POLICY AND PRACTICE IN EDUCATION: A HISTORICAL REVIEW OF FEDERAL SCIENCE POLICY, K-12 SCIENCE EDUCATION AND EDUCATION REFORM (1945-2012)

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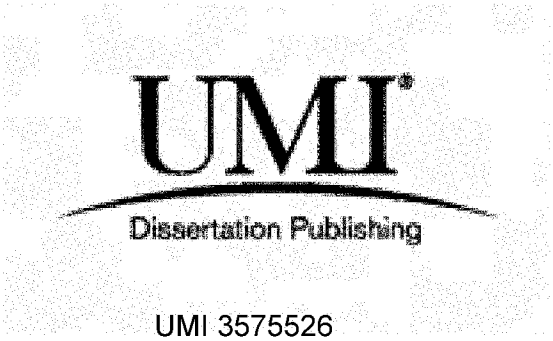

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APPROVAL FOR DISSERTATION PROPOSAL

Candidate, Margot Getman, has successfully completed all requisite requirements. This candidate's proposal has been reviewed and the candidate may proceed to collect data according to the approved proposal for dissertation under the direction of the mentor and the candidate's dissertation committee.

If there are substantive differences between what has been approved and the actual study, the final dissertation should indicate, on separate pages in the Appendix, the approval of the committee for those changes.

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Policy And Practice in Education: A Historical Review of Federal Science Policy, K-12 Science Education and Education Reform (1945-2012)

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ABSTRACT

Virtually any comprehensive "top ten" list of the most critical issues facing the world in the 21st century is likely to include the following: access to renewable low-cost energy, environmental challenges such as global warming, and world health issues such as the threat of global pandemics and sustainable food production among others. Successful solutions to these, and other, problems will require the application of higher order thinking skills such as those that characterize science, math and technology literacy. Many policymakers argue persuasively that (1) science, math and technology skills are a prerequisite for a continued strong and vibrant economy that can compete successfully in our global marketplace, and 2) these same skills will increasingly determine an individual's personal competitiveness in the 21st century workforce.

Present education reform efforts, such as the emphasis on standards, assessments, and accountability reflect the concerns of these policymakers. Therefore, central to the debate surrounding education reform is the question "What is the role of the federal government in education?" In this study I explore the relationship between federal science policies and education reform, as each has evolved, from World War II to the present.

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Chapter 1

STUDY DESIGN

Background of the Problem

Since *A Nation at Risk: The Imperative for Educational Reform* was published in 1983, national security, defined as the ability of the United States to compete in a global marketplace, has been the theoretical construct driving science policy decisions and education reform (National Commission on Excellence in Education, U.S. Department of Education, 1983). During the years from 1983 to the present, a number of books, policy documents, and speeches have reiterated this refrain. They include, but are not limited to, President Clinton's science policy statement, *Science in the National Interest, New York Times'* columnist Thomas Friedman's 2005 bestselling book *The World is Flat*, a National Academy of Sciences 2005 publication, *Rising Above the Gathering Storm,* and a 2008 publication prepared for the Office of the Secretary of Defense, *U.S. Competitiveness in Science and Technology*. This list does not include an uncounted number of candidate speeches and presidential speeches on the importance of education in general, and science education in particular, if the U.S. is to remain globally competitive. A 1998 report from the Committee for Economic Development stated, "Education and skills have become a more stark dividing line between success and failure in the new labor market" (p. 1).

Concerns about our education system and U.S. competitiveness in the global marketplace were not and are not confined to policymakers at the national level. States policymakers were equally aggressive in their response to the challenge of education reform. A few years after *A Nation at Risk* was released, the National Governors Association published *Time For Results*, which helped to usher in the standards, assessments, and accountability school culture in which

we now work. These and other reports by policymakers, economists, scientists, educators, and academics argue persuasively that science, technology, engineering, and math (STEM) skills are a prerequisite for a continued strong and vibrant economy that can compete successfully in our global marketplace and that these same skills will increasingly determine an individual's personal competitiveness in the 21st century workforce. Over the past quarter century there have been dozens, if not hundreds, of books, reports, and speeches reiterating this message, so much so that STEM education has become a cornerstone of present education reform efforts. However, a literature search revealed a relative scarcity of documentation linking the historical evolution of science policy and education reform up to the present time. My interest was to discover if federal science policies had influenced earlier reform efforts.

Purpose of the Study

The purpose of this study is to examine the evolution of federal science policies and government intervention into education reform. Today, globalization is the policy construct driving education reform, but what were the prior constructs? Have scientific and technological knowledge always been viewed as critical to our national health by policymakers? Will the pattern of prior government interventions offer any clues to educational leaders as to future reform measures? By examining the historical evolution of federal science policy and the parallel developments in K-12 education, from World War II to the present, it is hoped that any connections between the two, should they exist, will be uncovered.

Significance of Study

A search of the literature published over the past two decades has revealed a relative deficiency of historical analysis about the evolution of current education reform efforts as an outcome of science policy initiatives. A literature search, using Pro Quest and EBSCO Host, for

existing books and articles that provided a historical review of U.S. science policy and education reform was largely unsuccessful. To be sure, there are excellent texts by Atkin and Black (2003), DeBoer (1997) and Bybee (1997) among others that I relied on heavily. Most of the literature, however, does not bring the discussion up to the current reform environment. As a doctoral candidate in Education Leadership, Management, and Policy with an interest in science, my intent was to examine the relationship between federal science policy and education reform efforts from World War II to the present. If past truly is prologue, then I hop this longitudinal examination might provide education leaders with some insight into the direction and magnitude of future reform initiatives.

This study is significant in that it:

1. offers a historical perspective on how national science policy influences science education in particular and education reform in general
2. provides suggestions as to what education leaders may expect with regard to the role of the federal government in the area of education reform in general and science education in particular.

Conceptual Framework

My historical policy analysis draws upon Fowler's (2009) four theoretical frameworks. Of the four theoretical frameworks, I focus on competing values, which recognizes that policies are always based upon value-laden beliefs. According to Fowler, public values are divided into three categories: general social values, democratic (political) values, and economic values. She states that, "...although all of these values are always factors in education policy in the United States, their relative importance changes over time" (p. 327). I discuss these competing values at length as I examine each policy period and again in my Overarching Questions.

This study reviews the evolution of federal science policies from World War II to the present within the context of political, social, and economic forces. This study also examines K-12 science education as it changed over that same time period, whether in response to changing science policy or due to other factors. Furthermore, I was interested in uncovering contemporaneous developments in science education with an eye to understanding the links, if any, between federal science policy and science education.

Using an archival research design approach, I investigated the relationship between national science policies and education reform. The primary sources of information included policy documents and speeches, as well as a literature review of the subject. In designing my research questions, I kept Fowler's Competing Values framework in mind. The following Overarching Questions served as a guiding framework, providing some consistency (connectivity) to the research process from policy period to policy period.

Overarching Questions

- What were the democratic, social and economic contexts or forces that shaped or influenced federal science policies from 1945 to the present?
- What have been the philosophical and theoretical perspectives that form the basis for education pedagogy during each study period?
- How was federal science policy reflected in K-12 science education during each policy period?

Organization of the Study

In Chapter II, I provide a backdrop to the primary focus of my research by briefly examining the evolution of our education system and the special role that science enjoyed in the development of our early nation.

In Chapter III, I look at the origins of U.S. National Science Policy and the context in which it was formulated. I was interested to discover whether there was a concurrent expanding role for the government in education during this period.

In Chapter IV, I examine the evolution of National Science Policy after Sputnik and the parallel developments in education. There is virtually unanimous agreement among policymakers and historians that Sputnik represented a dramatic transitional moment in both science policy and education policy.

In Chapter V, I examine the period of time beginning with the moon landing and ending with *A Nation At Risk*; 1969-1983. This is in many ways the least fertile period for both science policy and education reform. It marks the intermediate period between the Sputnik revolution and current science policy and education reform efforts.

In Chapter VI, I examine the underpinnings of the current education reform environment. Among other things, I am interested in the scope of present education reform efforts compared to previous efforts, whether or not the federal government's role in reform efforts have changed over the years, and how strong the consensus is as to the policy agenda.

In Chapter VII, I look back at the trajectory of National Science Policy and education reform efforts over the past sixty years in an attempt to determine what, if any, conclusions can be made. I want to determine whether there are any consistent underlying trends uncovered by my research in the hope that they may provide educational leaders with a better understanding of existing reform efforts.

At the beginning of Chapters III through VI, I identify some of the key political, economic, and social milestones or characteristics of each period. There is an abundance of sources, including newspapers and online chronological databases to confirm these historical

facts. It is my intention that these facts will set the scene for federal policies initiated during each period. The following sections of each chapter identify and illuminate the key science policy documents or speeches of that period, examine how changes in science policy manifested themselves, and examine what was occurring in K-12 science education during the period in question. In the last chapter I look at the trajectory of federal science policies and education reform in an attempt to uncover consistent themes and new directions.

Definition of Terms

Policy: For the purposes of this study, the researcher defines federal policy as an overarching plan for achieving agreed upon national goals. Federal policies have a purpose and are inherently forward looking. They are generally produced as a response to a perceived problem.

Scientific Literacy: According to the National Science Education Standards, scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity.

Progressivism: Progressivism is a student-centered pedagogy. This philosophy emphasizes a learning process that is active or experimental and focused on student interests. John Dewey was a proponent of this teaching style. It is sometimes also referred to as constructivism.

Traditional or Essentialist pedagogy: The belief that there is a core curriculum based on essential knowledge and skills that should be taught and learned. It is a practical approach designed to prepare students to become productive wage earners.

Chapter II

HISTORICAL CONTEXT

"Educate and inform the whole mass of the people...
They are the only sure reliance for the preservation of our liberty."
-- Thomas Jefferson

Reports such as *America's Perfect Storm*, published in 2007 by The Educational Testing Service, and *Into the Eye of the Storm: Assessing the Evidence on Science and Engineering Education, Quality, and Workforce Demand,* published in 2007 by the Urban Institute, are representative of research conducted over the past two decades strongly suggesting that U.S. students are falling behind students of other countries in math and science achievement. These reports assert a direct relationship between deficiencies in U.S. education and the future ability of our nation to innovate and compete in a global economy. Other reports such as *Rising Above the Gathering Storm*, published in 2008 by the National Academies Committee on Science, Engineering, and Public Policy, suggest that too many elementary teachers lack the requisite content knowledge and inquiry-based pedagogical skills needed to affect broad-based improvement.

Over the past three decades, politicians, economists, and corporate leaders, among others, have become increasingly strident about the importance of scientific literacy as a prerequisite for individual and national economic health. Decision makers, galvanized by the arguments put forward by these policymakers, have passed legislation that requires states to implement accountability systems based on standardized tests. As a direct outcome of this policy agenda, No Child Left Behind (NCLB) requires that all states administer science assessments to fourth, eighth, and twelfth grade students. The growing importance of scientific literacy to policy-

makers raises the stakes for educational leaders and is likely to generate greater interest among the public regarding K-12 science education.

Although the Constitution left science and education to prosper outside the control of the federal government, this study reveals that the federal government has not been reluctant about using its influence to ensure that they do thrive. Any review of this country's history cannot fail to notice the deep-rooted faith policymakers have always maintained in the power of education and science to transform society and individuals for the betterment of both. Federal science policy is embedded in national economic policy, foreign policy, and education policy. A review of where we have been and how federal science policy has impacted science education over the past half century may provide insight into where we are going and what education leaders can do to prepare for success.

Policymaking and Education: Colonial Period to World War II

This study examines the evolution of American science policy and the parallel developments in K-12 science education from World War II to the present. Before beginning this examination, it is important to establish the historic context: the role of science policy and education policy in this country from its settlement up to World War II. "Consequently, for those who would influence an institution such as the American school to function in a manner relevant to tomorrow as well as today, two things are essential: an analysis of factors of change in contemporary society and the history of that institution" (Thayer, 1965, Preface, para. 1).

It is worth remembering that the first settlers in what became the United States were individuals of action and strong beliefs. They had lived through a period of philosophical and scientific advances in Europe that had changed how people viewed nature and man's relationship to the state, and they brought these notions with them to America. Early in the 17th century, the

telescope and microscope had been invented, opening up the world to man's curiosity and inquiry. Galileo was examining the movement of the heavens during the same period that European explorers were discovering new lands for trade and settlement. A rising merchant class in Europe had stimulated economic change and progress. Enlightenment thinkers, like Locke and Rousseau, profoundly influenced our founding fathers and enlightenment thoughts regarding natural law and self-determination found their way into our founding documents.

One fundamental belief of the enlightenment is that humans are perfectible, that education is an instrument for individual improvement and improvement of reasoning skills. Locke's *An Essay Concerning Human Understanding* (1690) represents arguably the first published work on human cognition. Locke, like other enlightenment thinkers, believed in the value of education as a means to improve the moral and intellectual character of individuals. He favored an extension of education to every member of society.

Given these powerful intellectual currents, it is not surprising that from the time Europeans first settled in the New England colonies, policymakers have taken a very utilitarian view regarding the value of education. Whatever other benefits education offers, it has always been seen as a means to improve society and enhance individual opportunities. For most of the 17tth and 18th centuries, the promotion of education in New England was largely devoted to moral improvement and civic responsibility. Through the earliest years of colonial settlement, education was primarily the responsibility of the family or master, but in 1647 the Massachusetts colony passed the Old Deluder Satan Act, requiring settlements of over 50 families to employ a teacher of reading and writing. Similar acts were passed in other colonies for the purpose of ensuring that its citizenry would be able to read the Bible and participate in colonial governance. Home schooling remained the delivery model in the Southern colonies for many decades. In the

Rand McNally Education Series, *Social History of American Education: Colonial Times to 1860*, the authors found that although the colonies differed significantly in how education was provided, whether at home or in a common school, there was widespread agreement about the importance of education to develop character and good citizenship.

This pragmatic attitude toward the value of education remains as prevalent today among policymakers as it was for the Puritans, who saw it as a means for man to better understand God and contribute to civic order. Over the next one hundred years the challenges of pioneer life, the need to unite together against common threats, economic changes such as the rise of a wealthy merchant class, and a more participative government began to erode the stern conventions that had characterized education throughout most of the 17th century. These changes represent the beginning of a period of secularism, individualism, and commercialism that remains a hallmark of American society. The humanist assumption that all men could reason prompted Thomas Jefferson to propose public schools in Virginia so that "the state might avail itself 'of those talents which nature has sown as liberally among the poor as the rich, but which perish without use, if not sought for and cultivated'" (Thayer, 1965, p. 41). In 1785 and 1787 Congress introduced land grants to support education in the territories.

In his farewell address in 1796, George Washington acknowledged the importance of education. "Promote, then, as an object of primary importance, institutions for the general diffusion of knowledge. In proportion as the structure of government gives force to public opinion, it is essential that public opinion should be enlightened." Nevertheless, despite these liberal stirrings, it should be noted that throughout most of the 18th century, schooling remained largely a local matter, one that was honored more in theory than in practice.

The 19th century witnessed the settlement of the West, the development of mass production following the War of 1812, explosive industrialization following the Civil War, the rise of corporations and trusts, the growth of national labor organizations, and the "common school" movement. In New England, the term *common* referred to the parcel of land held in common for the community and on which the church, meeting-house, and schoolhouse were built. The principle of education for all received widespread support from the rising middle class, businessmen, and political leaders. Horace Mann and others stressed the importance of education as a means to develop the necessary labor pool upon which industrialization depended. This argument was used in support of an education system funded by taxes. As an example of the growing support for general education, in 1820, the Association of Workingmen of New Castle, Delaware, declared in their constitution, "Let us unite at the polls and give our vote to no candidate who is not pledged to support a national system of education to be paid out of public funds" (Thayer, 1965, p.75).

With the exception of establishing an Office of Education for the purpose of collecting and disseminating educational data and the First Morrill Act of 1862, which donated public land for the endowment, support, and maintenance of at least one college, education remained primarily a state and local matter throughout the 19th century. However, the Morrill Act, which provided support for agricultural research, laid the groundwork for what became basic science departments in colleges. In 1827 Massachusetts passed legislation which required towns of more than 500 families to have a public high school open to all students. The National Teachers Association, now the National Education Association, was formed in 1857 and by the end of the 19th century, 32 states had adopted compulsory school attendance laws.

In the United States, the first half of the 20th century was punctuated by World War I (1914-1918), the Great Depression (1929-1939), and World War II (1939-1944). Through these crises, the education model continued to change, influenced as always by social, economic, and democratic (political) forces. In the early decades of the 20th century, policymakers were faced with business excesses such as the Standard Oil Company and various large trusts, as well as child labor abuses. On the education front, compulsory attendance laws, combined with more stringent child labor legislation and a growing population, served to dramatically increase school enrollment. At the same time, policymakers turned to the corporate example as a model of organizational structure that would reduce the waste and inefficiency of unwieldy school boards. "Centralized responsibility and control, clearly defined functions, and single-hearted concentration of each member of the organization upon his work seemed indeed an ideal and a method worthy of incorporation in the conduct of school affairs" (Thayer, 1965, p. 280).

These years witnessed a number of important developments in learning theory, including John Dewey's *Democracy and Education*, which launched the progressive movement, and Jean Piaget's *The Child's Conception of the World* on cognitive development. The federal government remained noticeably inactive in matters of education during the first half of the 20th century, excepting the Smith-Hughes Act of 1917, which provided federal funding for agricultural and vocational education, and the G.I. Bill in 1944.

It is apparent that policymakers throughout U.S. history have had enormous faith in the power of education as a means for individual and societal improvement. During the 17th century, education was primarily seen as a means to promote moral virtue and civic responsibility. The 18th century viewed education as a means to more rapidly assimilate immigrants into this country and to democratize a more diverse population. The industrial revolution of the 19th

century required a skilled workforce to keep the engine of economic growth going and to ensure that the benefits of democracy and economic growth were enjoyed by a greater percentage of the population. Today, policymakers emphasize the need for an educated populace in an increasingly complex, competitive, and global marketplace. In short, the underlying purpose and value of education reflects a remarkable consistency, having changed little from the founding of our nation.

Policymaking and Science: Colonial Period to World War II

The scientific revolution of the 17th century occurred contemporaneously with the settling of Europeans in North America. The changes in thinking and philosophy wrought by Kepler (1571-1630), Galileo (1564-1642), Francis Bacon (1561-1626), Descartes (1596-1650), Boyle (1627-1691), and Newton (1642-1727), among others, shook the world. Advances in medicine, biology, and astronomy were known to non-scientists, who began to value inquiry over dogma and reason over mysticism. During this century, scientists communicated with one another and formed societies, such as the Royal Society in 1660 and the French Academie des Sciences in 1666, for the advancement of knowledge. A number of polemical books and tracts were available to the reading public and new advances such as the telescope and medical instruments would have been known by everyone.

Many of our founding fathers had a particularly close and deep appreciation of the value of scientific endeavors. Benjamin Franklin's fame as an inventor and scientist is the most well known. Among his other accomplishments, Franklin helped found the American Philosophical Society in Philadelphia in 1742, and he was also a member of France's Royal Academy of Science. Washington had served as a surveyor and engineer as a young man before assuming command of the Continental Army. Thomas Jefferson enjoyed a range of scientific interests and

served as the president of the American Philosophical Society from 1779-1815. Alexander Hamilton promoted the funding of scientific endeavors "as a part of his program for the stimulation and development of manufacturing in the young nation" (Cox, 1964, p. 3).

Policymakers in the new United States recognized from the beginning the particular economic and social benefits that derive from scientific endeavors. Therefore, although science, like education, was not expressly provided for in the Constitution, Article I, Section 8 gives Congress the power "to promote the progress of science and the useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." One of the first acts of the new government was to create a Patent Office in 1790. These protections combined with a favorable policy environment, a high tolerance for risk and innovation, and the availability of capital markets have allowed America to benefit, seemingly disproportionally, from advances in science.

Although scientific endeavors ostensibly remained outside federal control, in the 19th century federal policymakers found ways to support scientific activities and the establishment of scientific agencies and academic institutions. Concerns shared in common among states, such as safe water and communicable diseases, created a demand for federal intervention. In 1803, President Jefferson ordered the first government-sponsored scientific expedition by Lewis and Clark, and in 1832, the "first government grant for experimental research was made by the U.S. Treasury Department to the Franklin Institute in Philadelphia for an investigation of steam boiler explosions on steamboats" (Cox, 1964, p. 4). The country's first scientific periodical, *The American Journal of Science,* was inaugurated in 1818, and the American Association for the Advancement of Science was founded in 1847. In 1846 the first national science foundation, the Smithsonian Institution, was founded. During the Civil War, the U.S. Department of Agriculture

(1862) was established, the Morrill Act (1862) provided for the establishment of at least one college to provide instruction in agricultural research, and the National Academy of Science (1863) was established. In its 1968 publication, *National Science Policies in the U.S.A.: Origins, Development, and Present Status,* UNESCO reported that the charter of the newly established National Academy of Science "authorized the scientists to determine its rules and membership, and laid upon the members of the Academy an obligation to investigate, examine, experiment, and report upon any subject of science or art in response to a request from any department of the government" (p. 14). It goes on to state that Academy members were not to be compensated by the government, thus ensuring that they, and their efforts, would remain independent of government control.

In such ways did the federal government support and influence science while not controlling science. By the beginning of the 20th century, the United States had become an economic force on the world stage. Despite this new stature in the area of science research and science education, graduate students such as Robert Oppenheimer still felt it necessary to go to Europe for advanced study. Excepting necessary contracts between the government and industry for military purposes, there was no mechanism in place for consistent collaboration between government and the science community. The public and the science community had long and deeply held biases against federal involvement in education and in scientific research, both of which were to remain uncorrupted by federal intervention. These biases changed in the aftermath of World War II as stunning scientific and technological advances made clear the critical importance of science and technology to our nation's security and economic health. It became abundantly clear to policymakers that education and science were too important to the national interest to remain outside the influence of federal policy.

Conclusion

In respect to the sentiment of the day, which was suspicious of concentrated power, the founders of our country chose to leave education out of the Constitution. The Tenth Amendment to the Constitution states: "The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people." Nevertheless, during the 150 years from 1789 to 1940, as the United States transformed from a relatively thinly populated rural agrarian society to a more heterogeneous highly industrialized world power, education governance transitioned from loosely regulated local control to tightly regulated state control. Throughout this evolution, policymakers always maintained a compelling interest in education and science, doing so from a comfortable distance that respected the federal nature of our government. Any review of this country's history cannot overlook the deep-rooted faith policymakers have always maintained in the power of education and science to transform society and individuals for the betterment of both. This decision to keep education outside the control of the federal government was to have repercussions, which will be touched upon in Chapter VII.

Given the unusually long time period under review in this chapter, the reader will note an evolution in the dominant competing framework. The first noticeable framework evident in our founder's education initiatives reflected a religious purpose. Although the early education models in the Northern and Southern states differed, both were motivated by a desire for their population to be able to read the bible and participate in governance. As more people immigrated to the United States, education was viewed as a way to help assimilate new citizens into our culture. By the mid 19th century we see evidence of a more commercial or economic engine driving public support of education. Whether policymakers valued education for religious,

cultural, and/or economic reasons, each motive reveals a practical utilitarian attitude toward education that has never wavered.

The first half of the 20th century was punctuated by World War I, the Great Depression, and World War II. Each of these cataclysmic trials demanded government intervention on a level that would not have been tolerated by the American public during normal times. World War II remains the watershed event with regard to federal influence on education and scientific activities. Subsequent to World War II, the federal role vis. a vis. education and science policy has become increasingly interventionist. The U.S. Department of Education, which became a cabinet level post in 1980, defines the federal role as a kind of "emergency response system," a means of filling gaps in state and local support for education when critical needs arise. It is this evolution of federal science policy as it applies to science and K-12 science education reform that is the focus of this study.

World War II represents the starting date for my investigation, since the first widely recognized science policy document, *Science: The Endless Frontier,* was published in 1945. Key milestone events, such as World War II, Sputnik, and the moon landing mark the beginning and end of policy periods wherever possible. By allowing the historical narrative as revealed in the literature to mark policy periods, my intent is to be true to the purpose of the study. When no single defining event was evident, I turned to the policy documents themselves to introduce a new policy period as is the case with *A Nation At Risk* in 1983.

Chapter III

1945-1957

"From Stettin in the Baltic to Trieste in the Adriatic, an iron curtain has descended across the continent" -- Winston Churchill, March 5, 1946

"The physicists have known sin; and this is a knowledge which they cannot lose." -- J. Robert Oppenheimer, 1955

Economic, Democratic, and Social Context

The end of World War II and the successful launch of Sputnik are the bookends to this policy period, with the Korean conflict situated approximately mid-point. In April 1945, President Truman assumed the presidency upon the death of Franklin D. Roosevelt, who had led the United States through the dark times of the Great Depression (1929-1939) and World War II (1939-1945). These crises, as well as World War I (1914-1918), had necessitated a new activism on the part of the federal government that would not have been tolerated during normal times. The greatest change in the government's role occurred during the New Deal, President Roosevelt's response to the Great Depression. Roosevelt's New Deal legislation represented government peacetime activity on a massive scale (Boyer, 2001), resulting in the government becoming the largest single employer in the nation. According to a U.S. Department of State report, *Growth of Government Intervention in the Economy,* "Many Americans concluded that unfettered capitalism had failed. So they looked to government to ease hardships and reduce what appeared to be self-destructive competition. Roosevelt and the Congress enacted a host of new laws that gave government the power to intervene in the economy" (Conte & Karr, 2001, para. 2).

By the end of World War II, the United States had assumed status as a superpower, and it became impossible to completely separate domestic policies, including science policy, from foreign policies. In the aftermath of World War I, the United States had attempted to withdraw

into itself as is evidenced by its refusal to join the League of Nations and its reluctance to enter World War II. Isolationism was not an option in the aftermath of World War II. The end of World War II found Europe and Japan devastated and in economic ruin and the Western powers and the Soviet Union challenging each other in a divided Germany. During this cold war phase, Soviet Premier Nikita Khrushchev repeatedly announced that communism would eventually defeat capitalism and made bold attempts to intervene in Iran, Turkey, and Greece. Formation of the Soviet Bloc and the Soviet rejection of the Baruch Plan to control atomic energy generated tremendous distrust of the Soviet Union in the United States. It was in this atmosphere that the Truman Doctrine was introduced, which promised U.S. aid to any country resisting communism. The United States also implemented the Marshall Plan to help rebuild the economies of Europe (Boyer, 2001).

The rise of tensions between the West and the Soviet Union led to the arms race, the space race, and the McCarthy hearings. During this period the United States began rebuilding its war machinery. In 1947, the Department of Defense, the National Security Council, and the Central Intelligence Agency were formed. The Selective Service system was reintroduced in 1948 and the United States established military bases in Europe to provide security against Soviet expansion in Western Europe. In 1949, the Western powers formed the North Atlantic Treaty Organization (NATO), and in 1955, the socialist states of Eastern Europe formed the Warsaw Pact to counter NATO. The Soviet Union's explosion of an atomic bomb in 1949, years earlier than expected, launched a crash program in the United States to build a hydrogen bomb. This cold war, between the capitalist West and the Soviet Union, was to last for 45 years and greatly influence U.S. science policy for all that time (Berube, 1991).

Cold war sentiments intensified when communist North Korea invaded South Korea in June 1950. What began as a civil war escalated into a contest between communist support of North Korea and United States support of South Korea. Just five years after World War II, the United States again found itself engaged in a military struggle across the globe. The United States lost over 33,000 soldiers in Korea before a cease fire was signed in July 1953 (Rhem, 20000. The Korean conflict served to heat up the cold-war fervor in the United States, leading to a doubling of the U.S. defense budget from $24 billion in 1950 to $52 billion in 1952. At the peak of the "red scare," anti-communist sentiment found a spokesperson in Senator Joseph McCarthy of Wisconsin. McCarthy claimed that there were communists in positions of influence in government and in society and that they posed a threat to freedom and democracy. Writers and actors were blacklisted, teachers fired, and books destroyed. The Rosenbergs were found guilty of selling secrets to the Soviet Union and, in 1947, President Truman instituted a Loyalty Program, requiring that people wanting to work for the government take loyalty oaths.

In the aftermath of World War II, it became obvious to policymakers and the public that strong federal policies would be required to transition the nation's economy from its wartime footing to a peacetime status. This attitude was made manifest in documents such as *Science: The Endless Frontier*, President Truman's 1946 State of the Union Address, and Eisenhower's 1954 State of the Union Address. This transition was made somewhat easier by the fact that, while Europe's infrastructure had been destroyed during the war, the United States had seen its prosperity increase. Returning military and support personnel came home expecting to be able to go to college, marry, buy a house, and raise families. In his January 1946 State of the Union Address, President Truman acknowledged that it is the government's responsibility to support and stimulate our economic system, as only the government is accountable to all the people.

These sentiments generally found favor among the public and not only did the United States successfully transition its economy in a manner that generated tremendous growth and opportunity, but it did so while helping to reconstruct Europe and Japan. On the economic front, the post-war years were characterized by rapid economic growth and renewal. In *The Affluent Society*, economist John Kenneth Galbraith noted "that the bottom 20% of the U.S. population experienced a 42% increase in income between 1941 and 1950" (Berube, 1991, p. 32). Our government was able to return the U.S. economy to a peacetime footing while keeping unemployment below 7% throughout the 1950s, something that had concerned policymakers who remembered the Great Depression. This prosperity was fueled by federal spending, higher wages, pent up consumer demand, and the G.I. Bill. To be sure, not everyone participated in this new prosperity; small farmers found it more difficult to compete and African Americans did not share to the same extent as most. In 1946, President Truman signed the Full Employment Act, which acknowledged federal responsibility for achieving and maintaining full employment. In a country whose economic strength had been, in large part, due to a laissez-faire policy, this Act recognized that the federal government has a central role to play in ensuring our nations' economic health. When President Truman signed this bill he stated, "The people do expect the government, however, to create and maintain conditions in which the individual businessman and the individual job seeker have a chance to succeed by their own efforts" (para. 4).

The social fabric of American life was changing in the 1950s, although, in light of the unrest that characterized the 1960s, the 1950s seem relatively tame. The mid 1940s marked the beginning of the baby boom generation, which had profound implications for education in the 1950s and 1960s. Specifically, the baby boomer wave necessitated more capacity; new schools and more teachers. In 1950, there were an estimated 6 million television sets in the United States,

and by the end of that decade the number was 60 million. Television was the communication medium of choice and social norms, such as two-parent families and homemaker wives, were promoted on shows like Ozzie and Harriet and Father Knows Best. Live news shows, including videotaped events from around the world, were brought into virtually everyone's living room. Elvis was king and Rock and Roll was here to stay.

The wish to return to some traditional normalcy, an understandable urge in the aftermath of the Great Depression and World War II, only partially cloaked deeper social unrest, which was to erupt in the 1960s. Students were likely to walk to school, poodle skirts were the rage, and the student population was much less ethnically diverse than today. Fear of the use of atomic energy gave rise to bomb shelters or "fall out" shelters in the 1950s. Students were taught to "duck and cover" during air raid exercises in schools across the country. America's love affair with the automobile combined with a greatly improved highway system led to suburbs, drive-ins, and shopping centers. Teenagers copied the beatnik fashion and parents worried about juvenile delinquency. Scientific themes were popular during this period and chemistry sets and microscopes were often found under the Christmas tree. The "wonders of nature" and "science for tomorrow" appeared as common motifs on television and in magazines. (Montgomery, 1994, p. 193)

Federal Science Policy

These were the formative years of the U.S. research establishment. In 1941 President Roosevelt had established an Office of Scientific Research and Development (OSRD), to oversee mobilization of the country's resources during the war effort. The war had provided stunning examples of the rewards of scientific investment, including, but not limited to, development of the atomic bomb, the discovery of antibiotics, advances in rocketry, and radar. It was apparent to

politicians, policymakers, and the general public that the United States owed much of its success in World War II to advances in science and technology, which was increasingly viewed as absolutely essential to the country's national security and continued economic prosperity. With an end to the war in sight, President Roosevelt sent a letter in November 1944 to the director of OSRD, Dr. Vannevar Bush. In this letter President Roosevelt solicited Bush's opinion with regard to the following questions: What can be done to disseminate scientific knowledge for the purposes of stimulating new enterprises and providing jobs? What can be done to ensure that medical advances continue? What can the government do to aid research activities in the public and private sector, and how can we identify and develop scientific talent in American youth so that the continuing future of scientific research in this country may be assured?

Bush appointed four committees, each to address one of the President's questions, while he authored a summary document entitled, *Science: The Endless Frontier*. This document is commonly referenced as the first national science policy document, although that was not its intent. What is noteworthy about this document is that it advocates eloquently for a role that the federal government play in supporting scientific research at universities as well as in government laboratories. In his report, Bush recommended the formation of a National Research Foundation (NRF) to provide funding for research and to coordinate research activities of interest to the national welfare. Among those who opposed Bush's proposal, were potential beneficiaries of government research funding, who rejected the very idea of any government influence over science. President Truman vetoed legislation calling for the creation of the NRF on the grounds that as President he did not have the Constitutional authority to disburse public funds to an independent agency.

Despite Truman's veto of the NRF legislation, he remained supportive of the general idea and created the President's Scientific Research Board to examine options for a policy-related science agency in 1946. John R. Steelman, an economist who had worked closely with Truman on labor matters, was named chairman. In 1947, the Steelman report, *Science and Public Policy*, was submitted to the President. The Steelman Report maximized the use of data to support the need for government support of academic research. This second report also had the benefit of coming out two years later, a period of time that only underscored the importance of science and technology. Among its other findings, *Science and Public Policy* made clear that scientific personnel shortages would be a more limiting factor in the country's science capacity than financial resources. The Board began its report with these words: "The security and prosperity of the United States depend today, as never before, upon the rapid expansion of scientific knowledge. So important in fact, has this extension become to our country that it may reasonably be said to be a major factor in national survival" (p. 3).

These two documents constitute the framework for federal science policy in the second half of the 20th century. *Science: The Endless Frontier* was authored by a classic laissez-faire conservative, while *Science and Public Policy* was authored by a group of individuals who had been part of Roosevelt's liberal New Deal program (Blanpied, 1998). Despite the philosophical differences of the authors, both documents represent a departure from previous political doctrine in that they deemed it necessary for the federal government to assume new responsibilities, responsibilities not expressly set down in the Constitution, for the creation of scientific knowledge in the national interest. These documents are the closest thing we have to a formal science policy statement. Both recognize that the government is uniquely qualified to perform certain functions, the scope of which is beyond the capabilities of the individual states. Both

reports made recommendations that established policies that remain central to federal science policy today:

- Creation of a permanent science advisory board to advise the President and Congress
- Government funding of research, with a focus on basic research
- Government funding of science education (grants and scholarships)
- Coordination of research efforts among industry, government. and university sectors
- Civilian control of science-insulate research from politics
- "Mission-oriented" basic research-practical goals of government

It may be said that federal science policy was largely conceived of and designed during this period. Prior to World War II, federal science policy, to the extent that it existed at all, was ad hoc; without structure and formal lines of accountability. It was during the post-war years that the federal government first assumed a direct and publicly visible role in funding, guiding, and coordinating scientific activities in the national interest. Federal science policy manifested itself primarily through the creation of national agencies such as the Atomic Energy Commission, the National Institute of Health, the Office of Naval Research, and the National Science Foundation. Each of these agencies and the many that have followed fund and coordinate federal policies that relate to its mission. During this historical period, science policies were promoted by a relatively small group of political and industry insiders, and policymaking followed a top-down model.

World War II was a watershed event with regard to the relationship between government and science and government and education. Beginning with World War II, the federal government began to assume a much more interventionist role in both spheres of activity and for the same reasons: recognition of the central importance of education in general and science education in particular to national security, whether measured in terms of economic and/or

military strength. In his September 13, 1948, address at the Centennial Meeting of the American Association for the Advancement of Science (AAAS) in Washington (Blanpied, 1948, para 1), President Truman proposed a national science policy consisting of five principles:

1. Double public and private spending on research and development sciences.
2. Greater emphasis on basic research and medical research
3. Establish a National Science Foundation
4. Give more aid to universities for scholarships and research facilities
5. Ensure that work of federal research agencies is better financed and coordinated

These were the formative years of the U.S. research establishment. Federal science policy between 1945 and 1957 was focused on the following: (a) capacity building; i.e., creating the federal structure(s) and mechanisms that would direct future federal science policy, (b) concerns about atomic energy and national security concerns relating to the cold war, and (c) the military build-up in Korea. Agencies were created to establish mechanisms for the collaboration of science activities among the government, industry, and academic sectors to serve to automate the discovery process itself.

The policy documents discussed earlier in this chapter, *Science: The Endless Frontier* and *Science and Public Policy,* formed the philosophical foundations that secured a central role for the federal government in the scientific arena. While both reports languished in political limbo until 1950 due to Truman's concerns over administrative control of the agency and ongoing concerns regarding atomic energy, the National Science Foundation (NSF) was finally signed into law in 1950. The NSF has two primary roles: to fund research (primarily basic research) and to support K-12 science programs as a means to stimulate interest in science. The NSF got off to a relatively slow start with limited funding because other agencies, such as the

Atomic Energy Commission, the Office of Naval Research, and the National Institute of Health, were already fulfilling some of the responsibilities originally conceived of for NSF. Over the past 50 years, the number of science-related agencies has grown exponentially, but it is the NSF that remains the cornerstone of federal influence over science education.

This period ended with a science policy address by President Eisenhower. On November 7, 1957, President Eisenhower made a televised address entitled "Science and National Security" from the White House. In this address the President stated that "one of our greatest and most glaring deficiencies is the failure of us in this country to give high enough priority to scientific education and to the place of science in our national life."

Education Policy during the Truman Presidency (1945-1953)

During the military recruitment process leading up to World War II, it became clear to policymakers that a significant portion of our population was deficient in basic reading and math skills. In his book, *A History of Ideas in Science Education: Implications for Practice*, George DeBoer revealed that the testing of recruits and officers for World War II highlighted deficiencies in literacy and reasoning skills. The war itself resulted in personnel shortages in key technical fields that were needed during and after the war. He went on to say that the war highlighted the strategic importance of science, mathematics, and technology and "strengthened our commitment to the principles of democracy, especially universal education" (DeBoer, 1991, pp. 128-129).

A large well-educated workforce able to capitalize on the new technologically driven economy was seen as a limiting factor to the post war recovery. Roosevelt's G.I. Bill of Rights (1944), which subsidized higher education for returning veterans, including women, served to improve the nation's labor pool, support the notion of a "right to education," and change public

perceptions about who should go to college. In 1946 President Truman created a Commission on Higher Education to study the issue of universal higher education. In a series of reports, the commission proclaimed education to be 'the foundation of democratic liberties' (Berube, 1991, p. 35). Truman's support for education was motivated by his belief in the need for an educated public to win the cold war against Russia. During his tenure as President, a number of bills were introduced into Congress for the purpose of providing federal aid to education. These measures failed until 1965, when President Johnson signed the Elementary and Secondary Education Act into law as part of his War on Poverty.

Education Policy during Eisenhower's First Term (1953-1957)

Excepting President Eisenhower's creation of a Department of Health, Education and Welfare in 1953, Eisenhower did not distinguish himself as an education president until 1957, when Russia launched Sputnik. The most pressing issue in education during these years had to do with the baby boomers that began entering the education system in 1951. These students created a demand for more classrooms and teachers, which led to requests for federal aid. The relative lack of activity on the education front during Eisenhower's early years reflected his reluctance to impose on what he viewed as a local matter, concern that federal money might go to religious schools, and the issue of racial desegregation. In 1954, the Supreme Court in *Brown v. Board of Education of Topeka* ruled that "separate educational facilities are inherently unequal." In 1955, Eisenhower hosted a White House Conference on Education, primarily to discuss the implications of racial desegregation. Eisenhower preferred a gradual approach to the issue of desegregation, an approach which was not supported by the Northern members of Congress. From 1955 to 1958, Eisenhower submitted legislation for school construction only to be met with resistance by Congressman Adam Clayton Powell, who "refused to allow federal

grants to flow to unconstitutionally segregated schools" (New York State Department of Education, 2009, pp. 9-10). The desegregation issue came to a crisis in Little Rock, Arkansas, in 1957 when Eisenhower sent the National Guard to escort nine Black students into Little Rock's all-White high school. In the battle over states rights vs. civil rights, the federal government had come down squarely on the side of racial equality in education.

In the 1950s, schools were impacted by changing social values, and Rudolph Flesch's book *Why Johnny Can't Read* became a popular bestseller in 1955. Flesch's book revealed that the popular "look-say" teaching method of the day was generating students who could not read and recommended a return to phonics. Schools experienced dramatic increases in enrollment as baby boomers entered elementary school. Enrollment increased thirty percent during the decade as the new student population increased to twice that of the general population. As a result, schools experienced overcrowding and a teacher shortage. The U.S. Office of Education reported a shortage of 345,000 classrooms in 1953. Twenty percent of students attended schools that failed to meet basic safety standards. Federal aid to education focused on school construction, and by 1959 some $21 billion had been spent on new construction.

Science Education

Science education during this post-war period was influenced by science policy concerns. Foremost among these were scientific, engineering, and technical personnel shortages due to the war. These shortages were of particular concern to policymakers at a time when the Soviet Union developed the atomic bomb (1949) and South Korea (1950) was invaded. There already existed widespread recognition, among the public as well as policymakers, of the critical importance of scientific advances to our national security and economic health. In 1947, the American Association for the Advancement of Science published a report entitled *The Present*

Effectiveness of Our Schools in the Training of Scientists. This report was written at the request of the President's Scientific Research Board and was included in its report to the President. Among its findings, the AAAS found that too few students were taking high school science courses and that there were insufficient numbers of high quality high school science teachers.

The two seminal science policy reports, *Science: The Endless Frontier* and *Science and Public Policy,* emphasized the importance of elementary and secondary education. In the former, Vannevar Bush states, "The government should accept new responsibilities for promoting the flow of new scientific knowledge and the development of scientific talent in our youth. These responsibilities are the proper concern of the government, for they vitally affect our health, our jobs, and our national security" (A Program for Action section, para. 1). Bush's focus was primarily on secondary and graduate education with the objective of developing more scientists. In Volume IV of *Science and Public Policy*, Steelman revealed a number of deficiencies in the teaching of mathematics and science at the elementary and secondary levels and made specific recommendations for remedial action. (Blanpied, 1998).

Although the guiding science policy documents acknowledged the importance of elementary and secondary education, the bulk of federal funding for science education during these years was directed toward graduate and postgraduate programs. The immediate goal was to fill the personnel shortages in the scientific and technology arena. The primary objective of science education funding was to develop scientists. As a result, funding was directed to the brightest, and science education adopted a decidedly elitist approach. Science was not for everyone.

Overarching Questions

What were the democratic, social, and economic contexts or forces that shaped or influenced federal science policy during the immediate post WWII period?

In my Definitions section, I determined that public policies are most often originated and produced in response to a perceived problem. The problem that preoccupied federal policymakers after World War II was primarily that of ensuring national security. Therefore, using Fowler's "competing values" framework, I conclude that during this period political considerations, enabled by a strong economy, dominated social considerations in shaping national science policy. The driving constructs were as follows:

1. Science, broadly defined to include technological advances, had been stunningly successful during the war years and was widely recognized as a prerequisite to national security and economic health.
2. The importance and scope of scientific endeavors necessitated a central role for the federal government in funding and coordinating scientific research.
3. Science education policy was driven by personnel shortages in the science, technology, and engineering disciplines, due to the war effort.
4. Science education policy tended to focus on institutions of higher learning with the goal of funding basic research and generating more scientists.
5. Science education policy was still somewhat elitist; science was not for everyone.

It was not that the economy or changes in social values were unimportant; it was just that they were not perceived as problematic. The economy was strong, supported by pent up demand for homes and cars, a baby boom which added to the number of consumers and a government

which "recognized its central role in economic affairs." The social landscape changed radically in the post-war era, but the turbulence of the 1960s was absent.

What have been the philosophical and theoretical perspectives that form the basis for K-12 education in general and science education, in particular, during this policy period?

After World War II, there were two competing trends in K-12 science education. John Dewey's progressive philosophy of education was the dominant language of education after World War II. The progressive model emphasized coursework targeted to the majority of students, who were not expected to work in any scientific field. Progressivism emphasized a teaching style that was based on the needs and developmental stages of the student, encouraging student engagement and discovery. "Schools do not exist solely to prepare students for their lives as adults. Rather, they are also places where young people engage in meaningful activities at their own level" (Atkin and Black, 2003, p. 82). The progressive emphasis on everyday activities that were supposed to prepare students for life in society was reflected in the U.S. Office of Education's support of life adjustment education, which tended to focus on personal and social growth over more traditional math and science curricula. This trend resulted in science courses designed to be relevant to life circumstances, such as Consumer Science, Fused Physical Science and Survey Science. "If one thing was to characterize the movement (Life Adjustment Movement), it was the almost complete abandonment of traditional subject matter in favor of activities that would prepare students for life" (DeBoer, 1991, p. 143).

"To many lay persons in particular, there was such an obvious anti-intellectual character to many of these programs that it became easier and easier for the traditionalists to win the day" (DeBoer, 1991, p. 143). By the mid 1950s, we witness a backlash against the anti-intellectualism

of the progressive model and loud concerns about declining standards and in 1955 the Progressive Education Association closed its doors. (Bybee, 1995, para. 6.)

How was federal science policy reflected in NSF and AAAS activities as they relate to K12 science education during this policy period?

In keeping with policymakers' concerns regarding personnel shortages in the scientific arena after World War II, the President's Scientific Research Board requested assistance from the AAAS in determining the effectiveness of science teaching. In 1949, the AAAS issued a report, *The Present Effectiveness of Our Schools in the Training of Scientists.* In this report, the AAAS recognized the dual role of science education: to produce scientists and to educate the general population who would be called upon to support scientific efforts.

The AAAS recommended that students be encouraged to take chemistry and physics in addition to the general science and biology courses that were the more typical offerings in high school. The AAAS promoted more professional development and higher pay for science teachers in an effort to address the shortage of science teachers. The AAAS committee recognized that gifted and talented students were not given the support and guidance needed to develop their talents. In 1953, the AAAS Cooperative Committee on the Teaching of Science and Mathematics, in cooperation with the U.S. Office of Education, published a report on gifted education entitled *Education for the Talented in Mathematics and Science.* (DeBoer, 1991, pp. 133-136)

In 1956, Jerold Zacharies, a physicist from MIT, and a group of other like-minded scientists applied to the NSF for funding and received approval for the Physical Science Study Committee (PSSC). Their goal was to introduce more intellectual vigor into the high school science curriculum. (DeBoer, 1991, pp. 147-148) NSF activities in support of science curriculum development, was to dramatically increase in the next policy period, after Sputnik.

Conclusions

It was during this period, 1945-1957, that the federal government assumed a central role in support of newly defined national science policies. As we examine this policy period through Fowler's competing lens, we conclude that democratic or political values dominated science policy development, owing much to the fact that our economy was strong and society was enjoying a short-lived post-war optimism. Furthermore, the war had provided stunning examples of the rewards of scientific investment, including, but not limited to, development of the atomic bomb, the discovery of antibiotics, advances in rocketry, and radar. It was apparent to politicians, policymakers, and the general public that the United States owed much of its success in World War II to advances in science and technology, which was increasingly viewed as absolutely essential to the country's national security and continued economic prosperity. The science policy agenda was to establish and maintain U.S. superiority in the realm of technological advances and to generate scientists to keep our economy strong. It should be noted that Europe's scientific capacity, which had been preeminent leading up to World War II, had been devastated by the war.

Throughout U.S. history, policymakers have been reluctant to encroach on laissez-faire principles, believing that free markets and individual self interest are generally best for the economy (Adam Smith). This national identification with laissez-faire economics did not extend so far as to deny the necessity for federal intervention during times of crisis or for purposes of such scope that only federal intervention will do. Examples of the first, times of national crisis, include, but are not limited to, President Theodore Roosevelt's trust busting policies, President Franklin Roosevelt's New Deal, federal policies to mobilize wartime efforts and, more recently, the federal bail out of the banking industry. Examples of the kinds of purposes for which federal

government intervention is required due to the scale or scope of effort include, but are not limited to, landing a man on the moon, the regulation of railroads, maintaining a currency, and large scale science projects, such as the (now defunct) Super Conducting Super Collider. Most American citizens also recognized the right, if not the obligation, for the federal government to intervene in cases of social inequities such as forced racial integration of public schools.

It is also the case that in the aftermath of World War II, the federal government began to assume a broader role in national and foreign affairs. During this period the United States implemented the Marshall Plan to rebuild Europe, introduced the Truman Doctrine to halt the spread of communism, helped establish the North Atlantic Treaty Organization (NATO), and supported South Korea in its fight against communism. On the home front, President Truman authorized the Full Employment Act, which heralded the federal government's role in maintaining full employment. Whatever reservations some people may have had about U.S. intervention abroad, for the most part people were happy the war was over, the U.S. economy was healthy, and they were buying their first house.

This period marks the birth of U.S. National Science Policy as defined by the publication of *Science: The Endless Frontier* and *Science and Public Policy*. Despite the passage of almost sixty years, these documents still represent the seminal thinking with regard to the importance of science as the engine of economic growth, the role of the federal government in building scientific capacity, and the establishment of scientific agencies to coordinate government interests.

Two developments stand out as we study this time period; at the beginning of this period we witness a hesitation on the part of policymakers to define a role for the federal government in support of science policy, and by the end of this period we see no such hesitation. When Sputnik

went into orbit, the federal government responded quickly and confidently, bolstered by public outrage at the Soviet Union's perceived technological superiority. The second defining characteristic of this policy period is the open acknowledgment on the part of policymakers about the critical role that science plays in national security and economic growth.

During these immediate post-war years, the federal government refused to assert itself to the same degree in the arena of education, which remained a local matter. In education, democratic and social values were the drivers of change. That is not to say that the federal government did not make its interests known. Education policy actions such as the G.I. Bill and federal funding geared toward capacity building in K-12 education reflected social and public values over economic considerations, although I submit that these priorities are not mutually exclusive. The G.I. Bill provided college financing for a large group of Americans who otherwise would have been excluded from the opportunities that a higher education brings. The National Science Foundation funded research efforts, primarily at the graduate level. Federal funding for K-12 education was geared toward capacity building as the baby boomers entered school. Excepting the issue of desegregation, the federal government has remained relatively quiet with regard to education policy.

Chapter IV

1957-1969

"I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to earth." -- President Kennedy, 1961
"Turn on, tune in and drop out." -- Timothy Leary, 1967

Economic, Democratic and Social Context

This policy period began with the launch of Sputnik and ended when the United States put a man on the moon in 1969. The years in between were characterized by tremendous social upheaval at home and U.S. involvement in the Vietnam War. Eisenhower's presidency gave way to President Kennedy's election and the national trauma of his assassination almost three years later. President Johnson led the nation during the remaining years of the decade and inaugurated his Great Society, including an aggressive education policy, which is discussed later in this chapter.

In October 1957 the Soviet Union put a 184-pound satellite in orbit around the earth, suggesting to U.S. policymakers and the public that the Soviet Union could just as easily have put an intercontinental ballistic missile into orbit capable of targeting American cities. American policymakers and the public reacted with great alarm, concluding that Soviet scientists, technology, and education were superior to that of the United States. The United States was still very much in the midst of cold war fervor and President Eisenhower, understanding that the Soviet Union did not enjoy the technological advantage the public feared, was able to use the public fear to push through his policy agenda. Sputnik changed everything (Dickson, 2007). In an October 2007 article in *Phi Delta Kappan*, Gerald W. Bracey relates that then Senate Majority Leader Lyndon Johnson said that the Soviets could drop bombs on us from space and that author

Thomas Wolfe said, "Nothing less than the control of the heavens was at stake. It was Armageddon, the final and decisive battle of the forces of good and evil" (para. 2).

President John F. Kennedy was inaugurated in January 1961 and assassinated less than three years later. In 1961, just weeks before his inauguration, the United States had broken off diplomatic relations with Cuba after Fidel Castro announced that he was a communist. Short weeks after Kennedy's inauguration, the CIA led a failed attempt to invade Cuba at the Bay of Pigs. The Cuban Missile Crisis in the fall of 1962 had Russian and American ships confronting each other and the world stepped away from another world military conflict. In Southeast Asia, Kennedy held to a containment policy in Vietnam, believing that if South Vietnam fell to the communists, the rest of Southeast Asia would follow. Kennedy's political agenda was marked by the building of the Berlin Wall and the formation of the Peace Corps.

President Lyndon B. Johnson assumed the presidency upon Kennedy's assassination. One of his first acts was to ensure that Kennedy's Civil Rights Act was enacted (Berube, p. 62). This bill outlawed segregation in U.S. schools and public places and started the Equal Employment Opportunity Commission. President Johnson's time in the Executive Office was defined by the Vietnam War abroad and his Great Society agenda at home. The Great Society agenda promoted and implemented educational and social legislation that continues to benefit millions of Americans today, such as IDEA grants in education and Medicare/Medicaid. Unfortunately, his successes on the domestic front were too often overshadowed by the escalation of an increasingly unpopular war in Vietnam and Johnson's decision not to run for a second term in office.

The social fabric of the United States was strained and strengthened by the pace and increased militancy of change during the 1960s. Seventy million baby boomers became

teenagers and young adults during this decade. Social activism including the Free Speech Movement, the Civil Rights Movement, the Women's Liberation Movement, the Anti-War and Student Protest Movement, and the introduction of oral contraceptives all served to radicalize young people. President Kennedy's relative youth and charisma engaged the younger generation more actively in politics and social reform than ever before. These were the years of sit-ins and radical student protests on college campuses, civil rights demonstrations and the March on Selma, the tragic assassinations of Martin Luther King and Bobby Kennedy, the "peace and free love" philosophy of the hippies, psychedelic drugs, Haight-Ashbury, and Dr. Timothy Leary advocating "turn on, tune in, and drop out." The British invaded American popular culture via the Beatles and James Bond, and Woodstock was the "happening" still remembered by anyone over fifty. Star Trek became a cult favorite that continues to "go where no one has gone before."

President Johnson's Great Society and War on Poverty resulted in tremendous social gains for million of Americans. These included the Social Security Act of 1965, which created the Medicare and Medicaid programs as well as programs such as Head Start, Job Corps, VISTA (a domestic model of the Peace Corps) and food stamps, among others. The economic prosperity and social turmoil of the sixties greatly impacted traditional values, life style choices, and education. Of the six decades since the end of World War II, this decade is arguably the most fertile from the perspective of educational policy in general and science education practice in particular.

Federal Science Policy

One of the earliest policy statements of this period is Eisenhower's "Science: Handmaiden of Freedom" speech, given in May 1959. In this speech he was assertive about government's role in science and education, reaffirming the necessity for a partnership between

government and the private sector in scientific research and recognized the importance of technology and science to the country's security. President Eisenhower created a number of advisory committees and agencies to enable the government to better organize and manage its scientific efforts. Included among these were the creation of the President's Science Advisory Committee (PSAC) in 1957, establishment of the National Aeronautics and Space Agency (NASA) in 1958, and the Federal Council for Science and Technology in 1959. In the formation of NASA, "the scientists were included in the political process for the first time on a grand scale, a substantial achievement" (Cox, 1964, p. 65).

The worst of the House Committee on Un-American Activities (HUAC) and FBI abuses seemed to dissipate by the late 1950s. In August of 1956, "the Eisenhower administration directed all government agencies not to deny grants or contracts for unclassified research on loyalty grounds unless criminal charges were involved," and the Supreme Court ruled that security measures were no longer necessary for employment to non-sensitive positions (Wang, p. 285). The atmosphere of cold war anticommunist fears was not dead, however, and HUAC remained a standing committee until 1975 (Wang, p. 285).

This policy period, inaugurated by Sputnik and continuing through the moon landing, is considered the "golden age" of science as marked by significantly increased NSF funding for education, increased status of scientists, and popular recognition of the benefits of science. According to the National Science Foundation's own website, the NSF appropriated $40 million in 1958, $134 million in 1959, and over $500 million by 1960. In President Eisenhower's January 1958 State of the Union speech he called for cooperation with and sharing of non-sensitive scientific information with allies. Eisenhower recommended legislation to formalize unity of purpose among NATO countries. He further recommended investment of approx $1

billion over four years through the Department of Health, Education and Welfare to improve teacher quality and student opportunities and a five-fold increase in NSF funding to science education.

During this period we witnessed the rise of interest in the social or behavioral sciences. The 1962 publication of *Silent Spring*, the Surgeon General's warning on the dangers of smoking in 1964, and the exposure of birth defects from the use of Thalidomide (1957-1961) contributed to the rise of the environmental movement (Silveria, 2001). Over sixty nations participated in the First International Geophysical Year (1957-1959), with U.S. participation being coordinated by the NSF. The purpose of the IGY, according to the National Academy of Sciences, was to conduct a global study and data collection effort in areas such as oceanography, cosmic rays, and longitude and latitude.

In a special address to Congress in 1961, President Kennedy set federal science policy for the rest of that decade, stating, " First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth (Kennedy, 1961, p. 404). President Johnson continued the commitment to space exploration; however, the costs of his Great Society and the Vietnam War limited federal expenditures on scientific pursuits.

Education Policy during Eisenhower's Second Term (1957-1961)

Science policy after Sputnik was dominated by fears that U.S. education was lagging behind that of the Soviet Union, cold-war national security concerns, the military build-up in South Korea, and the space race. Education, in general, and science education, in particular, was regarded as a solution to these concerns and essential for national security. In a paper presented in 1997 by Roger Bybee, *The Sputnik Era: Why Is This Educational Reform Different From All*

Other Reforms, the author described Sputnik as the milestone event ushering in a more traditional rigorous science and mathematics curriculum. Americans who had previously been opposed to government influence in education were now demanding education reform. Within a year of Sputnik's launch, Congress passed the National Defense Education Act (NDEA).

NDEA was the first of two significant education acts passed during this policy period. This Act was intended to promote the advancement of education in science and mathematics as well as aid in other areas. The bill provided funding of more than $1 billion for school construction and loans to students for higher education. Funds were also made available for vocational programs to address manpower shortages in the defense industry. The Act provides institutions of higher education with 90% of capital funds for low-interest loans to students. NDEA also provides federal support for improvement and change in elementary and secondary education, while prohibiting federal control over curriculum, administration, or personnel of any educational institution.

Education Policy during the Kennedy Presidency (1961-1963)

Kennedy's domestic program, called the New Frontier, did promise federal aid in support of public education; however, his short tenure as President did not see any significant pieces of legislation passed. Kennedy had been a supporter of federal aid to education since he served in Congress but, while President, his efforts stalled due to resistance from Southern democrats who feared federal funds might be used to support integration and from those who feared federal funds might be used to support parochial schools. He was able to pass a bill in support of disabled students and his Manpower Development and Training Act funded vocational programs for 'at risk' students (*Federal Education Policy and the States.* 2006). Kennedy's assassination in 1963 brought in a more liberally inclined Congress in the 1964 elections. This, combined with

President Johnson's interest in education and strong political deal making, paved the way for Johnson to push through many of Kennedy's social and education policies. (Berube, 1991)

Education Policy during the Johnson Presidency (1963-1969)

During his tenure as Chief Executive, President Johnson pursued an aggressive education agenda, and a number of important pieces of educational legislation were passed. Foremost among these was the Elementary and Secondary Education Act (ESEA) of 1965, the second significant education act of this policy period. ESEA, part of President Johnson's War on Poverty, was the first and remains the largest source of federal funding to K-2 education. ESEA funds programs that target the needs of educationally deprived children: programs like Title I, Head Start, and Bilingual Education, among others. (Berube, 1991, p. 76) ESEA has been reauthorized every five years since its enactment and is currently known as the No Child Left Behind Act (NCLB) of 2001.

One of the most influential studies in the history of education, the Coleman Report, was published the year after President Johnson signed ESEA into law. The general assumption of educators, indeed Coleman's assumption, was that the funding differences between Black and White schools would be large, and that these differences would provide the central explanation for the unequal achievements of Black and White students. In 1966, after conducting what was then the second largest social science research project in history--involving 600,000 children in 4,000 schools nationally--Coleman and his colleagues issued *Equality of Educational Opportunity*. In a June 22, 2001, article for *The Public Interest*, Nicholas Lemann is quoted as saying that the Coleman Report was, "probably the single best-known piece of quantitative social science in American history" (Kahlenberg, 2001, para. 4). The Coleman Report revealed that the disparities in funding between schools attended by Black and White students were far smaller

than anticipated and that family economic status was far more predictive of educational achievement than school funding.

Other important milestones occurred on the education front during this policy period. Secondary institutions experienced enormous enrollment growth as the baby boomers reached college age. Research universities benefited from increased funding from government and industry and assumed a more central role in policymaking as advisors to government and industry. Membership in teachers' unions grew dramatically and intelligence testing came into its own as a way to screen candidates for admission to college. "In conclusion, Johnson became the education President against whom all others will be measured" (Berube, 1991, p. 81).

Science Education

"After Sputnik, the federal government's role in science education became more explicit, though it still carefully avoided any hint or threat of federal control of education" (Rossiter, 1985, p. 285). Ever since the first science policy documents were released in the immediate aftermath of World War II, politicians and corporate leaders kept reiterating their concern that we were not generating enough new scientists and technologists necessary for the United States to maintain its technological and economic lead. (Fitzpatrick, 1953)

This policy backdrop allowed traditionalists, including stakeholders outside the education structure, to assert control of science curriculum. Federal agencies, particularly the National Science Foundation (NSF), and philanthropic foundations such as the Carnegie Corporation and the Rockefeller Fund provided ample financial support for the development of new programs. (Bybee, 1997)). Educators were not driving this reform agenda.

Overarching Questions

What were the democratic, social, and economic contexts or forces that shaped or influenced federal science policy during the Sputnik era?

Federal science policies during this period were defined by the space race, the arms race and social unrest. It was still policy for science. During the first half of this policy period, Fowler's democratic values, as defined by national security concerns, continued to dominate the science policy agenda. Most importantly, during this period, we saw a direct and almost immediate link between science policy and education reform. National security concerns drove the science agenda, which included a strong emphasis on education reform.

Stakeholders promoting science policy and science education policy represented a much broader and more vocal coalition than in the preceding policy period. During the first half of this policy period, the U.S. political agenda was consumed by fears of Soviet technological, scientific, and educational supremacy brought on by Sputnik and heightened cold war tensions caused by developments in Cuba. Sputnik, in particular, served to raise public concerns about the U.S. education system in general and science education in particular. Sputnik led immediately to increased funding for science education reform through the National Science Foundation, which is discussed in greater detail later in this chapter. The immediate response demanding education reform came from the top down and the bottom up. The public was engaged as never before, aware that the Russian satellite was circling above their heads every day.

During the second half of this policy period, Fowler's social values came to dominate the education policy agenda; anti-war and civil rights concerns were the driving force of change in society and in education. President Johnson's Great Society emphasized education as a solution to many of society's problems. The Elementary and Secondary Education Act (ESEA) of 1965

continues to represent the largest source of federal funding to education. This funding source did not support science education efforts. The National Defense Education Act of 1958 was a direct and immediate response to federal science policy developments. By the 1960s it becomes almost impossible to separate U.S. foreign and domestic policies from science policy; they had become so intertwined.

The 1960s witnessed a long period of sustained economic prosperity in the United States, allowing Presidents Kennedy and Johnson to fund the space race, education reform, and social programs. Real income had increased by 50% by the end of the decade for most Americans.

What have been the philosophical and theoretical perspectives that form the basis of K-12 education in general and science education in particular during this policy period?

By the mid 1950s a more academically rigorous traditionalist/essentialist model gained influence at the expense of the progressive model, which had been dominant after the war, in response to fears about Soviet supremacy. However, by the mid-1960s the rigor of the essentialist model was giving way to a more socially oriented model, influenced by Kennedy's and Johnson's social reforms. President Johnson's Great Society saw education as a solution to social problems such as unemployment, poverty, and crime. Anti-war sentiment and the civil rights movement, supported by a strong economy, prompted a return to an educational model that emphasized equity and opportunity over academism. In keeping with this social value framework, science was promoted as a means to improve man's environment and, as such, represented a return to the Progressive idea of science in the service of man. (Montgomery, 1994)

For some years preceding NDEA, the education community had witnessed a backlash against the perceived anti-intellectualism of the progressive model. Concerns about declining

standards in education were heralded in books such as Arthur Bestor's *Educational Wastelands* (1953) and Mortimer Smith's *The Diminished Mind* (1954). Sputnik's launch in 1957 seemed to give credence to these concerns. Progressive education was dead by the late 1950s, replaced by the essentialist, or traditionalist, model which recommended a return to a more rigorous curriculum. "Shortages of technical personnel brought on by the war, the perceived threats to national security stimulated by the cold war competition and Sputnik moved education away from the theme of social relevance toward a mastery of the traditional disciplines" (DeBoer, 1991, p. 146). Although this traditionalist reawakening was short-lived, it did introduce a particularly fertile period of science curriculum reform that had a long-term impact on K-12 science education programs.

"By the mid 1950s scientists and their associations, funded by the National Science Foundation (NSF), began to investigate ways they could help to bring renewed intellectual vigor to school science programs" (DeBoer, 1991, p. 147). This foray into the development of science curriculum was done cautiously so as not to raise concerns about the federal government infringing into the arena of education, which was a state responsibility. In 1956 Jerrold Zacharias, a physicist from MIT, began discussing with other prominent physicists the possibility of creating a new course in school physics. The group applied to the National Science Foundation for funding and received approval for the Physical Science Study Committee (PSSC) project in November of that year. (DeBoer, 1991)

In September 1959 a group of 35 scientists and educators met at Woods Hole, Massachusetts, for 10 days. The Woods Hole conference, headed by Jerome Bruner, a psychologist from Harvard, met to discuss new developments in science and math teaching at the request of the National Academy of Sciences. The field of psychology was well represented at

this conference, and the fact that the learning philosophies of the psychologists meshed well with those of the curriculum makers contributed to the success of the product. (DeBoer, 1991, p.159) The PSSC curriculum is currently in its seventh edition. Other high school science curricula developed during this period include the Biological Sciences Curriculum Study (BSCS), the American Chemical Society, and the Earth Science Curriculum Project.

How was federal science policy reflected in NSF and AAAS activities as they relate to K12 science education during this policy period?

The NSF budget for science and science education increased from approximately 28% in 1956 to almost 40% in 1961. NSF sponsored efforts such as those of Zacharias and the Woods Hole group added rigor to the curriculum. The materials they developed were "teacher proof" and their agenda took no particular notice of the advice of educators. The new curriculum involved students directly in actually "doing science." (Montgomery, 1994, p. 211) This curriculum reform period, funded by the NSF, represents a rare example of university-based scholars and scientists leading the design of K-12 curricular reform.

> The national scope of the projects, the funding by the federal government, the widespread use of the courses across the country, and the involvement of noted scientists in the creation of the courses all made this effort unmatched in the history of American education (DeBoer, 1997, p. 166).

The federally funded curricula developed during this period became widely disseminated, with almost two thirds of middle and high schools using one or more of these programs in 1977. In that same year, 30% of school districts reported using at least one program in elementary schools (Bybee, 2007, para. 1).

In 1958 over 100 scientists, along with dozens of representatives from academia and industry, were invited to a "Parliament of Science" hosted by the AAAS. The purpose of this parliament was to consider current science and technology policy issues and their impact on national welfare. Parliamentarians acknowledged the importance and influence of Sputnik on education policy but recommended a broader view. They wanted to examine man's relationship to himself, the universe and the subatomic world (Crumpton & Teich, 1999).

In the 1960s and early 1970s, AAAS was actively involved in the development of school curricula and teacher training. From 1963 through the mid 1970s, the AAAS introduced Science: A Process Approach (SAPA), in response to the Sputnik-generated interest in science education. Funded by the NSF, this program was relatively broad in scope, including five volumes of textbooks, kits, and classroom materials for students in Grades K-6. Throughout these years and beyond, both the AAAS and NSF supported science education through the funding of summer institutes for teachers around the country and by supporting science programming on public television.

Conclusion

With respect to U.S. science policy and education policy, Fowler's democratic, or political, agenda clearly dominated social and economic considerations through the first half of this policy period. Sputnik changed everything. Whatever reservations remained about the proper role of the federal government in support of a national science agenda ended with Sputnik. An examination of newspaper headlines and media records of the time reveals just how traumatic the notion of a Soviet satellite flying overhead was to the American public. Whether the threat was

real or simply used by savvy policymakers to push forward their agenda, Sputnik called for a strong federal response.

Sputnik also directly and quickly ushered in the first era of education reform. Within a year, the federal government passed the National Defense Education Act (NDEA), with the primary purpose of funding interest and achievement in math and the sciences. Sputnik led directly to a more assertive role for the federal government in science education. This was arguably the most fertile period of science curriculum development in our nation's history. Top level scientists, funded by the NSF and working with educators, created new curriculum some of which remains in use today. Sputnik and the race to the moon served to concentrate public attention and support for science education and a more rigorous education pedagogy.

Toward the middle of this policy period, we witness a shift in the dominant theoretical framework from one that focused on political values such as national security to an emphasis on social values such as equity. This social, or more liberal, education agenda remained dominant throughout most of the 1960s and ushered in funding legislation that remains the primary source of federal aid to education today. In 1966 the Elementary and Secondary Education Act (ESEA) was passed and. it remains the largest source of funding to education: No Child Left Behind and Race to the Top represent the current embodiment of ESEA.

Chapter V

1969-1983

"That's one small step for man, one giant leap for mankind."-- Neil Armstrong, 1969

"A strong American economy is essential to the well-being and security of our friends and allies."

-- Ronald Reagan, 1983

Economic, Democratic, and Social Context

This policy period covers the years between the moon landing and publication of *A Nation at Risk* in 1983. Richard Nixon, Gerald Ford, and Jimmy Carter held the office of President during these years that forced Americans to re-evaluate their place in the world. The political and economic traumas of these years engendered a more conservative policy agenda.

The darker political tone of these years was presaged by the killing of four students by National Guardsmen in 1970 at Kent State University, followed by the killing of 19 Israeli athletes by Muslim extremists at the Munich Olympics in 1972. American confidence was severely shaken, in the most public of forums, when the United States was forced to withdraw from Vietnam in 1975 and in 1979 when Iranian students seized the U.S. embassy in Tehran, holding 66 hostages for 444 days. In between, the United States had to face political corruption as represented by Watergate and Nixon's impeachment, corporate incompetence as represented by the government bailout of Chrysler, and American military humiliation as represented by the massacre at My Lai. Nixon implemented a policy of détente with the Soviet Union as cold war military expenditures threatened to bankrupt both economies. Nixon began the Strategic Arms Limitation Treaty (SALT) talks with the Soviets in 1969, which continued throughout the 1970s.

Equally disheartening to American morale was the fact that the 1970s remain the most economically ruinous decade of the past 75 years, due partly to government spending in support of an increasingly unpopular and unsuccessful war in Vietnam, Great Society social programs

and the space race. After decades of uninterrupted economic prosperity and international prestige, this one-two punch--political and military impotence combined with economic recession--served to erode support for the liberal agenda of the Great Society and launched a conservative backlash. The 1970s were marked by the first U.S. trade deficits in 80 years, two oil embargos, increasing foreign competition, stagflation, unemployment, and the first federal imposition of peacetime wage and price controls.

The political and economic turbulence of the 1970s led to social disillusionment. The decade of the 1970s was much less optimistic than the 1960s. Young adults became the "me" generation and people flocked to the Sun Belt. While young people in the 1960s were outward looking and politically active, Americans in the 1970s tended to be more inward looking; self-fulfillment and therapy were the mantra. The Beatles broke up, Elvis died, and disco was popular. Hot pants and leisure suits were the fashion rage. The United States celebrated the first Earth Day in 1970, and in 1973 *Roe v. Wade* legalized abortion. Blockbuster movies such as Star Wars, Jaws, and the Godfather saga were huge hits. Television covered topics previously considered taboo on shows like All in the Family, Saturday Night Live, and Rowan and Martin's Laugh In. Environmental concerns began to play a much more important role in social discourse.

Federal Science Policy

By 1965 the number of federal agencies funding the science establishment had increased significantly, not to mention the fifty or so universities with large research faculties and industrial laboratories also pursuing basic research. These new agencies were the mechanism by which federal support for science and technology was funded, particularly to the universities. (Mann, 2000)

By the mid 1970s Japan and Europe had largely recovered from the destruction of World War II, and foreign companies began to make inroads into American markets in what was termed a new industrial competition. American firms lost shares in the automotive, steel, and electronic markets, among others. "The U.S. share of world exports of R & D-intensive goods declined from 31 percent in 1962 to 21 percent in 1977.... taken together these measures point to dramatic economic changes that have shaken the postwar faith in American technological supremacy" (Smith, 1990, pp. 101-105).

Science was not immune to the public disillusionment that set in during the 1970s; the media, the public, and scientists themselves began to question the certain benefits of scientific research. The origins of anti-science sentiment that arose during this period were diverse. Rachel Carson's *Silent Spring*, published in 1962, documented the devastating effects of pesticides such as DDT on the environment. Ralph Nader's 1965 book, *Unsafe at Any Speed*, criticized the safety record of the U.S. automotive industry. Both books contributed to this sense of public skepticism.

The close and successful relationship between government and science that was evident after Sputnik and during the strong economic growth spurt of the 1960s came under greater scrutiny when the economic expansion reversed in the 1970s. This economic reversal coincided with a falling-out between some university scientists who opposed the Vietnam War and defense scientists working for the defense agencies. As a result, federal funding for basic research slowed in the 1970s. (Smith, 1990, pp. 72-75) According to an NSF report, *National Patterns of R & D Resources: 2008 Data Update*, federal funding for R & D as a percentage of total R & D (research and development) declined from the mid-60% in the 1960s to the low-50% in the 1970s.

Education Policy during the Nixon Presidency (1969-1974)

Despite the findings of the Coleman report in 1966, state and local policies continued to emphasize school-based reform. During the 1970s, court-ordered busing to establish racial balance in schools, state funding formulas, and special education were at the forefront of the education agenda. Congress enacted amendments to ESEA that greatly expanded federal aid to low-income areas in the following programs: career education, dropout prevention, school health, and migratory and delinquent programs, among many others. It was in this context that the first serious attacks on school funding took place. For instance, in *Serrano v. Priest (1971)*, the California Supreme Court found that the state's financial formula for schools was inadequate to meet the educational needs of all children. The California Supreme Court found that the state's existing funding method was discriminatory in that it made the quality of a student's education a function of his/her community's wealth.

One of President Nixon's first acts was to appoint James E. Allen, Jr., former New York State Commissioner of Education, federal commissioner and Assistant Secretary of Education in the Department of Health, Education, and Welfare (HEW). Allen became immediately embroiled in the issue of how to measure the effectiveness of federal funding programs. The issue of misuse of federal funds and the absence of and/or poor quality data to support the effectiveness of federal education programs became the focus of his efforts. Allen requested that Congress authorize a National Assessment of Educational Progress (NAEP) to track changes in student achievement over time. It was thought that the data collected would have descriptive as well as proscriptive value for school districts and educators; identifying areas in need of improvement across the country. (*Federal Education Policy and the States, 1945-2005*, 2009)

In 1972 another landmark case changed the education landscape. In *Mills v. Board of Education (1972)* a federal court held that while mainstreaming students with special needs might be preferable, schools could continue to provide their education in a separate setting so long as it promised improved educational benefits. This decision suggested that, depending upon the specific "needs" of the student in question, merely "equal" resources might not suffice and that in order to challenge charges of discrimination, disabled children were entitled to more resources than non-disabled children. Special education continued to receive a disproportionate share of Congressional attention and increased federal funds during the Nixon and Ford years. (*Federal Education Policy and the States, 1945-2005*, 2009)

Education Policy during the Ford Presidency (1974-1977)

During his 29-month presidency, President Ford signed into law the Education for All Handicapped Children Act in 1975 despite concerns that this bill would strain the financial resources of the federal government. The law mandated a "free, appropriate education" for children with disabilities, opening the door to an estimated 1 million children who had not been receiving educational services. By the time Ford left office and after federal aid became available, the number of children diagnosed with disabilities had increased dramatically. For example, federal aid for special education increased from $100 million in 1974 to $660 million in 1975 (*Federal Education Policy and the States, 1945-2005*, 2009)

Education Policy during the Carter Presidency (1977-1981)

By the late 1970s, there was increasing concern about low academic achievement which "led to an increasing emphasis throughout the nation on standardized test results as the best way to measure both student progress and program effectiveness....By 1978, thirty-three states had taken action to mandate minimum competency standards for grade-to-grade promotion or high

school graduation...testing *was* the reform." (*Federal Education Policy and the States, 1945-2005, 2009*, pp. 41-43) The U.S. Department of Education became a cabinet level agency in 1980 under Carter. Federal funds were distributed to states for the purpose of building capacity, offices, and programs. This influx of federal dollars served to create a dependency on the part of states to maintain their educational operations, a development only too evident to administrators charged with school budgeting.

Science Education

By the late 1960s and early 1970s a social agenda emphasizing educational equity over educational excellence dominated the education agenda. The unpopular war in Vietnam combined with poverty and racial tensions served as a catalyst to heighten feelings of discontent and even anger with many facets of American life. "The new need was for an enlightened citizenry, not an educational elite. To these critics, the science curriculum should be relevant to the lives of a broad range of students, not just those planning careers in science, and the methods of instruction should demonstrate a concern for the differences in ability" (DeBoer, 1991, p. 173).

Overarching Questions

What were the democratic, social and economic contexts or forces that shaped or influenced federal science policy during this policy period?

Fowler's economic values dominated science and education policy during this study period, reflecting growing public distrust of the government in the aftermath of the Vietnam War and Watergate, a weakened economy and economic outlook and a more conservative social outlook. We had successfully landed a man on the moon, putting to rest (at least temporarily) concerns that the U.S. was second best to the Soviet Union. The war was costing more than what President Johnson or President Nixon had anticipated, and both decided that fiscal discretion was

called for. It was decided that since funding for science agencies did not directly contribute to war efforts, they could be reduced. Accordingly, the NSF budget declined 20% in 1969. (Mann, 2000) This fiscal conservatism did give birth to a program known as Research Applied to National Needs (RANN). The Office of Management and Budget gave NSF a $100 million increase in return for NSF support for research programs focused on national problems. This program was also viewed as a means to stimulate the economy. (Mann, 2000)

The social landscape was much less radical in the 1970s than in the 1960s. Many Americans experienced their first real economic recession and were much less optimistic about the future. The social agendas begun during the 1960s continued into the 1970s but at a much less militant pace. Economic considerations took precedence over social and democratic values.

What have been the philosophical and theoretical perspectives that form the basis for K-12 education in general and science education, in particular, during this policy period?

During the economic hard times of the 1970s, conservatives rebelled against the student-centered learning movement that had been so popular during the social relativism of the 1960s. Education leaders pursued a more broad back-to-basics approach, with the intent to restore lost discipline and make learning more accountable to measurable forms of performance. (Montgomery, 1994) Science, in particular, "was taken to task for its abuses of power and for its presumed epistemological prejudice against women and minorities. The belief was that technical knowledge contained a large subjective component, one oriented away from certain groups in society" (Montgomery, 1994, p. 240).

Humanistic education was advocated by a number of science educators who believed that science teaching should do a better job of portraying science as a human activity and should be more concerned about the emotional response of learners. William McElroy, director of the NSF

and former president of AIBS, said, "The science community should consider more carefully...emphasizing man as an emotional and feeling creature as well as a reasoning one" (DeBoer, 1991, pp. 179-180).

In addition, the courses achieved the rigor that critics found missing in the older courses, and they encouraged students to think and act like scientists within the structure that was established. What the curriculum reformers failed to do was to adequately take into account the importance of student interest or the pedagogical need to relate science knowledge to the experiential world of the students (DeBoer, 1997, para. 5).

But the reform efforts were successful in many ways and they had a widespread effect on the science curriculum. In 1978, Suzanne Quick identified three innovations of the curriculum reform movement that had been integrated into mainstream commercially published textbooks during the 1960s and 1970s. The three movements were (1) updating and redistributing subject matter content to more accurately reflect the current state of a scientific discipline, (2) organizing content around a few conceptual schemes that are central to understanding a scientific discipline, and (3) using an activity-oriented approach to science education. (DeBoer, 1997, para. 5).

How was federal science policy reflected in NSF and AAAS activities as they relate to K-12 science education during this policy period?

One of the educational programs that the NSF helped create and support, *Man: A Course of Study* (MACOS), was introduced in the mid 1960s. This program was designed to encourage students to explore what it means to be human. Units included, but were not limited to, tool-making and social organization among different cultures. MACOS was based on Jerome Bruner's spiral curriculum, with concepts taught repeatedly in increasing complexity.

> *Man: A Course of Study* would eventually go down in history as one of the most dramatic instances of public indignation against the efforts of discipline-based scholars to create progressive curricular reform....The course was considered to be a breakthrough both in its content and its pedagogy. In 1969 Bruner received an award from the American Educational Research Association and the American Textbook Publishers Institute for his leadership in the development of MACOS. He was credited with having made "one of the most important efforts of our time to relate research findings and theory in educational psychology to the development of new and better instructional material. By 1974, when approximately 328,000 students in 1728 schools in 47 states were using MACOS, teachers responding to a National Council for the Social Studies survey rated MACOS second best overall and best of all federally funded curricular projects....However, by 1975, the course was awash in controversy...conservative parents in several states began to campaign against the federally funded course by writing stinging opinion pieces in local newspapers. They objected to content dealing with reproduction, aggression, killing, religion, and views of life and death" (Symcox, 2002, pp. 19-22).

The NSF was not as involved with science curriculum development in the 1970s as it had been in the 1960s. K-12 science education, which never accounted for a significant share of NSF funds, was particularly susceptible to the 1970s economic downturn. "The MACOS scandal brought the entire NSF sponsored reform movement to an end" (Symcox, 2002, p. 23). However, studies conducted by the NSF in the 1970s to evaluate the status of science and math education did show that NSF sponsored initiatives in the 1960s had been very successful. "Never before

had a single curriculum initiative had such a widespread effect on science teaching in this country" (DeBoer, 1991, p. 167).

Conclusion

Confidence in U.S. technological superiority restored with the moon landing. In the 1970s it became "it's the economy, stupid." The war in Vietnam, the space race, and the costly social programs of the 1960s, combined with higher inflation and unemployment, set the stage for a more conservative scientific and education agenda during this policy period. By the 1970s Japan and the countries of Europe had recovered from their post-war devastation and began challenging the United States in certain markets. The public became less bullish about the benefits of science.

During this policy period the dominant theoretical framework moved from one that focused on social values such as segregation and equity to one that reflected a more economic framework. Economic values were reflected in efforts to change inadequate funding formulas, while social values were reflected in efforts to extend the benefits of special education. The 1970s also witnessed an increasing emphasis on standardized testing to evaluate student achievement and programmatic effectiveness. Testing became the reform.

Chapter VI

1983-2012

"Mr. Gorbachev, tear down this wall!" -- Ronald Reagan 1987
"IMF says 'Age of America' will end in less than five years..." -- Robert Tsu, Editor, China Strategy, 2011

Economic, Democratic, and Social context

The final policy period of this study covers the years from 1983 to the present. It begins with the presidency of Ronald Reagan, continues through the presidencies of George H. W. Bush, Bill Clinton, George W. Bush, and ends with the presidency of Barack Obama. These years witnessed the beginnings of a profound revaluation of our position on the world stage, and it is this insecurity that has driven U.S. science and education policy up to the present time. When this period began, the United States was still the undisputed economic giant on the world stage. Many economists are now predicting that China's economy will surpass that of the United States within the next decade.

For most of this policy period, the United States enjoyed a period of prolonged economic expansion, with Federal Reserve Chairman Paul Volker (1979-1987) and Alan Greenspan (1987-2006) regulating the pace of the U.S. economy. By 1983, the economic picture had improved; inflation was down and the economy was stronger. Reagan's (1981-1989) economic philosophy, Reaganomics, was based on supply-side economics and an end to "big government." He cut taxes to stimulate spending and private investment and cut government expenditures, except defense spending, across the board. With the exception of a brief recession in 1982 and a dramatic stock market correction, Black Monday in 1987, the United States experienced strong economic growth during most of the Reagan presidency. However, there were economic clouds on the horizon. The 1980s witnessed the first perceived threat to U.S. economic dominance with

the striking rise of Japan as an economic powerhouse. By 1980, the U.S. auto industry had lost its first place status to Japan. Japanese investment in the United States. surged in the 1980s, including the acquisition of such high profile assets as Rockefeller Center and the Pebble Beach Golf Course. This spending spree led some media outlets to speculate that Japan was buying the United States.

George H. W. Bush's (1989-1993) term in office was marked by an economic downturn, rising unemployment, and a significantly higher federal deficit ($220 billion in 1990), forcing him to renege on his promise of "no new taxes." A savings and loan industry crisis threatened to make a bad situation worse, and in 1989 President Bush introduced a plan for the federal government to bail out this industry. In 1991, President Bush proposed the North American Free Trade Area (NAFTA), which was passed during President Clinton's tenure.

The economy during President Clinton's terms in office (1993-2001) was defined by the dot-com boom of the 1990s and the emergence of a new technology-driven economy. These years also witnessed a close working relationship between the Federal Reserve and the executive office. Clinton focused on debt reduction instead of tax cuts as the way to stimulate the economy. Congress passed NAFTA in 1995, creating a free trade zone between Canada, Mexico, and the United States. During his eight years in office, the U.S. economy increased 50%, representing 25% of the world's economic output, and unemployment declined to a 40-year low. During these years, the U.S. trade deficit increased to $400 billion.

U.S. economic growth was less robust under George W. Bush (2001-2008) than under his predecessors. The nation's poverty rate and debt increased significantly. During most of Bush's term in office, 9/11 and the War in Iraq dominated political discourse. More recently, the sub-prime mortgage crisis and related housing market correction have served to bring the economy

back to the forefront of public attention. Many economists and the public believe we are now in a recession, and economists foresee the day when China will surpass the United States as the world's leading economic powerhouse.

President Obama's (2008-present) tenure in office has been marked by almost unprecedented economic woes: a financial sector that was in crisis, an automotive industry that was on life support, and a housing market that was in free fall. Obama successfully pushed for health care reform legislation that previous presidents had been unable to achieve and made a decision to bail out the American automotive industry. At the same time Obama drew down the American presence in Iraq and built relationships with other countries fighting terrorism.

It is the U.S. economic outlook that has defined U.S. science and education policy more than political or social factors during this policy period. For the 35-year period from the end of World War II into the 1980s, the United States. was the preeminent and unchallenged world economic power. The technology boom that took off in the 1990s has served to dramatically alter the global economic playing field. Countries such as China and India, among others, are experiencing amazing economic growth. This more competitive landscape has generated angst, if not panic, among policymakers about the ability of the United States to maintain its innovative and economic status in a global marketplace. Large investments in the U.S. economy by sovereign funds, a term most had never even heard of five years ago, reflects the growing integration of the global economy. Policymakers have expressed concern over what the consequences of this level of investment, if any, may be. This change in the relative economic position of the United States versus other countries represents a complete sea change from where the United States stood fifty years ago. The unbounded optimism of the 1950s has morphed into a guarded pessimism in this first decade of the 21st century.

The political landscape of the past quarter century has been defined, in large part, by U.S. foreign policy. The economic malaise of the 1970s generated a conservative backlash that brought Ronald Reagan to the White House. Reagan's tenure got a political boost when the Iranian hostages were released just days after his inauguration. Reagan quickly assumed a very hard line with regard to the Soviet Union, calling it the "evil empire," and increased the defense budget over 40 %. Reagan's "get tough" rhetoric and willingness to outspend the one other world superpower is credited, in large part, for what is arguably the single most important political event of the past quarter century, the collapse of the Soviet Union in 1991. Within a matter of months after the fall of the Berlin Wall (November, 1989), the United States launched Operation Desert Storm (1990-1991) to liberate Kuwait from Iraq. The destruction of the World Trade Centers on September 11, 2001, marks the beginning of the War on Terrorism and the subsequent U.S. invasion of Afghanistan and Iraq. The second Gulf War (2003) was marketed as a way to remove Saddam Hussein from power and to eliminate Iraq's weapons of mass destruction. More recently an "Arab Spring" promises to revolutionize the Middle East.

Social trends during this period include the growth of non-traditional families and the spread of HIV & AIDS. The end of the cold war, Tiananmen Square, and the Arab Spring have presaged the growth of democratic forms of government. Concerns about the environment and health issues have served to unify cultures around the globe. Americans bought SUVs by the millions, only to find themselves trapped with gas-guzzling vehicles as oil prices skyrocketed to $140 per barrel. The most obvious and fully disseminated worldwide cultural and social phenomenon of this policy period must be our love affair with technological devices and social networking. Today, ubiquitous access to new technologies has radically changed the way humans interact with one another and has served to democratize the innovation landscape.

Advances in technology, as represented by the human genome project, the International Space Station, and nanotechnology have opened up possibilities that will benefit people across the globe.

Federal Science Policy

Science and education policymakers view *A Nation at Risk* as the defining policy document of this period. *A Nation at Risk* was published by the National Commission on Excellence in Education, at the behest of the U.S. Department of Education, in 1983. The Commission's charter was, among other things, to do the following:

- Assess the quality of teaching and learning in our Nation's schools
- Compare American schools with those of other nations
- Assess the degree to which major social and educational changes in the last quarter century have affected student achievement
- Define problems which must be faced and overcome

A Nation at Risk (1983) sounded the alarm that our educational system was failing to provide the country with a workforce sufficiently well-trained to adjust to, let alone succeed in, the new world economy. The report found the following:

> The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people...If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war (para 1, 2).

Among the Commission's recommendations, the following recommendations are worth noting:

- State and local high school graduation requirements be strengthened

- Schools adopt more rigorous and measurable standards

These concerns about U.S. global competitiveness have been echoed forcefully and frequently by policymakers in other policy reports throughout the past (almost) thirty years. A small sampling of these reports include the following:

1986 *Time for Results*, National Governors Association (organization/financing)

1989 *Science for all Americans*, AAAS

http://www.project2061.org/publications/sfaa/online/sfaatoc.html

1993 *Harnessing Science and Technology for America's Economic Growth*,

http://www.nap.edu/openbook.php?record_id=9456&page=9

Science: The Endless Resource, Clinton speech

http://clinton1.nara.gov/White_House/EOP/OSTP/Science/html/endless.html

1994 *Science in the National Interest*, Clinton's science policy statement

http://clinton1.nara.gov/White_House/EOP/OSTP/Science/html/Sitni_Home.htl

1998 *Unlocking our Future: Toward a New Science Policy*

http://www.gpo.gov/fdsys/pkg/GPO-CPRT-105hprt105-b/pdf/GPO-CPRT-105hprt105-b.pdf

2000 *Before It's Too Late: A Report to...*

http://www.ptec.org/items/detail.cfm?ID=4059

2002 *Science for Sustainable Development*

http://www.un.org/esa/dsd/agenda21/res_agenda21_35.shtml

2004 *Science for the 21st Century*

http://www.whitehouse.gov/files/documents/ostp/NSTC%20Reports/Science21Century.pdf

2005 Assessment of 21st Century Skills

Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future

http://www.nap.edu/catalog.php?record_id=11463

2006 *America's Pressing Challenge*

http://www.nsf.gov/statistics/nsb0602/

National Defense Education and Innovation Initiative

www.aau.edu/reports/NDEII.pdf

2007 *Into the Eye of the Storm: Assessing the Evidence on Science and Engineering Education, Quality, and Workforce Demand*

www.urban.org/url.cfm?id=411562

2007 *America's Perfect Storm: Three Forces Changing our Nation's Future*

www.ets.org/Media/Education_Topics/.../AmericasPerfectStorm.pdf

All of these policy documents, studies, and reports make manifest that since *A Nation at Risk* was published in 1983, national security, as defined by the U.S. ability to compete in a global marketplace, is the theoretical construct driving science policy decisions, education reform in general and science education reform in particular. These reports, and others, have set the current policy agenda for education reform. All of these reports share the following attitudes and/or concerns in common:

1. Scientific literacy is the basis of innovation and economic strength.
2. The United States no longer holds a preferential position with regard to innovation and economic competition. The technological revolution has democratized the

innovative process and other countries are challenging our technological and innovative leadership.

3. As measured by international tests, such as TMSS and PISA, U.S. students are not distinguishing themselves relative to students in other countries, despite the fact that the United States spends more per pupil than most other countries do.
4. The U.S. education system is failing to prepare students for success in the new global information era.
5. Our inability to compete effectively is a serious threat to our nation's future.
6. Education is the best hope for our citizenry and nation.
7. A sense of urgency has been markedly absent since Sputnik
8. The federal government has a key role to play in addressing these concerns
9. Systemic education reform is needed
10. Education reform is a much more inclusive process, reaching beyond the walls of the school and into the business community

It should be noted that the conclusions reached in *A Nation at Risk* were not without critics. In 1990, the Sandia Report examining existing federal data on SAT scores, dropout statistics, funding and international comparisons, among other criteria, concluded,"To our surprise, on nearly every measure, we found steady or slightly improving trends" (Ansary, 2007. para. 2). Nevertheless, most federal, state, and corporate policy makers are persuaded by the compelling arguments put forward in these reports.

The seat of American science policy in the Executive Branch is the Office of Science and Technology Policy, whose director is the President's science advisor. The influence of this office has waxed and waned with time (mostly waned), but it has never exercised significant influence

over budgetary planning. Furthermore, during the half century that had elapsed since the *Science: The Endless Frontier and Science* and *Public Policy* were published in 1945 and 1947, respectively, the number of mission agencies has grown exponentially, creating a highly Balkanized budget process. "This precludes any strategic approach to priority setting and funding allocations...From this perspective, it can reasonably be asserted that there is no such thing as science policy in the United States" (Sarewitz, 2003, para. 7).

Education Policy during the Reagan Presidency (1981-1989)

Despite the call to arms, which *A Nation at Risk* represented, President Reagan resisted a strong federal role in education. Reagan's attitude toward the federal role in education is best expressed by his stated intention, although never implemented, to abolish the U.S. Department of Education. He settled for a new brand of federalism, which significantly reduced federal categorical aid for education in favor of block grants. These block grants were seen as a means of restoring power to the people. (Marcus & Stickney, 1990) "As one scholar put it, 'Understanding the distinction between education as a national concern but a state and local responsibility is important in understanding the President's contention that education is high on the national agenda but low in his budgetary priorities'" (New York State Archives, 2006).

States, not Washington, took up the challenge of education reform. In 1986 the National Governor's Association met in Hilton Head, Georgia, to address the issue of education reform. A politically ambitious governor from Arkansas, Bill Clinton, and Lamar Alexander, then governor of Tennessee, worked with other governors on a policy statement. *Time for Results,* which followed *A Nation at Risk* by three years, proposes a compromise; the federal government would relax federal regulations for schools and school systems and, in return, the states would be held accountable for demonstrable gains in student achievement. This model had state support as well

as support from the business community, who thought that a move toward decentralization might lead to more innovation in education. Lamar Alexander was to become President Bush's Secretary of Education in 1991.

By this time, some business groups were beginning to argue for increased federal aid for education. The involvement of the federal government is now seen as an essential component of a comprehensive effort to improve American education in order to meet foreign economic competition. (Marcus & Stickney, 1990, p. 10)

This 30-year period is defined as one policy period from an educational policy perspective because of certain trends that gained favor in the aftermath of *A Nation at Risk* and increased political legitimacy throughout this period. It was during this policy period that standard assessments and accountability became the acknowledged responsibility of individual states in return for a loosening of federal regulations. This latter led to and benefited the development of alternative school options, including charter, voucher, and independent schools. In 1990 the Milwaukee Parental Choice program allowed parents to send students, under specific circumstances, to private schools at no charge. In 1991 Minnesota passed the first charter school law. In his book, *Teach Your Own: A Hopeful Path for Education* (1997), author John Holt says, "The states, localities, and the private sector are now the sources of most new ideas and practices--tutoring programs, student learning standards, performance-based school accountability, new teacher accreditation practices, investments in new school designs" (p. 71).

Education Policy during the George H.W. Bush Presidency (1989-1993)

In 1989, President Bush called for governors to meet again at an Education Summit in Charlottesville, Virginia. The 1989 summit was the first meeting of the governors and President devoted to education since the Great Depression. It was at this summit that the first national

education goals were established. This Education Summit inaugurated an all-too-brief period in which there appeared to be broad bipartisan support for some sort of national movement to support explicit state and local education goals and standards.

This consensus resulted in *America 2000: An Education Strategy*, a report released by President Bush in 1991. Among other things, the goals enumerated in this report state that by 2000, all children will enter school ready to learn, U.S. students will be first in the world as measured by achievement in math and science, all U.S. students will be assessed in critical subject areas in fourth, eighth, and twelfth grades, and U.S. high school graduation rates will be 90%. *America 2000* looked to school choice as a way to stimulate innovation in education. This report, which never progressed into legislation, was resurrected, in a slightly different form, as *Goals 2000* under President Clinton.

Education Policy during the Clinton Presidency (1993-2001)

President Clinton picked up where Bush left off in 1994 when he signed *Goals 2000: The Educate America Act* into law. The core of *Goals 2000* was a grant program to support state development of standards and assessments and school district implementation of standards-based reform. This Act established six goals to be achieved by the year 2000. Goals 7 and 8 were added subsequently.

1. All U.S. children will enter school ready to learn.
2. U.S. high school graduation will increase to 90%.
3. All students will be tested in Grades 4, 8 and 12.
4. U.S. students will be first in the world in math and science achievement.
5. Every adult will be literate and able to compete in a global economy.
6. U.S. schools will be drug and violence-free.

7. Teachers will have access to adequate training.

8. Every school will promote partnerships to increase parental involvement

This growing federal role in shaping education for all students provided the basis for increased federal funding in the years 1995-2000 and foreshadowed the even larger impact sought by Clinton's successor. (NYSED, 2009, p. 68).

Education Policy during the George W. Bush Presidency (2001-2008)

Just days after George W. Bush assumed office, he introduced the No Child Left Behind Act (NCLB). "The signature provisions that were ultimately included in NCLB advanced the strategy, begun with *Goals 2000*, of federal support for improving achievement through standards, assessments, and specific requirements of accountability" (*Federal Education Policy and the States, 1945-2005*, 2006, p. 73). NCLB required that all students be 'proficient' in reading, math and science by 2014. NCLB required that all students be tested in reading, math, and science in Grades 3-8 and that these test scores be used to determine whether or not the schools had made adequate yearly progress (AYP). Congress enacted the legislation with bipartisan support. Supporters of the bill included the Business Coalition for Excellence in Education, the American Federation of Teachers, and the Council of Chief State School Officers.

Groups opposed to the bill included the National School Boards Association, the American Association of School Administrators, and the National Education Association. Critics of the legislation point to the relative lack of federal funding, the fact that states have widely different definitions of what constitutes "proficiency," the inclusion of English language learners and students with disabilities in the calculation, and the fact that states have different methods for determining AYP, among other objections. Complaints and court appeals have resulted in the

federal government allowing for greater flexibility with regard to certain mandates in the legislation.

Education Policy during the Barack Obama Presidency (2008-2012)

In 2009, President Obama signed the American Recovery and Reinvestment Act (ARRA) into law. This appropriated over $40 billion to states to fill state budget gaps and to provide additional funds for IDEA and Title I. The quid pro quo for this money is that states eliminate barriers to the use of student testing data to assess teacher performance. The move toward Common Core Curriculum standards continues under this President, although it doesn't have the blessing of every state.

Under President Obama's Race to the Top program, states could apply for a portion of the $330 million in federal grant money available for states to develop new assessments. These new assessments are expected to be ready in 2014. The President has given verbal and financial support for charter schools and opposed public vouchers to send students to private schools.

After more than 10 years, it is evident to most that some of the objectives of NCLB were and are unattainable. For example, the stated mission that all our students in every state would be 100% proficient in reading and math test scores by 2014 was probably an unreasonable expectation. In 2011, President Obama awarded waivers to states, giving them necessary relief from NCLB regulations in return for a commitment to reform.

Science Education

Global economic competitiveness has replaced Sputnik as the raison d'etre for education reform in general and STEM (science, technology, engineering and math) education reform in particular. Studies conducted in the early 1980s and funded by business groups and economists

"found a strong link between the educational level of a people and a country's ability to compete economically" (Marcus & Stickney, 1990, p. 5).

In *No Child Left Behind and Science Education: Opportunities, Challenges, and Risks* (2006), authors Ronald W. Marx and Christopher J. Harris credit current education reform efforts as implemented in NCLB, in part, to the policy reports outlined on pages 68 and 69 of this study. There are a number of other reports published during this policy period that have informed science curriculum reform. In chronological order these include, but are not limited to, the AAAS 1989 report, *Science for All Americans,* the National Science Teachers Association (NSTA) 1989 publication, *Scope, Sequence and Coordination;* the National Center for Improving Science Education (NCISE) 1990 and 1991 reports on middle school and secondary science *Benchmarks for Science Literacy* in 1993, and the *Atlas for Science Literacy*, Volumes I and II.

Overarching Questions

What were the democratic, social, and economic contexts or forces that shaped or influenced federal science policy during this policy period?

During this policy period we witness a marriage of democratic and economic values, which together transcend social values as the engine driving science policy. It should be noted that social considerations never disappear and are always intimately linked to economic considerations. For example, to the extent that home ownership or college attendance is considered a social good, the opportunity for both is severely restricted during times of severe economic hardship.

Nevertheless, during this period national security as defined by the ability of the United States to compete in the global market is the driver of science and education policy discussions.

It has become science for policy, and this is the period in which we read and hear about science diplomacy. Narrowly defined, economists and policymakers have tended to focus on globalization from a primarily economic point of view. Broadly defined, globalization has unmistakable political and social implications. If, in twenty-five years, the United States is no longer the sole world economic superpower, what does that mean in terms of our political agenda, our standard of living? Is economic status a zero sum game, or does the rapid growth in China, India, and other countries simply mean the pie is getting bigger? Whatever the answer to these questions, there is no doubt in the minds of politicians, policymakers, economists, and the business community that a scientifically literate citizenry is essential, if we are not to lose ground in this new century.

What have been the philosophical and theoretical perspectives that form the basis of K-12 education in general and science education, in particular, during this policy period?

Compared to previous attempts to reform education, current educational reform efforts are more holistic in scope, taking into consideration curriculum, professional development, assessments, and structural change. In the 1990s, the idea that all parts of the education system must be changed to meet new standards and goals was formalized in an often cited brief, *Putting the Pieces Together: Systemic School Reform* by Smith and O'Day (1991), which put forward the notion of "systemic" approaches to reform.

Constructivist learning theory, with roots going back to Dewey, Piaget, and Vygotsky became popular again in the 1990s. In 1993, Massachusetts implemented a common curriculum and statewide testing. Diane Ravitch's 2000 book, *Left Back: A Century of Failed School Reform,* calls for a more traditional academic oriented education. As in the 1960s, this policy period was a fertile time of science education reform. Unlike the situation in the 1960s, which was still

somewhat elitist in its purpose, the current education reform efforts herald "science for everyone." George DeBoer, in his 1997 book, *What We Have Learned*, relates that today's education reform efforts are more holistic, emphasizing the connections between science, technology, and math.

How was federal science policy reflected in NSF and AAAS activities as they relate to K12 science education during each policy period?

In 1984 Bassim Shakashiri became the head of NSF's Education Directorate. By aggressively courting legislators, he was able to increase the NSF education budget from $55 million in 1986 to over $200 million in 1990. In 1987 the NSF funded three multi-million dollar efforts designed to create a coherent program of science education for the elementary and secondary schools, the largest NSF grants for science education since 1975. Unlike the NSF-inspired science curriculum programs of the 1960s, the goal of these grants was not to foster an academic elite (Dow, 1996). Science curriculum coming out of these educator/scientist collaborations include, but are not limited to, *Full Option Science System* (FOSS), and *Science and Technology for Children* and *Insights* (Lopez & Schultz, 2001). According to the NSF website, NSF has funded over 200 projects in more than 140 different universities throughout the United States and Puerto Rico.

AAAS and Project 2061

Project 2061, funded by the NSF, represents arguably the single most comprehensive, broad-based, and long-term effort to reform U.S. science education and to promote science literacy for all citizens. Project 2061's lifespan corresponds almost exactly with the current policy period, having been introduced by the AAAS in 1985 and remaining a strong influence over science education today. *A Nation at Risk* and the numerous follow-up reports testifying to

the critical importance of scientific literacy to our national security and the failure of our education system established the climate of urgency which continues to support and sustain Project 2061's effort today. The funders for Project 2061 include, but are not limited to, the U.S. Department of Education, the National Science Foundation, Carnegie Corporation of New York, the John D. and Catherine T. MacArthur Foundation, I.B.M., the Pew Charitable Trust and the California State Department of Education. Twenty-seven years after its birth, Project 2061 is still going strong, helping educators to implement reform in science, math, and technology education.

For the purposes of understanding the sequence of Project 2061 initiatives, the AAAS originally conceptualized a three-phase rollout. A description of each of the three phases is taken directly from the AAAS website.

> Phase I focused on the substance of science literacy. *Science for All Americans (SFAA)* and the reports of the science panels constitute the chief products of that phase. The purpose of Phase I was to establish a conceptual base for reform by spelling out the knowledge, skills, and attitudes all students should acquire as a consequence of their total school experience from kindergarten through high school.
>
> Phase II involves teams of educators and scientists transforming *Science for All Americans* into several alternative curriculum models for the use of school districts and states.
>
> Phase III will be a widespread collaborative effort, lasting a decade or longer, in which many groups active in educational reform will use the resources of Phases I and II to move the nation toward science literacy.

In 1996 SRI International, under contract to the AAAS, published *An Evaluation of the American Association for the Advancement of Science's Project 2061.* This evaluation found that

"taken as a whole, the evidence of Project 2061's broad influence demonstrates its positive contribution to the national climate for science education reform" (Zucker, Young, & Luczak, 1996, p. 2). Over 80% of the state leaders reported that Project 2061 helped them to define what scientific literacy means and was instrumental in the development of their state curriculum standards. In 2004, Project 2061, began to develop online assessment resources to help users better understand content standards. AAAS's Project 2061's Phase III is ongoing and open-ended.

Conclusion

If *Science: The Endless Frontier* represents the seminal science policy document of the past 65 years, then *A Nation At Risk* represents the defining science and education policy document of the past quarter century. *A Nation At Risk* established the dominant themes driving education reform in general and science education in particular, national security as defined through the lens of economic competitiveness, globalization, innovation, and productivity. Thus, the dominant theoretical framework driving education policy during this policy period and continuing today is one that stresses the economic value of education.

As policymakers attempted to implement incentives and stimulate reform, their efforts were hampered by the fact that the United States does not have an education system. Since education was always considered a local matter, it was, by definition, a cottage industry with teachers exercising almost complete autonomy over what went on in the classroom. This traditional model has been under attack since *A Nation At Risk* was published, and standards-based reform became the *linqua franca* of our current reform environment. Every state has developed its own standards, representing varying degrees of rigor.

Standards-based reform aside, there has been a noticeable, if not quantifiable, change in teaching roles and how teachers have been perceived by outside interest groups over the past ten years. When this policy period began, teachers were still masters of their own domain, able to interpret the curriculum as they chose and defined success by their own standards. It was understood to be political suicide to criticize the teaching profession. Education reformers today are as likely to view teachers as an impediment to meaningful reform. Teachers who have never had to contribute toward their own health benefits are now required to do so. Teacher tenure and collective bargaining contracts are being challenged in a number of states. Teacher performance is open to public scrutiny in certain areas of the country. The same kind of encroachment is also occurring at the school administration level, where administrator autonomy is increasingly constrained by unfunded mandates and regulatory constraints.

Chapter VII

Then and Now

As I look back to see what I have uncovered as a result of this archival historical examination, it is important to first acknowledge what I did not uncover. Beginning with *A Nation At Risk* and continuing through the many subsequent policy documents in support of science literacy and education reform, the recurring argument is the following:

1. U.S. students are underperforming students of other countries on test scores such as TIMSS and PISA.
2. If we are unable to improve U.S. student achievement, as measured by test scores, our country will inevitably lose its share in the global marketplace.

Implicit in present reform efforts is the assumption that higher test scores will result in a more robust economic future. Although this premise does make intuitive sense, I found no empirical evidence that this is the case.

There are variables that may partially explain these test score results: quality of teachers, length of school year or day, curriculum, etc. Many (if not most) of the education systems in other countries are centralized, although there appears to be a trend toward decentralization. This study reveals that while our system of education is ostensibly decentralized, World War II led directly to a more expansive role for the federal government as policymakers asserted again and again the importance of education to our national security. The tension between state and federal policy objectives and largely local financing may be a factor in explaining the gap between education policy objectives and education policy implementation in the United States, surely a fertile area for future research. The following chart provides a visual representation of how U.S. science policy and education policy have evolved over the period of my study.

	1945-1957	1957-1969
Presidents	Truman Eisenhower	Eisenhower Kennedy Johnson
Democratic Economic Social Fowler's values	Cold war / Korean War / McCarthy Economic boom / rebuild Europe/Japan Baby boomers / conservative / suburbs Political values dominate	Sputnik / space race / Cuban Missile Crisis Social Security / Medicare Great Society/civil rights/ activism Political values give way to social values
Science Policy	Policy for Science Science for scientists/manpower shortage Capacity building – NSF/DOD/AED	Golden age of science Increased NSF Funding for Science Ed
Policy Doc / speeches	Science the Endless Frontier –'45 Science and Public Policy – '47 Science and National Security – '57	Science: Handmaiden of Freedom (Ike)
Science Education	Federal funding targeted to graduate education to fill shortage	Wood's Hole Conference – '59 NSF funding for science curriculum Scientists involved
Education Policy	Deficiencies unveiled – GI Bill Boomers enter school-teacher and space shortage	Sputnik=1st era of education reform Nat'l Defense Ed Act (NDEA) '58 Elem & Secondary Ed Act (ESEA) '65 Coleman Report '66
Court Decisions	Everson Vs.BOE '47 Separation church & state Brown Vs. BOE Topeka '54 Desegregation	Abinton School District Vs. Schempp '63 School prayer
Ed Pedagogy	Progressive to Essentialist Why Can't Johnny Read B.F. Skinner's Science & Human Behavior '53 Bloom's Taxonomy '56	Essentialist to Progressive Constructivist theories Vygotsky's Thought & Lang '62 H. Kohl's Open Classroom '69
U.S. Population % HS grad % BA degree	139 to 172 million	172 to 203 million ~ 27% ~ 6%

	1969-1983	1983-2012
Presidents	Nixon Ford Carter Reagen	Reagan Bush Clinton Bush Obama
Democratic Economic Social Fowler's values	Watergate/ end Vietnam War/ Iran hostage Oil embargos/recession/foreign competition Social disillusionment / Kent State Economic values dominate	Collapse of USSR/Middle East/911 2008-2012 global economic crisis Social media Political and economic values merge
Science Policy	Accountability- ROE Environmental Protection Agency (EPA) Established '70	Science for Policy – science diplomacy Globalization Science for everyone
Policy Doc / speeches	Proposed Energy Policy, Carter '77 Silent Spring, Rachel Carson	A Nation At Risk '83 Time For Results '86 (NGA) Science in the Nat'l Interest (Clinton) The World if Flat '05 (Friedman)
Science Education	MACOS	STEM focus Project 2061
Education Policy	Standardized testing Special education & school busing Equal Educational Opportunity Act '74 Nat'l Assessment of Ed Progress (NAEP)	Standards / assessments / accountability Improving America's Sch Act '94 Goals 2000-Clinton Wisconsin eliminates collective bargaining
Court Decisions	Tinker V DesMoines '69 Student speech (dress) Serrano Vs. Priest Mills Vs BOE	NJ V T.L.O. Unreasonable student searches
Ed Pedagogy	Progressive to Essentialist Piaget's *The Science of Education*	Constructivist theory popular in '90s
U.S. Popularion	203 to 234 million ~ 45% ~ 9%	234 to 313 million ~ 81% ~ 23%

This study covers a period of over sixty five years, from WWII to the present. Over that time period, our nation has more than doubled in size from approximately 140 million to over 300 million, and census data shows that we are a much more heterogeneous population today, as measured by ethnicity and age, than we were then. For the term of this study, the U.S. has been the dominant economic power in the world. Even during the decades when the U.S. shared super power status with Russia, our economic model was virtually unchallenged; except for a worrisome period in the 1980s when Japan began to flex its economic strengths. Our military, economic and social dominance on the international stage has forged our sense of self. It is this sense of nationhood that is threatened in today's global marketplace.

Overarching Questions

I posed the following overarching questions as a framework for this research:

1. What were the democratic, social, and economic factors that informed federal science policy during each of the policy periods from 1945 to the present?
2. What were the currents of educational theory and/or philosophy that defined K-12 education in general and science education in particular, during each of the policy periods?
3. How was federal science policy reflected in K-12 science education and/or education reform during each policy period?

The first question acknowledges that policy arises in response to perceived political, social, and/or economic forces. While one agenda may dominate for a period of time, it is always within the context of a fluid national landscape. For example, national security concerns dominated the policy agenda immediately after World War II only to seemingly give way in the 1960s to a more socially progressive policy agenda and in the 1970s to limiting economic

realities. In fact, both agendas coexisted after Sputnik through to the moon landing. National security concerns did not go away in the 1960s or 1970s; they just went underground. The political factors driving science policy have never been subtle and have always reflected concerns about national security in one form or another. During and after World War II, it was national security from a military preparedness perspective. After Sputnik, and through the 1960s, it was national security from a technological superiority perspective. Over the past quarter century, it has been and remains national security from a global competitiveness perspective.

The answer to the second question is that the favored educational pedagogy in each study period has reflected the dominant political agenda of the time. The progressive philosophy of K-12 education remained entrenched immediately after World War II, as evidenced by a strong vocational focus. In 1953 B.F. Skinner published *Science and Human Behavior* and Bloom's Taxonomy was published in 1956. Policymakers recognized the importance of science more than ever and intended to build the nation's science capacity; science was not for everyone, but for an educated elite. Baby boomers were entering school and federal funds were used to build infrastructure. Beginning in the late 1950s the progressive model made way for a more rigorous traditionalist/essentialist model of pedagogy in response to criticisms that the progressive model was anti-intellectual. The traditionalist/essentialist pedagogy did not remain dominant for long, giving way again in the mid-to-late 1960s to a more progressive model in keeping with the social agenda that dominated the national debate. The economic realities of the 1970s generated a "back to basics' pedagogy more associated with the traditionalist model. Since *A Nation At Risk* was published in 1983, the achievement gap that used to signify the gap between White and minority students, is today as likely to refer to the achievement gap between U.S. students and their foreign peers.

Educational philosophies such as progressivism and essentialism have each dominated the instructional debate at various times, only to retreat from the forefront before reestablishing themselves in some new hybrid form. As an example, we point to the current recommendation, as laid out in Benchmarks and the National Science Education Standards, that "less is more," only to remember that Vannevar Bush and Steelman both advanced the same advice more than fifty years ago. "There was abundant evidence of a resurgence of progressive ideas among science educators during the 1970s and 1980s. But there is just as much evidence of continued support by science educators for the basic ideas of the curriculum reform movement of the late 1950s and early 1960s" (DeBoer, 1991, p 190).

In answer to the third question, National science policy today is very different from science policy sixty years ago. Science for scientists has evolved to science for everyone. In the 1950s, policymakers were focused on training and educating future scientists who would then fill the existing gaps in research and industry. Today, policymakers fret about a citizenry capable of making informed decisions on complex global issues such as global warming, renewable energy sources, and sustainable food production for a world population that is doubling every fifty years. Fifty years ago science policy emphasized basic research, whereas today there is a trend toward more funding for applied research. Today some of the most interesting science research is in areas that didn't even exist fifty years ago, including plate tectonics, dark energy, dark matter, and fractals, among others.

National Science Policies and K-12 Education Reform

It seems self evident that virtually any list of the "top ten" critical issues facing the world today is likely to include global warming, threat of pandemics, food production, population management, and access to renewable energy. These problems and others are not the kinds that

respect geographic boundaries. Solving these problems will require international cooperation--hence scientific diplomacy--and the application of skills that are most likely to be developed in the STEM disciplines. My choice of a dissertation subject was motivated by a desire to research to what degree U.S. science policy has historically impacted education reform and to determine if any apparent trends would be revealed. As a school administrator and graduate student in Education Leadership, Management, and Policy, I was aware of the present emphasis on STEM education and wondered if "it had always been so"?

1. First and foremost, this research supports the claim that scientific endeavors and education practice have always held a foremost place in the minds of policymakers throughout the life of this nation. Policymakers have long heralded the individual and collective benefits of educational and scientific endeavors and sought to facilitate the development of these resources to the extent permissible in a federal model of government. While policy activity necessarily reflected the personal traits and interests of the president and the political, economic, and social context of the period, science policy and science education have never been far from the forefront of the policy agenda.
2. Second, science and education policy are inseparable. Science policy depends upon an educated citizenry, and education policy has always had a strong utilitarian bent: to improve the life of the individual and the nation. Another common theme, as regards science policy, is the construct of national security. National security has always been and remains the cornerstone of national science policy; during the 1950s national security was defined by the cold war and fears of Soviet advances while during the

current policy period, national security is defined by economic competitiveness in a global marketplace.

3. This study reveals that federal influence over education has become much more overt. There is a pattern of intent that has been revealed as the federal government has graduated from funding schools and curriculum development to linking federal funds to standards and assessment models that directly influence what is being taught and how teachers and schools will be accountable. The recent literature is relatively silent on the issue of whether or not the federal government has a right to influence education. Perhaps policymakers view the stakes as too high.

Implications for Education Leadership, Management, and Policy

What, if any, trends are evident as a result of this investigation that might be of predictive value to educational leaders? It has become evident that policymakers and stakeholders view education as the essential ingredient in any strategy to remain economically competitive and politically relevant. Will these same policymakers and stakeholders allow "business as usual" in education to remain a barrier to achieving this goal? This study reveals a definite shift in the role of the federal government as it pertains to education. Before and during World War II, the role of the federal government was subtle, reflecting a popular consensus that the federal government should not interfere in local matters. Although policymakers held a utilitarian view of education, to assimilate immigrants, to provide a skilled workforce, and to increase productivity, education was still local in theory and in practice. Over the past sixty-five years, the federal role in education has become markedly more assertive. Beginning with the National Defense Education Act of 1958 and continuing through the many incarnations of the Elementary and Secondary Education Act of 1965, of which Race to The Top is just the latest face, the federal government

has shown a willingness to use education to promote social and economic agendas such as funding for special education, prohibiting segregation, prayer in the schools, evolution, sports for girls, among others. Political and economic agendas rising out of a concern about U.S. competitiveness and stature have led directly to the present focus on standards, assessments, and accountability.

What does this mean for education and educators going forward?

- Educators are not in control of the education reform agenda. Reform is coming from outside in, not top down. Administrators are on the defensive, struggling to maintain a stable educational system.
- Policymakers have learned that improving curriculum is not sufficient if educational reform is the goal. While the world outside the classroom is changing at an increasingly disconcerting pace, what goes on inside the classroom moves glacially slow. The old paradigm ensured that education remained a cottage industry and that what happened in the classroom was more likely to reflect the confidence, skills, and preferences of the teacher in question than any perceived common good. Collective bargaining contracts and tenure protections have ensured that, in many states, the teacher is protected or isolated from outside influence.
- The combination of legislative action (challenges to tenure and collective bargaining), regulatory policies (national standards and assessments), transparency measures (report cards, evaluations), and more market-based options (choice, charter) that are being discussed and/or implemented should serve to weaken the entitlement culture that has pervaded education over the past many

decades. Recently Wisconsin decided to eliminate collective bargaining rights for public employees, including teachers. Other states are considering the same. Tenure rights are under attack in a number of states. New York City is now publishing a ranking of teachers based on the results of test scores. Public support for teachers is showing some signs of strain after decades of unequivocal support. One danger to educational reform is that the regulatory burden combined with growing financial constraints overwhelms the capacity of districts to adapt, threatening the very entrepreneurial changes it was intended to stimulate.

- It seems possible to this author that we might see a shift in educational leadership; away from the traditional career path--teacher/coach, building administrator, district administrator--toward consideration of more alternative candidates, alternative candidates who have not spent their entire career in this same protected environment and who are used to working and adapting to a rapidly changing environment.
- It seems likely that we will see more market-based solutions to the neighborhood school; second and third generation charter schools, school choice models, and new models not yet introduced. Although the results on market-based options such as school choice are mixed, on paper, market-based solutions would seem one of the most powerful tools in the reform toolbox. Given the rapidly changing skills sets needed in the labor force, we might expect to see the corporate sector attempt to influence standards and graduation requirements in a more direct way.
- Federal funding for K-12 schools has focused, almost exclusively, on equity in education and not excellence. Today, special education typically represents 15%

to 20% of school budgets, while funding for gifted and talented is virtually non-existent. If policymakers are truly interested in promoting an educational system that is rigorous and develops innovative thinkers, I would expect to see a more balanced funding formula going forward.

- Rapid improvements in technology, user-friendly devices, and social networking can be seen as both a cause of our present dilemma and a solution to it. It can be seen as a cause in that innovations in and access to technology have served to democratize knowledge and spur economic growth around the world, so much so that countries that were considered third world countries just twenty years ago are now challenging the United States in many markets. It can be seen as a solution in that technology can be viewed as a stealth agent delivering content knowledge directly to the end user, the student.
- This study started by recognizing that globalization is the construct driving current education reform efforts. It is appropriate that we end this chapter by recognizing technology as one of the foremost drivers of globalization. Technology has leveled the playing field and the United States enjoys no favored status in technology. Each of us see everyday examples of ways that technology continues to transform the workplace, the way we communicate with one another, and even the way it impacts political movements such as the Arab Spring. It seems logical that technology has the same power to transform education. Virtual environments, 24/7 access, three-dimensional graphics, virtual field trips, simulated experiments, collaboration with students on the other side of the world: all these benefits and more promise to enrich the learning experience for all. So

why is it not happening? Schools are increasingly investing in technology, primarily in response to the need to comply with online assessments. Research suggests strongly, however, that technology is not being used optimally and that, while students are "technologically fluent," most teachers are not.

- From an administrative perspective, new technologies such as cloud computing and virtualization offer the promise of reduced costs to purchase, maintain and store IT. Online lesson plans, professional development communities, and collaboration opportunities abound for teachers. New devices and instructional software will permit truly personalized instruction for students. While technology can't eliminate those socioeconomic factors that may be limiting factors for some student populations; it can provide a window to the world for those students who would otherwise not have one.
- If fundamental radical education reform is the goal, then technology can be the game changer, but only if there are funds and the administrative will to invest in technology infrastructure and consequences for teachers who fail to utilize technology effectively. The author is put in mind of a change that occurred in pharmaceutical marketing thirty years ago. The old paradigm, demand push, had the pharmaceutical companies sending reps to the hospitals and doctors' offices with samples, which they could then give to their patients. In the 1980s pharmaceutical companies began to market directly to the patient, demand pull, through television advertisements for joint pain, headaches, insomnia, etc. Patients, seeing these ads, would then go to their doctors demanding a particular drug. It was and is very successful. Pharmaceutical companies still need reps, but

not as many of them and not with the old skills sets. With access to technology students can go directly to the source(s) of knowledge without as much need for a teacher intermediary. This is particularly critical in the areas of science because the scope of inquiry is just too broad for a single teacher or even a team of teachers to command.

The barriers to implementation of more technology include, but are not limited to, funding and lack of expertise. Technology, almost by definition, implies a short life cycle for new devices and applications. This rapid obsolescence is challenging to the conservative education establishment, which tends to have a prolonged decision-making process under the best of circumstances. Despite these difficulties, I am optimistic about the reform-boosting capabilities of technology

Recommendations for Further Research

The findings in this study offer many opportunities for further research and analysis. The almost seventy-year span of time covered in this report necessitated a less than thorough analysis of each period. This was by design, since it was my intent to uncover the trajectory of change as regards the relationship between science policy and education reform. I was more interested in whether policy influenced education reform over time and how that influence was manifested.

This report would have benefited from interviews with state and federal policymakers involved in education reform. Future researchers may want to focus on a specific interval of time or analyze science policy and education reform in a particular state. A detailed study on the birth of a particular policy document such as the National Governors Association's report, *Time for Results*, could be very informative about the policymaking process. In the fullness of time, perhaps some future researcher will be able to examine whether present reform efforts generated

scientifically literate citizens and whether or not that made a difference in U.S. global competitiveness.

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