyond a sandbox and a swing. The teacher may come up with his or her own obscure idea, and have a class debate on whether or not it would be appropriate for the tire. Furthermore, the teacher may ask the students to come up with their own idea of what to do with the tire. The possibilities can snowball with brainstorming. Brainstorming is a tool that, when practiced over time, will become a learned behavior. Children learn to brainstorm by modeling and doing it.

Besides brainstorming, **teachable moments** are a good way to encourage students to use inquiry-based thinking. Teachable moments are events that happen in the classroom that are not planned. In most cases, teachers are not even prepared for them. However, this should not be a deterrent from encouraging the students to have them (Lipscomb, 2002, pp. 237-238).

What if, going back to our tire example, during the brainstorming process a student asks the teacher: "Why can't we recycle tires to make basketballs?" "How do we make tires?" "Where does the rubber come from?" "Why are tires black?" These questions are an example of teachable moments. The student is inquiring about an idea beyond the present topic. This should not be discouraged. In this case, maybe the teacher can provide an explanation for it; maybe it can become a class discussion; or maybe the teacher could develop a future lesson around it. Nevertheless, by reacting to the student's question in a positive way, the teacher is making the teachable moment gratifying to the student. Thus, the teacher will be encouraging that student and other students to become more participatory in the lesson; taking a more active part in the learning process and expanding their minds beyond the perimeters of the lesson.

To summarize, in this chapter, I have tried to identify some of the ways in which successful teaching strategies might be implemented in order to make learning more interesting, meaningful, limitless, without prejudices, and a lifelong adventure. As has been identified in earlier chapters, one of the main impetuses behind the NCLB legislation was to help American students develop basic reading, math and science knowledge, from early on in their academic careers. I have tried to demonstrate the importance of this legislation, and the need for it to be more successfully implemented, starting in as early as the lower elementary grades. One of the stumbling blocks to the successful implementation of this legislation was the fact that the original language was so vague, and that individual states and schools were left to come up with

their own curriculum and testing standards. In addition, little thought was given to how to actually teach the material in such a way that the content could be learned.

In this chapter, I have tried to address this last problem by modeling several successful teaching strategies that have been developed by both teachers and educators, both in and out of the classroom. Though these strategies may have different emphases, they all seem to identify the need for teachers to work with the individual learning styles of the students. Teachers should integrate more opportunities for the students to demonstrate their mastery of the information by providing more learning opportunities that include multi-sensory and/or multiple intelligences lessons, the use of thematic units, a stronger emphasis on hands-on learning experiences, or a combination of one or all these techniques. By providing students with enriched learning opportunities, not only will students successfully learn the content, but at the same time build confidence and expand their minds.

By way of a provisional summary, in this chapter I have tried to identify how these theories, based on the actual experiences of teachers in classrooms, can potentially help to foster independent, critical science thinkers, which is one of the primary goals of the NCLB legislation (Sizer, 1992, 214). Every student, at every grade level, should be given the opportunity to learn. By ignoring how students learn, however, and how teachers teach, the NCLB legislation has fallen short of this goal of providing every child with this opportunity to learn successfully. This is why is it is so critical to be far more explicit with schools and school districts in terms of helping teachers to become themselves "master teachers," who can integrate the most successful teaching strategies into their own classroom setting. Only in this way can we ensure that our children will indeed be given the best opportunity to learn.

Conclusion

"Think left and think right
and think low and think high.
Oh, the Thinks you can think up
if only you try!"
(Dr. Suess, 1997, p.30)

Ironically, in Math, we learn that the shortest route between two points is a straight line. It is no wonder that teachers tend towards the path of least resistance (textbooks, lectures, and teacher-centered lessons) when instructing their students. In the past, our educational system did not allow for much creative freedom, flexibility, or aspirations/inspirations on the part of teachers. However, President Bush's No Child Left Behind Act of 2001 initially offered the potential for educational reform that could make a difference. According to the U.S. Department of Education, the No Child Left Behind Act of 2001,

> ...changes the federal government's role in kindergarten-through-grade 12 education by asking American schools to describe their success in terms of what each student accomplishes. The act contains the President's four basic education reform principals: stronger accountability for results, increased flexibility and local control, expanded options for parents, and an emphasis on teaching methods that have been proven to work (U.S. Department of Education, 2002),

This Act allows each State the authority to develop their own Standards and thus, each State will be held accountable for those Standards. In addition, the Act places emphasis on students with disabilities, students who are economically disadvantaged, minority groups, as well as students who are limited in speaking English. Understandably, in the past, these students usually fell through the gaps of the educational system, because their limitations made it difficult

to be academically successful.

When it came to Science education, NCLB statutes included partnerships among schools and local community organizations and businesses to enhance educational experiences in Science. It hoped to base curriculum development on *what works* through Scientifically Based Research (SBR) (U.S. Department of Education, February 2002). However, as this paper discussed, SBR is not a universally consistent resource for curriculum development. Why? All students learn differently. Regardless, NCLB failed Science education mainly due to the lack of legislative emphasis (concern), background/knowledge, and ultimately, due to the vagueness of the language used in the legislation itself. Lack of clarity seemed to be a recurring problem throughout the entire piece of legislation.

Another shortcoming of NCLB is the allocation of control and responsibility. The States are responsible for their Standards and assessments, and will be held accountable by the Federal government, who is responsible for the funding, rewards and consequences. This paper strongly supports federalism, where there is a nationwide set of Standards and assessments and/or rules on accountability. Not every school district, in the same state, uses the same lesson plan to teach a required learning standard. Why? The reasons are as numerous as the variations as the students found in those classrooms. So, how is a teacher expected to be successfully teaching within a system that requires them to base their curriculum on SBR? Again, this does not allow for much creative freedom, flexibility, or *teachable moments* on the part of teachers or even that of their students.

Our students' "proficient" understanding of Science scores should arguably be better than satisfactory. Not every student will go on to college to become physicists; however, we need to produce more Science literate individuals who are able to read the articles and vote responsibly

on Science related issues (Jemison, 2000, p, 3).

How can this be done? First and most importantly, legislators and educators need to acknowledge that all students learn differently. Next, NCLB of 2001 or its successor should be written with more precise language that includes who is responsible for what, which should include a nationwide educational set of Learning Standards. There also needs to be more emphasis placed on the research, funding, planning, support, initiatives, and encouragement of learning Science. ELA will only matter if in the future we have the means to manufacture a paper-like source, to print on and read from. In addition, our focus of *what works* should shift away from corporate, governmental, and/or private research, to successful and proven effective strategies that *do work.*

According to the U.S. Department of Education, during the 1990s and into the middle of this decade, researchers have proven that the best way is for the schools to first reject unproven fads (U.S. Department of Education, April 2003). When teachers incorporate more proven strategies, thematic curriculums, multi-sensory learning/Multiple Learning, and inquiry-based (research) activities, students, within all levels of learning, are more likely to succeed. In addition, using such techniques as centering a curriculum on a theme (thematic unit) students can relate to, students are more likely to build their confidence and spark their interests towards the lessons, and provide them with some sort of ownership to it. Students become much more enthusiastic and participate more actively in lessons that they feel they are connected to, and thus, making this curriculum a more life enriching experience for them.

Finally, these types of teaching practices and learning strategies can be adopted in every state and be implemented within their individual school districts; they can help close the learning gap, and increase the number of students who will be successful being proficient in their learning

standards. In doing so, the schools will be recognized for being successful in their curriculum development and teaching, because their students' academic achievements will be reflected in the Adequate Yearly Progress (AYP) reports. This will also ensure that they will successfully retain their students (remember the money goes where the students go), and potentially receive more rewards, initiatives and funding. More importantly, schools can prove that the theory of no child will be left behind can be a reality, and not just a title to a piece of legislation.

Appendix: 1.0

The eleven core questions explored at the historic 1893 Committee of Ten meeting on U.S. Education:

1. In the school course of study extending approximately from the age of six years to eighteen years—a course including the periods of both elementary and secondary instruction—at what age should the study which is the subject of the Conference be first introduced?
2. After it is introduced, how many hours a week for how many years should be devoted to it?
3. How many hours a week for how many years should be devoted to it during the last four years of the complete course; that is, during the ordinary high school period?
4. What topics, or parts, of the subject may reasonably be covered during the whole course?
5. What topics, or parts, of the subject may best be reserved for the last four years?
6. In what form and to what extent should the subject enter into college requirements for admission? Such questions as the sufficiency of translation at sight as a test of knowledge of a language, or the superiority of a laboratory examination in a scientific subject to a written examination on a text-book, are intended to be suggested under this head by the phrase "in what form."?
7. Should the subject be treated differently for pupils who are going to college, for those who are going to a scientific school, and for those who, presumably, are going to neither?
8. At what stage should this differentiation begin, if any be recommended?
9. Can any description be given of the best method of teaching this subject throughout the school course?
10. Can any description be given of the best mode of testing attainments in this subject at college admission examinations?
11. For those cases in which colleges and universities permit a division of the admission examination into a preliminary and a final examination separated by at least a year, can the best limit between the preliminary and final examinations be approximately defined?

(National Education Association, 1894, 6-7)

Appendix: 1.1

Herbert R. Kohl's Open Education Approach	Carl Roger's Facilitative Teaching Approach
Allow the student to have a choice in the selection of tasks and activities whenever possible. Help students learn to set realistic goals. Have students participate in group work, especially cooperative learning, in order to develop social and affective skills. Act as a facilitator for group discussions when appropriate. Be a role model for the attitudes, beliefs and habits you wish to foster. Constantly work on becoming a better person and then share yourself with your students.	Response to student feeling; Use of student ideas in ongoing instructional interactions; Discussion with students (dialogue); Praise of students; Congruent teacher talk (less ritualistic); Tailoring of contents to the individual student's frame of reference (explanations created to fit the immediate needs of the learners); and Smiling with students.
Studies of the Open Education approach showed strong evidence of the following among students:	Studies of the Facilitative Teaching approach showed strong evidence of the following among students:
Improved cooperativeness, creativity, and independence (moderate); Increased positive attitudes toward teacher and school, creativity, adjustment, and general mental ability (slight); Lower language achievement (negligible) and achievement motivation (moderate); No consistent effect on math, reading, or other types of academic achievement; and No consistent effect on anxiety, locus of control or self-concept.	Missed four fewer days of school (5 as compared to 9 for low facilitative teachers); Increased scores on self-concept measures; Greater gains on academic achievement measures, including both math and reading scores; Presented fewer disciplinary problems and committed fewer acts of vandalism to school property; and Were more spontaneous and used higher levels of thinking (knowledge versus comprehension through evaluation).

(Huitt, 2001)

Appendix 1.2

A summary of the key points of the 1970's Back-to Basic Movement:

- Confining students to a role of passive acceptance and obedience.
- Reliance on threat and punishment to en- force obedience.
- Teaching "grammar" via rule books and work books with an emphasis on correctness.
- "Covering literature" via anthologies or other common readings with an emphasis on form rather than substance.
- Teaching "composition" via writing assignments with an emphasis on form as a visual rendition of grammatical rules.
- Ignoring the demands of the present (and future) environment in which students must live.
- Neglecting the development of concepts critical to survival in the nuclear-space-age.

- Ignoring developments in media of communication since the appearance of movable type.
- Ignoring the fact that the processes of symbolic communication are the most distinctive,
- ubiquitous, and hazardous of all forms of human behavior.
- Ignoring the differences between males and females.
- Ignoring the fact that form follows function. (Weingartner, 1977, 44)

Appendix 1.3

The alarming indicators of "risks" as reported in 1983's A Nation at Risk:

- International comparisons of student achievement, completed a decade ago, reveal that on 19 academic tests American students were never first or second and, in comparison with other industrialized nations, were last seven times.
- Some 23 million American adults are functionally illiterate by the simplest tests of everyday reading, writing, and comprehension.
- About 13 percent of all 17-year-olds in the United States can be considered functionally illiterate. Functional illiteracy among minority youth may run as high as 40 percent.
- Average achievement of high school students on most standardized tests is now lower than 26 years ago when Sputnik was launched.
- Over half the population of gifted students do not match their tested ability with comparable achievement in school.
- The College Board's Scholastic Aptitude Tests (SAT) demonstrate a virtually unbroken decline from 1963 to 1980. Average verbal scores fell over 50 points and average mathematics scores dropped nearly 40 points.
- College Board achievement tests also reveal consistent declines in recent years in such subjects as physics and English.
- Both the number and proportion of students demonstrating superior achievement on the SATs (i.e., those with scores of 650 or higher) have also dramatically declined.
- Many 17-year-olds do not possess the "higher order" intellectual skills we should expect of them. Nearly 40 percent cannot draw inferences from written material; only one-fifth can write a persuasive essay; and only one-third can solve a mathematics problem requiring several steps.
- There was a steady decline in science achievement scores of U.S. 17-year-olds as measured by national assessments of science in 1969, 1973, and 1977.
- Between 1975 and 1980, remedial mathematics courses in public 4-year colleges increased by 72 percent and now constitute one-quarter of all mathematics courses taught in those institutions.
- Average tested achievement of students graduating from college is also lower.
- Business and military leaders complain that they are required to spend millions of dollars on costly remedial education and training programs in such basic skills as reading, writing, spelling, and computation. The Department of the Navy, for example, reported to the Commission that one-quarter of its recent recruits cannot read at the ninth grade level, the minimum needed simply to understand written safety instructions. Without remedial work they cannot even begin, much less complete, the sophisticated training essential in much of the modern military.

(U.S. Department of Education, 1999)

Appendix 2.0

New York State Academy for Teaching and Learning's Math, Science, and Technology (MST) Standards:

Mathematics, Science, and Technology

Standard 1: Analysis, Inquiry, and Design
Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Standard 2: Information Systems
Students will access, generate, process, and transfer information using appropriate technologies.

Standard 3: Mathematics
Students will understand mathematics and become mathematically confident by communicating and reasoning mathematically, by applying mathematics in real-world settings, and by solving problems through the integrated study of number systems, geometry, algebra, data analysis, probability, and trigonometry.

Standard 4: Science
Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Standard 5: Technology
Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.

Standard 6: Interconnectedness: Common Themes
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

Standard 7: Interdisciplinary Problem Solving
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

(New York State Education Department, September 2008)

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