ABSTRACT

The structure of public education has impacted science curriculum both nationally and in South Dakota public schools from the establishment of the first permanent schoolhouse in Vermillion in 1864 to the present day standards-based models. This paper compares the national social context, structural and educational reforms of the early common school era with the current standards-driven initiatives 200 years later. Among the issues explored are societal changes, school settings, educational resources, and teacher preparation. In the late 1800s, progress reforms inserted science into the basic literacy and numeracy subjects, common to most public schools at that time, broadening the school curriculum. From an early “practical curriculum” first taught in the typical one-room rural schoolhouse to the 2010 adoption of the Common Core and the current Next Generation Science Standards, the important issues facing public education have radically changed. Or have they? In the last few years, in response to No Child Left Behind and other national directives, standards review committees were formed in most states. These committees were composed of stakeholders from public and higher education, business, informal education entities and government. The newly released draft science standards include a surprising number of ideas, the seeds of which were already contained in earlier reports and commissions of the 1800 and 1900s. This paper draws examples and quotations from primary historical documents in order to highlight the parallels between these ideas, so widely spaced in time.

Keywords

Public school science curriculum, school curriculum reform, history of science in public schools, science education in South Dakota, Science subjects in schools,

INTRODUCTION

The basic aims of public schooling have been surprisingly consistent from the 1800’s through the present day. Progressive thinkers among public school educational reformers have long expounded a common message – that subjects taught
also must be presented from a concrete and applied point of view rather than only from an abstract or general position. Further, school curricula must be connected to other learning and the experiences of students. The purpose of this paper is to explore and compare the context into which science education appeared in schools in the United States, rooted in the Common School Era—refined and “reformed” over time. Specifically this paper will trace the curricula, including the science curricula, in American public schools over the last two hundred years.

HISTORY OF PUBLIC EDUCATION IN THE UNITED STATES

The European Model of Education had emphasized history, classical languages, philosophy, classical mathematics and science. Early American models changed this model in order to include more practical subjects for educating the masses like reading, bible study, and character education. Early curriculum tended to be infused with religious doctrine with rote learning methods such as oral recitation and repetition.

In early nineteenth century America, public schools were supported by towns in the northern British colonies. School was held for approximately ten to twelve weeks per year and enrolled more boys than girls. Often organized by town councils, these schools also charged parents a fee. Prior to this period, families had assumed most of the responsibility for educating children in partnership with churches. At that time, schooling was not free, not governmental, and not secular. This meant that family wealth, race, and student gender had an enormous impact on how much formal education was received (Kaestle 1983).

In 1837, social reformer, Horace Mann and others established a Massachusetts state board of education. Mann saw public schools as a way to improve the lives of common people by equalizing educational opportunities. The main purpose of early public education was to create a literate society in which reading, writing, and arithmetic were typically considered the most important topics. And, although science was known and incorporated into reading and mathematics examples, the emphasis was on practical applications of knowledge so that citizens could provide for their families. Science in the school curriculum appeared later and generally in the high school, where students were prepared for the professions and for college experiences.

At this time, institutes for teachers were established along with an increase in the length of the school year to six months. Taxes were raised to establish school furnishings, books, and supplies. Not all children, however, could attend public schools with Native Americans sent to special government schools and African Americans forced to create their own separate schools (Levin et al. 2000).

Another societal factor that impacted the distribution of the U.S. student population before and after the Civil War was the immigration to America that reached an all-time high. Due to harsh working conditions and hardship in the big cities of the northeast, many children were abandoned or orphaned with few resources. Between 1854 and 1929, upwards of 250,000 children were sent by train from cities in the East to towns in the Midwest (Katz 1987). Families interested in the orphans arrived at local train stations to look them over upon
their arrival. Many orphans ended up on farms as laborers. The fortunate few were adopted by humane families who treated them kindly (Cremin 1980). The influx of these children into the center of the country influenced the need for more schools and support of schools in communities already stressed financially. At the same time, the first versions of public schools similar to the schools we have today were loosely organized in cities and rural communities alike. These schools were known as “common schools,” and were the first to be funded by local property taxes, charging no tuition.

Common schools were open to all white children, run by local school boards and began to be subject to some state regulation, an early precursor to state intervention in local school operations and curriculum standards. First found in the Northeast and Midwest states in the twenty years prior to the Civil War, the common school movement spread to both the South and the West by the beginning of the 20th century (Levin et al. 2000).

In the U.S. and Canada, the boarding school era began in the late 1800s and continued through the 1920s. Separated from their families, many Indian children, some as young as three years old, were “Americanized” in schools where “affection was rare” and “punishment often severe.” Indian dress, language and beliefs were forbidden. Many children were abused, and tried to run away; unknown numbers died (Elliot and Dirr 1998).

CURRICULUM AND TEACHER PREPARATION BEFORE THE 20TH CENTURY

The common school curriculum in the mid-1800s consisted mainly of the basics—reading, penmanship, arithmetic, and “good manners.” A typical one-room schoolhouse housed students of all ages and abilities with learning methods that included oral recitation, drilling, and quizzes. Supplies included a slate, chalk, and a few books. Schools were sparsely supplied as families’ resources were focused on the farm and issues of survival. In sparsely populated areas of the U.S, school might be open only for a few weeks or months in a year, when students were not needed to work on the farm. In 1913, educational progressive, George H. Betts suggested several reform measures for the rural school curriculum that have parallels in the newly emerging national standards and which still have relevance today. Betts ideas included:

“If the rural school is to meet its problem[s], it must extend the scope of its curriculum. It was formerly thought by many that education, except in its simplest elements, was only for those planning to enter the “learned professions.” But this idea has given way before the onward sweep of the spirit of democracy, and we now conceive education as the right and duty of all. Nor by education do we mean the simple ability to read, write, and number.” (Betts 1913)

Common schools had meager resources and inadequate or non-existent teacher training. They had rejected the “European-style” curriculum as it was
considered impractical for preparing students for skills suited to rural life. In the mid to late 1800s, teachers began to receive more training and took tests for certification. In more populated areas, Normal Schools emerged to offer courses of preparation, ranging from a summer school course to a 2-year program and later a 4-year program. These efforts at preparing teachers had some deficiencies, however. Some teaching academies and colleges did not admit women. Often, when a woman married (and certainly when she became pregnant), she could no longer teach in a public school (Eliot 1898). Men were generally paid twice as much as a woman teaching in the same environment.

THE COMMON SCHOOL IN SOUTH DAKOTA

As an example, on the South Dakota plains farmers usually built the schoolhouse out of sod (due to harsh winter conditions and the lack of trees). Parents supplied fuel for the stove and feed for the horses that students sometimes rode to school. Teachers were housed with farm families, rotating households periodically (Levin et al., 2000). The first public school house was built in Vermillion, SD in 1864. Amos Shaw, its first public school teacher taught approximately 30 pupils, receiving compensation from parents of $2.50 per pupil per year. He was replaced by a Miss Baker who received the same rate of pay—highly unusual for this time. The curriculum included the McGuffey Readers—the Second Reader used excerpts from Pilgrim’s Progress and The Bible. Other subjects in the curriculum were: arithmetic, which enabled men to survey and measure precisely for building construction and provided women the ability to measure proper quantities and to prepare and preserve food for the winter (Lias 2011).

In the Chicago World’s Fair (Columbian Exposition) of 1893, schools from across America were highlighted in their state’s exhibition hall. Public school teachers and principals had been requested to provide excellent examples of scholarship. During a lecture at the Fair, Fredrick Jackson Turner announced that “the United States’ Western Frontier had been tamed.” Although South Dakota had become a state only four years previously, its exhibitions sought to show a prosperous state with resources to attract industry and investment. They extolled the “efficiency of the state’s educational system, quality of work produced by its mining industry, and magnitude of the crops yielded by its farmers on display at the Fair” (The World’s Columbian Exhibition 1893).

RESULTS OF BROADENING THE CURRICULUM

Figure 1. On the left, the first permanent schoolhouse in The Dakota Territory, constructed in Vermillion in 1864. This photo of the structure was taken in 1880. On the right is shown a typical rural school of the early 1900s. (Thaden 2008)
scholarship. During a lecture at the Fair, Fredrick Jackson Turner announced that “the United States’ Western Frontier had been tamed.” Although South Dakota had become a state only four years previously, its exhibitions sought to show a prosperous state with resources to attract industry and investment. They extolled the “efficiency of the state’s educational system, quality of work produced by its mining industry, and magnitude of the crops yielded by its farmers on display at the Fair” (The World’s Columbian Exhibition 1893).

RESULTS OF BROADENING THE CURRICULUM

With the advent of textbooks, the teacher could teach more easily in a classroom in which students were at different levels (Klopfer and Cooley 1963). The first school textbook recorded was the New England Primer, used between 1760 and 1843. The McGuffy Readers, first used in 1836, were based on examples of world literature. They were the basis for teaching reading and basic values such as honesty and charity.

During the late 19th century several national educational reform initiatives emerged. With the establishment of the National Educational Association (NEA) in 1857, a systematic study of schooling in America was undertaken. Interestingly enough, women were not allowed to join until 1866, even though the majority of the Nation’s teachers were women (Cremin 1980). According to the NEA in 1893, only about one-third of the pupils who entered the first year of the elementary school reached a four-year high school, and only about one in nine graduated. To address that problem, a commission instituted by the NEA met and defined a new curriculum called the Cardinal Principles of Secondary Education which included: “1) Health, 2) Command of fundamental processes, 3) Worthy home-membership, 4) Vocation, 5) Citizenship, 6) Worthy use of leisure, and 7) Ethical character.” Changes were also made to the structure of post-elementary education dividing the 6 secondary years into three junior and three senior segments and to broadening and deepening the curriculum. Students were divided into groups by ability, marking the beginning of what was later called “tracking.” Public schools had begun to change in response to the identified curricular deficiencies. A new concept of curriculum structure was emerging. By definition the term “curriculum” was used by the NEA commission:

…to designate a systematic arrangement of subjects, and courses in those subjects, both required and elective, extending through two or more years and designed for a group of pupils whose common aims and probable careers may properly differentiate a considerable part of their work from that of other groups in the school (NEA 1918).

DISCUSSION: SCIENCE IN THE CURRICULUM

In the U.S., science education originated as a scatter of disparate subjects prior to its standardization in the 1890s. In the early 1900s, formal science subjects be-
gan to be included in the curriculum in junior and senior high schools, not only for the intrinsic nature of the subject matter, but also to extend knowledge of science to the farm and home. Attention was also given to the way science should be taught, not only as a listing of facts and processes but as a coherent whole. As evident today, these were not only progressive for the time but anticipated the current reform movement’s integration of subject matter with applications (Del Giorno 1969). The context of science in public schools had begun to illuminate the problem, and, according to George Betts science began to function as a “candle in the dark.”

Material science should constitute an important section of the rural high school curriculum. Not only does its study afford one of the best means of mental development, but the subject-matter of science has a very direct bearing on the life and industries of the farm. To achieve the best results, however, the science taught must be presented from the concrete and applied point of view rather than from the abstract and general. This does not mean that a hodge-podge of unrelated facts shall be taught in the place of science; indeed, such a method would defeat the whole purpose of the course. It means, however, that the general laws and principles of science shall be carried out to their practical bearing on the problems of the home and the farm, and not be left just as general laws or abstract principles unapplied (Betts 1913).

Prior to this time, school textbooks were published with connections to practical applications of curriculum in the real world. High School was perceived as an option only for a few students whose parents could afford the supplies and

Figure 2. A secondary science textbook of the late 1880s is shown (Levin 2000).
books. Students who attended high school were thought “bound for the professions” such as medicine, law and politics with aspirations for college matriculation. Figure 2 shows an example of a common public school textbook. Highlighted are the “relative variations among the subjects of thought.”

John Dewey and other school reformers began to change teaching and learning in America. In Dewey’s The School and Society (1900), he maintained that learning should be grounded in experience. As an alternative to the drill-and-recitation methods of the nineteenth century, in Experience and Education (Dewey 1938), he posited that education should be based on the child’s psychological and physical development, as well as the world outside the schoolroom (Levin et al. 2000). Experiences in the classroom at all levels (now referred to as “hands-on” or experiential learning) have always been very suited as a method for teaching science.

Daniel Alexander Payne, Past President of Wilberforce University in Ohio and the first African-American college president in the United States born to free parents, opened his own school at the age of 19. He wrote about educating himself and his students in his autobiography the Recollections of Seventy Years. The following 1830’s excerpt reveals the societal context in which “black schools” operated at that time and something about how the curriculum sometimes evolved in those schools (Payne 1888).

My first school consisted of three children, for each of whom I was paid fifty cents a month. I also taught three adult slaves at night, thus making my monthly income from teaching only three dollars...The next thing which arrested my attention was botany... Descriptive chemistry, natural philosophy, and descriptive astronomy followed in rapid succession... My researches in botany gave me a relish for zoology; but as I could never get hold of any work on this science I had to make books for myself. This I did by killing such insects, toads, snakes, young alligators, fishes, and young sharks as I could catch. I then cleaned and stuffed those that I could, and hung them upon the walls of my school-room.

Laboratories were first introduced into the science courses in public high schools during the late 1800s. High school science laboratories have been defined as laboratory experiences that allow for students to interact directly with the material world (or with data drawn from the material world), using the necessary tools, data collection techniques, models, and theories of science (Singer et al. 2005).

Today, high school science education includes some appreciation of the nature of science in order to provide scientific literacy for all. As part of a liberal education and to prepare students for further study, work, and citizenship, the scientific methods of observing, investigating and discerning fact from myth has earned science a much needed place in the American public school curriculum. There is agreement that hands-on study of science is imperative.

Science and its methods of applying critical thinking, questioning, and organization of ideas from observation, deriving meaning from evidence, applying these to explanation, argumentation and prediction all stand solidly on the
ground of a well-articulated subject. These are the underpinnings of any long-lasting and deep learning. New standards have begun to be set for public school curriculum. The process continues today.

**DISCUSSION: EDUCATIONAL STANDARDS: THEN AND NOW**

The Cardinal Principles of Secondary Education prescribed changes to the structure and direction public education needed to take in the future. These and subsequent implemented reforms have led public schools to the current standard-based reform movement. Further, the NEA charged the Commission on the Reorganization of Secondary Education with the task of modifying secondary education so that it became more in line with the character of society, students and educational theory (NEA 1918).

A similar call for reform seventy-five years later and published in 1989 by the American Association for the Advancement of Science (AAAS), Project 2061’s Science for All Americans was a clarion call response to the urgent need for standards-based reform in the sciences. The purpose of the report was to re-clarify the goals of science education so that educators could begin to make scientific literacy attainable by all students (DeBoer 1991).

Since 2001, schools have operated under No Child Left Behind (NCLB) and a separate set of state and local statutes (in an atmosphere of ‘high stakes testing’) citing new assessment-based curricula. The impact of the NCLB movement on funding has been enormous. School districts have been swamped with additional reporting measures designed to close loopholes for the non-reporting of student test scores (Jorgenson and Hoffman 2003). The result has been a giant “leap backward” for curriculum reform and student-centered instructional measures.

Following the NCLB Act and in response to the need for a more balanced view of a curriculum based on expert recommendations, the Common Core State Standards Initiative was spawned. Additionally, in 2010, the Science Frameworks were released followed in 2012 by a draft of the Next Generation Science Standards (NGSS) (based on the Frameworks). The NGSS (and Frameworks) were developed collaboratively by 20 states by representatives from science, science education, higher education and industry. These Frameworks (and the NGSS constructed from them) will seek to integrate concepts, skills and ideas while describing inquiry-based settings in which science learning is most effective (BOSE 2011. The new Science Frameworks consist of a limited number of elements in three dimensions:

1. Scientific and engineering practices,
2. Crosscutting concepts, and
3. Disciplinary core ideas in science.

They describe how these should be developed (progress) across grades K-12. It is designed so that students continually build on and revise their science knowledge and abilities throughout their school years.
To support this learning, all three dimensions are to be integrated into standards, curricula, instruction, and assessment (Singer et al. 2005). In South Dakota, Secretary of Education Melody Schopp along with Science Education Specialist and Primary Point of Contact Sam Shaw are directing a large statewide group of standards reviewers. These new science standards are slated for release in early 2013 (Shaw 2012).

FUTURE IMPLICATIONS

In the previous sections of this paper, the evolution of American public schools was discussed including the inclusion of science subjects and reforms which remarkably contain several common elements. Although, U.S. public education eventually broadened to include all citizens, it didn’t begin that way. In the common school, prevalent in the Midwest including South Dakota, school curricula were designed based on physical necessity and financial expediency.

Over the last two centuries, the social context has changed in rural schools, the “small city” schools in urban and suburban areas. Since change is always inevitable, the context in which students learn and teachers teach has had to adapt to the swinging pendulum of social evolution and educational reform.

Students should be better educated in schools by teachers who receive appropriate, practical and more diverse educational preparation. All teachers should be supported with methods and curricula that tap a well-defined body of knowledge and framed in decades of educational research in order to effectively prepare them for the classroom. Further, science education should be the adding of rich new threads integrated into the “whole cloth” of any student’s rudimentary science knowledge base and not added as a “peripheral fringe” around its edges.

CONCLUSION

At a hearing early in 2007, Senator Edward Kennedy suggested that the way forward in science education lies in our knowledge of the past. He reminded us of events that have been forgotten in the present push for standards reform, “We did it after the Sputnik launch, [in 1957] when we trained a new generation of Americans in math and science. And we inspired millions more to greater and greater innovation when President Kennedy challenged us to send a man to the moon” (Abramson 2007). In 1958, Congress had passed the National Defense Education Act that gave a new science curriculum an infusion of more than a billion dollars when it passed.

The work is not complete, however. As long as society changes (and it must) and curriculum standards are again refined; as long as students must be educated and teachers must be prepared to teach, reforms will by their very nature continue. If the roots of today’s initiatives are framed in an historical context, with a deeper understanding and appreciation of how knowledge of past reforms can inform the present, future reformers may be able to instill a fuller and more responsive science education design in American public schools.
LITERATURE CITED


