A History of the Standards-Based Movement in Mathematics

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Abstract

This paper will examine the history of the standards-based movement in mathematics in the United States, starting from its beginning in 1980 up through the present day. The influence of various organizations, such as the National Council of Teachers of Mathematics (NCTM), as well as political motivations will be analyzed. Additionally a prediction of the future of the standards based movement will be provided. A discussion of the structure of the Math Standards of the Common Core State Standards (CCSS), as well as a comparison to the language of the Maine Learning Results is supplied. Finally, various resources and organizations which support educators in the implementation of the CCSS in mathematics are included.

A History of the Standards-Based Movement in Mathematics

As one examines the history of the standards-based movement in the United States, it is easy to see that the content area of mathematics was one of the leaders in the development of standards. Starting in 1980, the National Council of Teachers of Mathematics (NCTM) has had numerous papers and books published about standards in mathematics.

The 1980's

Although many people cite the report "A Nation at Risk" as the starting point of the standards-based movement in the United States, the starting point within mathematics can arguably be marked as pre-dating that report by about 3 years.

In April, 1980, NCTM released a series of recommendations titled "An Agenda for Action." These recommendations included such things as using problem solving as a focus of instruction, looking at basic skills in mathematics as more than just computational facility, utilizing calculators and computers at all grade levels, and requiring more mathematics studies for all students. Additionally, recommendations were made related to applying standards to the teaching of mathematics as well as requesting a higher level of professionalism among mathematics teachers (NCTM, 1980).

On August 26, 1981, the United States Secretary of Education, T.H. Bell, under the direction of the Reagan Administration, created the National Commission on Excellence in Education. This committee was directed to examine educational systems within the United States and to make a report publicly available within 18 months. (National Commission on Excellence

in Education, 1983). The resulting report, “A Nation at Risk,” published in April, 1983, is often regarded as the starting point of the standards-based movement in American education.

There are five specific recommendations that are given in this report. These recommendations are in the following areas: Content, Standards and Expectations, Time, Teaching, and Leadership and Fiscal Support. In the area of Content, the following recommendation for regarding mathematics was made.

> The teaching of **mathematics** in high school should equip graduates to: (a) understand geometric and algebraic concepts; (b) understand elementary probability and statistics; (c) apply mathematics in everyday situations; and (d) estimate, approximate, measure, and test the accuracy of their calculations. In addition to the traditional sequence of studies available for college-bound students, new, equally demanding mathematics curricula need to be developed for those who do not plan to continue their formal education immediately. (National Commission on Excellence in Education, 1983, Recommendation A.2)

Following these reports, in 1986 the Board of Directors for NCTM initiated the development of standards in mathematics. The first draft of this document was distributed to 10,000 members of NCTM in 1987 for review and feedback. The final version of these standards, *The Curriculum and Evaluation Standards for School Mathematics*, was published in 1989 (National Research Council, 1997, chapter 5).

The 1990's

Early in the 1990's a nationwide discussion began about the concept known as "Outcome Based Education," or OBE. In many ways, OBE was the precursor to many of the movements in education that have followed. In particular, there are some strong parallels between OBE and Proficiency-Based Education (PBE) in that both systems strive to measure student progress towards a fixed set of standards, rather than comparing students against one another.

According to William Spady, there were many controversies that surrounded OBE (Spady, 1994). In particular, there was substantial resistance from groups who felt that this was giving up too much local control, relinquishing that control to the federal government. Additionally, many religious factions, especially among conservative Christians, felt that this movement was detrimental to their core beliefs. Specifically, there was a desire to eliminate "New Age" philosophical influences from the public school curriculum, as well as to restore a pro-Christian philosophy they believed the founding fathers intended. (Spady, 1994, p. 152). Finally, as with any new idea, it appears that a simple resistance to change also contributed to the opposition. As a result, the phrase Outcome Based Education has largely disappeared from the public's vocabulary, although the concept has lived on, and is now generally referred to as Proficiency-Based or Competency-Based Education.

However, throughout the 1990's organizations and educators, in addition to business leaders and politicians, continued to talk, research, and try new ways to better educate students in mathematics. In 1997, the State of Maine released the "Maine Learning Results," and the content standards in mathematics in the Learning Results were heavily influenced by NCTM standards.

According to NCTM, in fact, most state standards went through refinement and were aligned with the NCTM Standards (Dossey, McCrone, & Halvorsen, 2016, p. 15). Crosswalks showing the connections between state standards and the NCTM standards became readily available as teachers worked to align what they were teaching both with national and state standards.

The 2000's

In April of 2000, NCTM published an updated set of standards for mathematics, called "Principles and Standards for School Mathematics." This document built on the standards from 11 years earlier, and broke the content into five specific areas. Additionally, these standards also focused on the processes for students to master in mathematics, such as Problem Solving, Communication, and Representation. These processes were the precursor to the Standards of Mathematical Practice (SMP) found in the Common Core State Standards (CCSS).

By the early 2000's, every state had adopted their own set of standards for elementary school and high school (Common Core Standards Development Process, n.d.). Additionally, in 2002 President George W. Bush signed into law the No Child Left Behind (NCLB) Act. This was a reauthorization of the 1965 Elementary and Secondary Education Act. In addition to providing Federal Title I funds for disadvantaged students, this act supported standards-based education. States were required to show that their students were meeting the individual state standards on selected grade levels.

However, every state had their own set of standards and their own proficiency definition, which varied from state to state. In 2008, the National Governors Association (NGA), the Council Chief State School Officers (CCSSO), and Achieve, Inc. released a report titled

"Benchmarking for Success" by Craig Jerald. This report, funded by the Bill & Melinda Gates Foundation, recommended that states should "upgrade state standards by adopting a common core of internationally benchmarked standards in math and language arts for grades K-12 to ensure that students are equipped with the necessary knowledge and skills to be globally competitive" (Jerald, 2008). This led to the development of the Common Core State Standards (CCSS) in Mathematics and English/Language Arts, an attempt to standardize the educational expectations across the country. The lead authors of the CCSS in Mathematics were William McCallum, Jason Zimba, and Phil Daro. The first draft of these standards were released in late 2009 for comments and feedback from various groups around the country.

The CCSS in Mathematics were heavily influenced by NCTM and the existing NCTM standards, in that there is a focus on both content and process. Additionally, the mathematical content is broken into specific areas, or Domains. These Domains are generally Number and Number Sense, Algebra, Functions, Geometry, and Statistics and Probability. Although not present in every grade level, the majority of the grade level standards will fall into one of these areas.

The Standards of Mathematical Practice (SMP) describe eight practices that the authors of the Common Core considered to be necessary practices for students to possess. The NCTM process standards from 2000 are included in here, as are some strands from other areas (Standards for Mathematical Practice, n.d.).

The 2010's

From 2011 - 2012, states and territories were examining the final copy of the CCSS for Mathematics and English. The majority of the states ultimately replaced their own standards in Math and ELA with CCSS. As of December 2013, a total of 45 states had adopted the CCSS. As of August, 2015, that number had dropped to 42 states plus some territories (Common Core Standards Development Process, n.d.).

In 2014, NCTM published "Principles to Actions: Ensuring Mathematical Success for All." According to NCTM, this document includes eight research-based Mathematical Teaching Practices, information on how to support these teaching practices, and lists of productive and unproductive beliefs that have to be addressed by all involved.

During this time, several states began enacting laws in the area of Competency-Based Education, or Proficiency-Based Education (PBE). This system of education has similarities to the OBE attempted in the 1990's, in that schools were being required to show student progress towards specific standards, rather than comparing student to student. Additionally, much conversation is around the idea of "Mastery" of standards, and the expectation that students must show mastery in all standards, and not just achieve a passing average of all assignments.

As far back as 2003, the Rhode Island Board of Regents began requiring high school students to show mastery in various subject areas. The Boards of Education in New Hampshire (2005), Oregon (2007), and Vermont (2014) implemented similar requirements. Additionally, as of early 2017 some 10 states have enacted laws requiring proficiency based education for high school students (National Conference of State Legislatures, 2017).

The Future of the Standards-Based Movement

Tracing the history of standards shows a great deal of evolution over time. It also shows that change is slow, and involves many people and many organizations. Initially focusing on mostly content, the standards in mathematics have been expanded to include not only content for students to know, but also the skills students need to reason mathematically, problem solve, and communicate about the mathematics. Additionally, much more emphasis is being placed on how a teacher should instruct and guide discussions to create a more mathematically literate student population.

It is my expectation that although the standards themselves will most certainly change and be refined over time, the existence of having standards is with us to stay. For good or for bad, there is far too much desire from state and national governments to see standards in place for all schools for these to disappear from American education. In a much more mobile society than seen in the past, having common standards between schools, districts, and states allows for greater ease in transition for families that move. Additionally, common measurements allow for much more sharing of resources. In many ways, the hardest acceptance will be for individuals, towns, and states that want to see a much greater level of local control.

Structure and Confusion of the Standards

Over the various iterations of standards, both at a national level and at the state level, several terms are used. For example, in the CCSS for Mathematics, the breakdown of the standards are often given in the following form: Grade Level, Domain, Cluster, Standard. The

grade level describes the standard grades kindergarten through eighth grade. However, at the high school level, grade levels are not used in the standards. Instead a broad set of categories are given. They are: Numbers and Quantity, Algebra, Functions, Modeling, Geometry, and Statistics & Probability.

Within each of these grade levels (elementary education) or broad categories (secondary education), the Domains are groups of related standards. For example, one domain that spans from Kindergarten to Grade 5 is “Numbers & Operations in Base 10,” commonly abbreviated as “NBT.”

Then each Domain is broken into one or more Clusters. These clusters are related standards. As an example, in Grade 5, NBT, the following clusters are given: Cluster A: “Understand the place value system” and Cluster B: “Perform operations with multi-digit whole numbers and with decimals to hundredths.”

Finally, each cluster is broken into one or more standards, and sometimes substandards. For example, in cluster 5.NBT.A there are four standards, and standard three has two substandards under it - 5.NBT.A.3.A and 5.NBT.A.3.B. Cluster 5.NBT.B has three additional standards, and they are numbered 5.NBT.B.5, 5.NBT.3.6, and 5.NBT.3.7.

To further complicate issues, some materials do not reference the clusters in their naming scheme. For example, a textbook might refer to standard 5.NBT.6, and not indicate that this is in cluster B. Although this is still a well-defined name, it seems to add to confusion.

Finally, states already have in place their own set of standards for many content areas. As such, they are forced to try to fit the structure of the CCSS with their existing structure of

standards in other content areas, and to keep vocabulary consistent. For example, the State of Maine Learning Results does not use the term "Domain," but does use the term "Performance Indicators." As such, they use the following terms: Instead of "Domain," they refer to "Content-area reporting standards." Then, instead of "Standards," they use the term "Performance Indicators." As such, when the state references students meeting "all the standards," they are not referring to meeting all of the CCSS standards, but rather meeting all the Domains in the CCSS. This language is summarized in a document published on the Department of Education website that provides a crosswalk between the language used (Maine Department of Education, 2014).

Organizations and Resources that support the standards

There are a multitude of organizations that support the CCSS mathematics standards. Some have been listed earlier, but are included again here for the sake of completeness. It is important to note that some organizations, while supporting the content of the CCSS, may not support the Standards of Mathematical Practice (SMP) of the CCSS. As such, the information from these organizations may need supplementation from other resources.

NCTM

The National Council of Teachers of Mathematics (www.nctm.org) is the professional organization that supports mathematics teachers in the classroom. As indicated earlier, NCTM was instrumental in the formation of standards in the country, and were a major influence on the creation of the CCSS Math Standards. Additionally, NCTM has provided numerous additional

resources, classroom activities, and sample videos that support both the content and the SMP of the CCSS.

NCSM

The National Council of Supervisors of Mathematics (NCSM) is a professional organization that supports leaders of mathematics within schools and districts. Their website (www.mathedleadership.org) provides a variety of resources geared around professional development and they are a strong supporter of Math Coaches, Curriculum Coordinators, and Math Interventionists. NCSM also supports both the content and the SMP of the CCSS.

Achieve the Core

The website www.achievethecore.org has a multitude of valuable tools for understanding the CCSS. Created by several distinguished educators, including lead authors for both CCSS Math and CCSS English, the site includes numerous tools for mathematics teachers and leaders. Of particular value are two items: the Coherence Map for the Mathematics standards (http://achievethecore.org/coherence-map/#), that allows a user to follow standards through grade levels and across domains, and the Focus Clusters, which identify the standards where the majority of classroom time at each grade level should be focused. Combined with slide show presentations and videos explaining why these standards were written and implemented, this site is a worthwhile resource for addressing both content and SMP in the CCSS.

Illustrative Mathematics

The website https://www.illustrativemathematics.org provides “instructional and assessment tasks, lesson plans, and other resources for teachers, assessment writers, and

curriculum developers." This site allows a user to search content standards by grade level or by domain, and also has sections for professional development, practice standards, progressions. They are just adding curricular materials to be used in the middle level grades, focusing on problem solving, discussion, and real world problems.

IXL

The website IXL (www.ixl.com) is fairly well known in many schools. Providing a complete list of skills for each grade level, and aligned to the CCSS, this site allows students to practice the specific skills they are learning in their class or to go back to practice skills learned earlier in the year. There are some basic tutorials included for students are struggling, as well as badges and awards for completing various activities. Although this site has a good emphasis on the content standards, because it is focused on individual student work there is little opportunity to focus on the SMP.

Moby Max

Similar to IXL, Moby Max (www.mobymax.com) has activities that are well-aligned to the CCSS. One advantage over IXL is that Moby Max does a diagnostic of a student's mathematical knowledge, and then provides instruction and practice on those areas where there are gaps. Students do not have the option to work on the skills of their own choosing, but rather will work on the areas where they need support. Additionally, teachers can override this selection of skills and assign skills currently being taught as added practice. Similar to IXL, while there is a good amount of alignment to the content standards, there is little opportunity to focus on the SMP.

Khan Academy

Khan Academy (www.khanacademy.org) is well known for the video explanations and tutorials of all levels of mathematics. Covering topics from Kindergarten math through AP Calculus, Khan Academy now has complete instructional curricular aligned to the CCSS. Additionally, Khan Academy rates each skill on a continuum from Needs Work, to Practiced, to Level 1, Level 2, and finally Mastered. Over time, previous skills are brought up as mastery challenges and students can progress higher on the scale of achievement until they reach Mastered. This also allows students to progress at their own rate, rather than at a pace set by the teacher. Again, however, there is little opportunity for students to work on the SMP.

CueThink

CueThink (www.cuethink.com) is a website geared towards problem solving skills. Students are presented with a problem selected or written by their teacher, and are guided through George Polya's four-step problem solving process. What makes this site particularly valuable is that students are asked to create a short video, where they record themselves giving an explanation of how they solved the problem. These videos can then be viewed by other students in the class and comments and annotations can be made on the videos. Additionally, students are given multiple opportunities to solve the problem, as they watch and listen to how other students attempted to solve the problem. Alignment to the content standards is dependent on the problem chosen by the teacher. Through the videos and classroom discussions that the videos generate, students are involved in several of the SMP.

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