

The Influences on the Development of Mathematics Curricula since 1900

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Introduction

The founding of a country lends it self nicely to the analysis of the varying influences that shape its society, industrial complexities, mores, and education. This "founding" provides a finite beginning from which the impact of such influences may be studied. It is the goal of this paper to look briefly at the influences that shaped the mathematics curricula from the turn of the twentieth century until now. While the date 1900 was arbitrarily chosen, it is a significant time in the development of mathematics education in the United States. Mathematics was emerging from the era of mathematics as a "mental discipline," to one in which, as was advocated by E. H. Moore and John Perry, emphasis was on application and the strong ties of mathematics to science (NCTM, 1970, p 39). It is this period that bears witness to the growth of mathematics curricula that appeal to such diverse influences as psychology, mathematicians, and mathematics educators. It is also during this time that the United States is engaged in two world-wide wars, in which the role of technology and the subsequent mathematical knowledge of it's citizens is moved to the fore. It is with these in mind that this paper looks at these influences, plus the influences of society's needs and parents. The limited scope and time of this paper does not lend itself to covering each of these in depth, and, therefore, will include a representative element that dramatically impacted the curriculum development of its day. It is, therefore, the concept of *influences* that I have traced through the years of mathematics curricula.

Pre-1900

While the focus of this work is on the development of mathematical curricula during this century, it may be instructional to have a sense of the climate within the new nation prior to this period. While many of the societal developments of the new nation were from industrialized nations, like England and France, the United States remained agrarian for some time after its founding. Society was divided into two distinct groupings: "The haves" and "The have nots." Consequently the educational system was developed with two foci. The first was at a craftsman level in which students, if they were lucky enough to attend school, received instruction in the rote application of mathematics. Dilworth's work, *Schoolmasters Assistant*, is a perfect example. In the text of the book (as quoted by NCTM, 1970, p 15) Dilworth express his belief that the "catechetical form" of his book was best suited for children so that "at any time in what place so-ever the scholar appears to be defective, he can immediately be put back to that place again." Even this, however, was a luxury. Most mathematics instruction in the 17th and 18th century was conducted by private tutors after school hours (NCTM, 1970, p 13). Those who did not attend formalized schooling usually received informal lessons in mathematics instruction from their master craftsman, whose primary concern would have been the application of mathematics to the task at hand.

The second group of society that would have received instruction would have been those who came from families wealthy enough to ensure a proper education. It was for these children of the new world nobility that academies, like those of Ben Franklin, were designed. The foundation of these schools was based on the English school system, whose emphasis was on the classics. Mathematics in this setting was for application, but also for "mental discipline" which pushed the curriculum toward a decided theoretical edge (p. 18). It is this emphasis on mental discipline that will shape mathematics education until the dawn of the 20th century. D. E. Smith (1925) states that it was algebra taught "for the purpose of developing patience and habits of persistence and of training a pupil in reasoning" (p. 13).

Post 1900

Societal Needs and Their Impact

As seen in the earlier days, society's needs for trained craftsmen and college-bound scholars drove the curriculum to be practical for one side of society and theoretical on the other. By the later part of the 19th century, the theoretical had taken strong hold of the curricula used in the schools. According to the National Council of Teachers of Mathematics (NCTM) yearbook for 1926, "one of the most popular texts of twenty-five years ago had eight pages of definitions and theory before a single example was given, and out of nearly 1600 exercises in the first 128 pages only 111 were verbal problems, and only two could lay claim to relating to human need" (p. 26).

Society at the turn of the century had indeed changed. Industrialization had taken a large leap forward with the development mass production automobiles and the introduction to human flight. Technology was moving to the fore, and with it came an increased emphasis on movement away from the purely theoretical to the more applicable. Mathematics text such as Shew's *A student's drill and review book in plane geometry*, while placing importance on drill, also placed importance on real life applications.

By the 1920's Thorndike's turn of the century work in the area of psychology and, in particular his work on the transfer of learning, was becoming more popular. He argued that teaching mathematics as a "mental discipline" was ineffectual, and encouraged a move toward connecting theory and application. A geometry text of the day illustrates the emphasis on drill for students. In her book, *A Student's Drill and Review Book in Plane Geometry*, Gertrude Shew (1923) emphasizes that "well-organized drill" was an effective way to fix "facts and principles of geometry" in the student. This is a direct appeal to Thorndike's concepts of connectionism. In their book, *How to Teach Arithmetic*, Brown and Coffman (1914) discuss the "value of drill" in terms of formal versus rational drill. Formal drill was the type of drill used in text during the 19th century. It involved recitation of facts and tables prior to the application of such. Rational drill, in the words of Brown and

Coffman, still involved the process of drill, but place emphasis on understanding the underlying principles as well as the ability to apply them.

This increasingly popular view led to a strong move from curricula written in the vein of the catechetical of Dilworth to more curricula designed using the connectionism of Thorndike. The National Council of Teachers of Mathematics reflected this shift in curriculum development in their first yearbook. "At the present time every leading writer of school algebras is making the attempt, with more or less success, to arrange the topics on a more rational basis. The sanely progressive books begin with the formula, then its meaning, its practical use, and the method of deriving one formula from another" (NCTM, 1926, p 23).

By the late 1920's emphasis on the application of mathematics seems to take a turn toward the theoretical, but only slightly. In the second NCTM yearbook, D. E. Smith (1927) argues for a split school system where students up to the ninth grade study the applicability of mathematics, while students in grades 10 - 12 should prepare for college. Smith's recommendation for the study of mathematics in grade 11 states explicitly that mathematics be "open only to those who wish to study it, who show an aptitude for it, and who will need it for work in science, economics, or pure mathematics ..." (p. 237). This is indeed an odd statement from someone who just two years previously had argued that - "we have demanded equality of privilege in education as we have demanded it in the courts .." (Smith, 1925, p 7).

During this time the curricula offered in high schools reflected the importance of utilitarian mathematics. E. R. Smith (1927) in the same yearbook gives a general outline of curricula that includes a substantial portion dedicated to this concept of utilitarianism. However, E. R. Smith points out that concomitant with these principles comes the heavy reliance on tables and short-cut methods (p. 245). It is probably in this context that D. E. Smith argues for the changes cited earlier.

World War II once again placed increased importance on applied mathematics. In 1942 the NCTM published the yearbook *Source book of Mathematical Applications*. The examples in the book range from engineering problems that involve bridge spans to navigational problems for geometric applications. While not all of the problems in the source book have direct military application, it is clear that the societal needs were focused sharply on the war effort.

The end of World War II ushered in the age of the atomic bomb and the start of the fear of communism. Mathematics was seen as the important fundamental element in the development of nuclear energy, and the shift once again toward the theoretical. Such a movement can be seen in the Harvard Report of 1945. The report placed emphasis "clearly on mathematics as an abstract, logical structure."

As we begin the age of technology, that emerged in post-war America, society was beginning to see a dramatic inability of mathematics education to prepare students for the future, which was certainly one in which mathematics would play a key role. It was during this period that mathematicians, in the light of the Harvard report, urged the schools and those in the business of curriculum development to increase their efforts to reach the mathematically gifted by going beyond the "usefulness" of mathematics. It would

appear, at least in these meager readings that the placement of application had been at the expense of the theoretical, and that the age of technology would require an understanding of both. Kenneth May (as quoted in NCTM, 1970, p. 251) reported that "the present crisis in mathematics is due ... to an urgent national need for more and better mathematics at a time when administrators and the public have for years slighted mathematics and, indeed, discouraged vigorous mental effort in the high schools .." Reform of the curriculum was once again in the air, and the needs of society was, once again, the rallying cry.

Public support for curriculum reform was in no small way influenced by the popular press when they reported the launch of Sputnik in 1957, and the subsequent fear of Communism's spread to Cuba and South East Asia. The public was ready and willing to fund projects that increased our mathematical ability as a nation. Consequently, funding from the National Science Foundation and other governmental organizations was used to develop reform curricula that saw the age of the "new math" curricula.

However, the "new math" was not as well received by the rather "mathematical illiterate" populace as was anticipated. Once again the influences of the people forced a change in curricula away from the newer presentation of mathematics to a more traditional series of mathematics texts and curricula in which the emphasis is once again on drilling mathematical procedures. This return to the traditional seems to have moved well beyond the traditional drill-and-practice series of the late 1920's. The curricula of post-"new math" saw the return of formal drill in the sense of Brown and Coffman (1914).

The success of this trend to the traditional continues to be argued today. However, in 1983 the National Commission on Excellence in Education (NCEE) released a report that placed the entire educational system in the United States in question. This report, entitled *A nation at risk* has been credited with laying the ground work for what would become the set of standards for school mathematics promulgated by the NCTM (McLeod, Stake, Shappelle, Mellissinos, & Gierl, 1996). A number of other popular works were published in the 1980's that seem to have been the harbingers of this new revolution in mathematics curriculum development. Of the many important documents that were published during this time, perhaps the best known to the public, besides *A nation at risk*, were the reports such as *Everybody counts* and the NCTM's *Curriculum and Evaluation Standards for School Mathematics*. While each remains controversial for various reasons (both political and academic), it is almost universally accepted that each has had a profound impact on the development of curricula in the United States.

Mathematics for Everybody

Implicit in the argument of society's impact on curriculum development is the desire of some to teach all children the required mathematics that is needed for them to function as effective citizens. The curriculum that is seen throughout these periods seems to place emphasis on either the theoretical or the applied. And those that seem to emphasized the applied focus mainly on the utilitarian mathematics rather than on more advanced, applied concepts. There seemed to be no middle ground.

D. E. Smith's (1927) argument that mathematics after grade 10 should be for those going to college is a perfect example of this "black and white" approach to mathematics curriculum development. E. R. Smith (1927) in the same issue of the NCTM yearbook was concerned that even those who were getting the basics in mathematics instruction, were not understanding enough of the mathematics to be able to apply it in their every day lives.

But most of the skills and knowledges universally needed, including knowledge sufficient for the contacts with matters of mathematical interest are included in arithmetic and other mathematics that is studied before senior high school. Is it mastered there and can that part therefore be considered as finished? I think not and therefore I wish that all students could be required as a prerequisite to take a course in mathematics in common use or of such value that it should be in common use, among those having no particular mathematical contacts. (NCTM, 1927, p. 250).

The first report of the Commission on Post-War Plans, written in 1944, recognized that mathematical literacy was important for all and "held that the school should ensure mathematical literacy for all who can possibly achieve it" (NCTM, 1970).

Parents

The parental influence to change curriculum cannot be understated, especially when the popular press has an influence on them. Parents, who are concerned about the future of their children and fear that their children will not be able to gain admission to the college of their choice, may exert a strong political influence on the very governmental organizations that hold the purse strings for research money. Fullan (1991) emphasizes the importance of the parental involvement in educational decisions. He points out that "communities can either (1) put pressure on district administrators 'to do something' about a problem, (2) oppose specific innovations that have been adopted, or (3) do nothing" (p 243). In the case of innovations in mathematics curriculum the "problem" referred to by Fullan may only be a "perceived problem," as in the introduction of new-math curricula. Whether it was "perceived" or "real" there is little doubt that the lack of support, and perhaps lack of understanding, on behalf of the communities led to the rapid decline in the use of new-math related curricula.

Colleges

The influence of colleges, especially from the research mathematicians who sat on many committees, has been profound in the development of the mathematics curricula. Universities, such as the University of Illinois, have been involved from the start of the "new math" era in the development and research of effective curricula.

The foundation of the College Entrance Examination Board (CEEB) in 1900 was a significant milestone in the process of education in the United States. In 1927, D. E. Smith states that "No other influence in the reform of the teaching of mathematics in our secondary schools of the present time has been more potent than that exerted by this board" (NCTM, 1927, p. 9). It was the duty of

the board to administer the tests that determined the mathematical (among other subjects) viability of the future high school student. In 1922, the CEEB updated its requirements eliminating what it considered the unessential work in mathematics. This edict effectively removed anything that was "not reasonably justified," i.e., "long and elaborate multiplications or division of polynomials ..." (NCTM, 1970, p 10). D. E. Smith (1925) heralds this change as "one of the most convincing evidences of the progress of algebra in the last quarter of a century" (Smith, 1925, p 51).

Summary

While these influences are not inclusive, they show the impact of society on the ever-changing face of mathematics curriculum development. The focus of this paper on the societal needs does not diminish the tremendous impact of other influences. It could be argued that the developments in psychology had a greater impact, or that without the influences of research mathematicians, such as E. H. Moore, reform may never have happened. It is a humble opinion that states that it is all of these combined. There is a synergism that occurs when all of the forces are working in unison. One by itself may have had little impact, but together they sounded the call that continues to be heard.

Curriculum development continues on a cycle. With every new theory there is a counter theory, or a call for a return to a more simplistic approach. Newer curriculum of today know all too well the desire of some to place traditional, basic concepts at the fore. This is a cycle that has been persistent since the founding of the educational system of this nation. There is little doubt that it will continue.

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