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Analyzing the Next Generation Sunshine State Standards for Mathematics: Is the State Curriculum Still a Mile Wide and an Inch Deep?

Robert C. Schoen, Evrim Erbilgin, and Erhan Selcuk Haciomeroglu

The school year 2010-2011 marks the first year of full implementation of the Next Generation Sunshine State Standards (NGSSS) for mathematics in Florida. The NGSSS are different from the original Sunshine State Standards (SSS), the previous state curriculum standards in mathematics, in many ways. For example, the NGSSS are written by grade level for the Kindergarten through eighth grade rather than by grade band. Additionally, the NGSSS are guided by mathematics education research conducted over the past two or three decades. For example, the benchmarks in Kindergarten through third grade related to operations on whole numbers draw heavily from the research base provided by Cognitively Guided Instruction (Carpenter, Fennema, & Franke, 1996). In this paper, we share our process of examining the mathematics curriculum standards that the state of Florida adopted in 2007 and share our process, results, and some interpretations.

Background

In revising the Florida mathematics curriculum standards, the stakeholders who convened to decide how to revise the standards listened to five presentations from national and international experts in mathematics curricula. The consistent opinion across all of these experts was that the Florida standards were “a mile wide and an inch deep.” To make this point, they compared the average number of grade level expectations for each level at grades K-8 in Florida with the number of grade level expectations in other states and countries (Clark & Wright, 2006). Florida consistently had more than any other state or country. For example, Singapore that consistently had the highest mean achievement on Trends in International Mathematics and Science Study (TIMSS) had on average 15 expectations per grade level.

One of the primary goals of the mathematics standards committee was to decrease the number of topics at each grade level and replace the breadth with depth, and thus the revision required attention to the sequencing of topics and the specificity of the benchmarks. As Table 1 shows, the resulting set of standards had fewer grade level expectations than either the Sunshine State Standards or the 1999 Grade Level Expectations.

Comparing the number of benchmarks in the SSS and the number of grade level expectations to the number of benchmarks in the NGSSS may lead one to believe that the content is narrower in scope in the NGSSS than it was in the SSS. Of course, simply counting the number of benchmarks provides very little detail or useful information regarding the scope and organization of the mathematics content, so our curiosity about the structure and content of the NGSSS and the SSS was not satisfied. The question for us was, do the NGSSS really address the problem of “mile wide, inch deep” and provide more focus to the state curriculum standards?

Table 1. Number of standards or benchmark expected by grade level in the three state mathematics curriculum documents.			
Grade Level	Sunshine State Standards (1996)	Grade-level Expectations (1999)	Next Generation Sunshine State Standards (2007)
K	34	67	11
1	34	78	14
2	34	84	21
3	34	88	17
4	34	89	21
5	34	77	23
6	34	78	19
7	34	89	22
8	34	93	19
Mean	34.0	82.6	18.6

The purpose of our investigation was to identify and use a method for analyzing the organization and depth of the mathematics content in the Next Generation Sunshine State Standards that was replicable and guided by student achievement data. The two research questions we explored were

1. Are the Next Generation Sunshine State Standards narrower in scope than the Sunshine State Standards?
2. How does the content and organization of the Next Generation Sunshine State Standards compare with the content and organization of other state and national mathematics curriculum standards?

Method

We selected a method of analysis that was developed and used to compare mathematics curriculum across different countries as part of the 1995 Third International Mathematics and Science Study (Schmidt, Wang, & McKnight, 2005). This method is called General Topics Trace Mapping (GTTM). Schmidt et al. listed major mathematics topics in the TIMSS examination and asked curriculum experts in each of the participating TIMSS countries to indicate the grade levels where each mathematics topic was taught in their country. This analysis resulted in a GTTM matrix for each country. The TIMSS researchers then selected the six highest achieving countries on the 1995 TIMSS examination and examined their GTTM matrices to look for consistent patterns. The six top achieving countries in the 1995 TIMSS examination were Singapore, Hong Kong, Belgium (Flemish-speaking), Korea, Japan, and the Czech Republic.

Schmidt, Houang, and Cogan (2002) analyzed the data by looking for topics that were taught at the same grade level in at least four of the six countries, indicating that the higher-achieving countries consistently included a given topic at the same grade level. This resulted in a list of 32 mathematics topics, representing a subset of all of the possible GTTM topics. They then ordered this subset of topics chronologically through the grade levels so that the topics introduced in the earliest grades were at the top rows of the matrix, and the topics not included in the common curricula until later grades were lower in the matrix. They called the resulting matrix the *A+ Composite* (Schmidt et al., 2002; Schmidt, Wang, & McKnight, 2005).

We used a targeted modification of the GTTM method to analyze the content of both the 1996 Sunshine State Standards and the 2007 Next Generation Sunshine State Standards. This method would allow some standardized comparison of the mathematics content in the standards as well as compare the content with the general organization of the mathematics curriculum in the six highest achieving countries on the TIMSS examination. Just as importantly, the method of analysis is reliable and replicable, and the inferences resulting from the interpretation are guided by empirical observations of student achievement.

Working separately, we coded the Florida standards in a way such that the grade level expectations or benchmarks were assigned codes according to whichever one or more of the 32 GTTM topics related to the given grade level expectation or benchmark. In the first step, we each coded the benchmarks in the NGSSS for grades K through 8. Next, we each entered our respective codes into the GTTM matrix. After we each completed the initial coding of the NGSSS and translation of the codes into the GTTM maps separately, we met to discuss each benchmark and the assigned codes.

Looking at the maps generated from our first round of coding, we estimated the reliability of this method using the formula in Figure 1 to calculate reliability (Miles & Huberman, 1994). We counted the number of times we coded a given grade level and topic the same and the number of times where we coded a grade level and topic differently. After discussion and clarification of codes, occasionally consulting colleagues in mathematics education, we attained full agreement on the final assignment of codes.

$$\textit{Reliability} = \frac{\textit{\# of agreements}}{\textit{\# of agreements + \# of disagreements}}$$

Figure 1. Formula used to estimate reliability during check-coding.

After this process was complete for the NGSSS, we then worked separately again and coded the SSS for grades K through 8. The first round of individual coding of the NGSSS benchmarks yielded a reliability statistic of 0.69, while the second round (coding the SSS) resulted in a reliability statistic of 0.86. Following the same protocol as we did for coding the NGSSS, we calculated the reliability estimate and then discussed every place where there was discrepancy in our coding until we reached full agreement in the assignment of codes onto the GTTM matrix for the SSS.

Results

Tables 2, 3, and 4 contain the results of the analyses of the SSS and the NGSSS using the streamlined GTTM method. Table 2 compares the SSS with the *A+ Composite* matrix. For the unfamiliar reader, it may be worthwhile to examine the structure of the *A+ Composite* matrix. The shaded region (indicating the *A+ Composite* matrix) has an upper-triangular, somewhat banded, structure. Additionally, the *A+ Composite* is sparse, with no entries in the lower left triangle. William Schmidt, the director of the TIMSS studies and an invited expert who presented his work to the framers of the science NGSSS, has suggested that this upper-triangular quality indicates focus and rigor, demonstrating a coherent vertical alignment of topics.

Table 2. GTTM analysis of the 1996 Sunshine State Standards for mathematics

Legend

♦ Next Generation Sunshine State Standards include the topic at the grade level

4 of 6 top TIMSS Countries include the topic at the grade level

GTTM Topic	K	1	2	3	4	5	6	7	8
Whole Number Meaning	♦	♦	♦	♦	♦	♦	♦	♦	
Whole Number Operations	♦	♦	♦	♦	♦	♦	♦	♦	♦
Measurement Units	♦	♦	♦	♦	♦	♦	♦	♦	♦
Common Fractions	♦	♦	♦	♦	♦	♦	♦	♦	♦
Equations & Formulas		♦	♦	♦	♦	♦	♦	♦	♦
Data Representation & Analysis	♦	♦	♦	♦	♦	♦	♦	♦	♦
2-D Geometry: Basics	♦	♦	♦	♦	♦	♦	♦	♦	♦
Polygons & Circles	♦	♦	♦	♦	♦	♦	♦	♦	♦
Perimeter, Area & Volume				♦	♦	♦	♦	♦	♦
Rounding & Significant Figures				♦	♦	♦	♦	♦	♦
Estimating Computations		♦	♦	♦	♦	♦	♦	♦	♦
Properties of Whole Number Operations		♦	♦	♦	♦	♦	♦		
Estimating Quantity & Size	♦	♦	♦	♦	♦	♦	♦	♦	♦
Decimal Fractions				♦	♦	♦	♦	♦	♦
Relationship of Common & Decimal Fractions				♦	♦	♦	♦	♦	♦
Properties of Common & Decimal Fractions				♦	♦	♦	♦	♦	♦
Percentages						♦	♦	♦	♦
Proportionality Concepts							♦	♦	♦
Proportionality Problems							♦	♦	♦
2-D Coordinate Geometry			♦	♦	♦	♦	♦	♦	♦
Geometry: Transformations	♦	♦	♦	♦	♦	♦	♦	♦	♦
Negative Numbers, Integers & Their Properties							♦	♦	♦
Number Theory	♦	♦	♦	♦	♦	♦	♦	♦	♦
Exponents, Roots & Radicals						♦	♦	♦	♦
Exponents & Orders of Magnitude							♦	♦	♦
Measurement Estimation & Errors	♦	♦	♦	♦	♦	♦	♦	♦	♦
Constructions w/ Straightedge & Compass									
3-D Geometry	♦	♦	♦	♦	♦	♦	♦	♦	♦
Congruence & Similarity			♦	♦	♦	♦	♦	♦	♦
Rational Numbers & Their Properties							♦	♦	♦
Patterns, Relations & Functions	♦	♦	♦	♦	♦	♦	♦	♦	♦
Slope & Trigonometry									♦

Table 3. GTTM analysis of the 2007 Next Generation Sunshine State Standards for mathematics

Legend

♦ Next Generation Sunshine State Standards include the topic at the grade level

4 of 6 top achieving TIMSS Countries include the topic at the grade level

GTTM Topic	K	1	2	3	4	5	6	7	8
Whole Number Meaning	♦	♦	♦	♦	♦	♦			
Whole Number Operations	♦	♦	♦	♦	♦	♦			
Measurement Units		♦	♦	♦	♦	♦		♦	♦
Common Fractions				♦	♦	♦	♦		
Equations & Formulas			♦	♦	♦	♦	♦	♦	♦
Data Representation & Analysis				♦		♦	♦	♦	♦
2-D Geometry: Basics	♦	♦	♦	♦	♦	♦	♦		
Polygons & Circles			♦	♦	♦		♦		♦
Perimeter, Area & Volume			♦	♦	♦	♦	♦	♦	
Rounding & Significant Figures						♦			♦
Estimating Computations			♦	♦	♦	♦	♦		♦
Properties of Whole Number Operations		♦	♦	♦	♦	♦			
Estimating Quantity & Size			♦		♦	♦			
Decimal Fractions					♦	♦	♦	♦	
Relationship of Common & Decimal Fractions					♦	♦	♦	♦	
Properties of Common & Decimal Fractions					♦	♦	♦		
Percentages					♦		♦	♦	♦
Proportionality Concepts			♦		♦	♦	♦	♦	
Proportionality Problems			♦		♦	♦	♦	♦	♦
2-D Coordinate Geometry						♦	♦	♦	♦
Geometry: Transformations				♦	♦			♦	
Negative Numbers, Integers & Their Properties						♦		♦	
Number Theory					♦	♦			
Exponents, Roots & Radicals								♦	♦
Exponents & Orders of Magnitude						♦			♦
Measurement Estimation & Errors			♦		♦	♦	♦		
Constructions w/ Straightedge & Compass									
3-D Geometry	♦	♦			♦	♦	♦	♦	
Congruence & Similarity			♦	♦				♦	♦
Rational Numbers & Their Properties								♦	♦
Patterns, Relations & Functions	♦	♦	♦	♦	♦	♦	♦		♦
Slope & Trigonometry									♦

Table 4. Comparison of the 1996 Sunshine State Standards with the 2007 Next Generation Sunshine State Standards

Legend

♦ Next Generation Sunshine State Standards include the topic at the grade level

       1996 Sunshine State Standards include the topic at the grade level

<table>
<tr><th>GTTM Topic</th><th>K</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th></tr>
<tr><td>Whole Number Meaning</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1"></td><td style="background-color:#c6d9f1"></td><td style="background-color:#c6d9f1"></td><td></td></tr>
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<tr><td>Congruence & Similarity</td><td></td><td></td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1"></td><td style="background-color:#c6d9f1"></td><td style="background-color:#c6d9f1"></td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td></tr>
<tr><td>Rational Numbers & Their Properties</td><td></td><td></td><td></td><td></td><td></td><td></td><td style="background-color:#c6d9f1"></td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td></tr>
<tr><td>Patterns, Relations & Functions</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1">♦</td><td style="background-color:#c6d9f1"></td><td style="background-color:#c6d9f1">♦</td></tr>
<tr><td>Slope & Trigonometry</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td style="background-color:#c6d9f1">♦</td></tr>
</table>

Overall number of topics.

It can be misleading to compare the GTTM matrix of a single country with the *A+ Composite* matrix. Given that the *A+ Composite* is, by definition, the intersection of the curriculum of the smallest majority of the six highest achieving countries, it is likely that individual *A+* countries' matrices contain more material than the *A+ Composite* does. There is little published information available regarding the matrices of individual countries, but Tables 5 and 6 were generated through a secondary analysis of a report by Schmidt, McKnight, Valverde, Wolf, Britton, Bianchi, and Houang (1997).

With a total of 32 topics listed in the matrix and 8 grade levels (excluding Kindergarten for the sake of comparison), there are 256 possible cells in the matrix. The percent of the total possible number of cells that are included in a matrix may be thought of as density of the matrix, where the *A+ Composite* is less dense (i.e., more sparse), and the SSS matrix is more dense. In fact, comparing only the NGSSS or the SSS with the *A+ Composite*, one may be led to believe that the NGSSS matrix is more dense than the matrices of the *A+* countries. Table 5 contains the calculated density of individual countries matrices as well as the density of the *A+ Composite* matrix. As it turns out, the density of the NGSSS matrix is identical to that of both the mean and the median density of individual *A+* countries. The density of the SSS is higher than the maximum density of any individual A+ country, reflecting the "mile wide" description of the SSS.

Table 5. Density of GTTM matrices.

Country	Density
Singapore	0.47
Japan	0.53
Hong Kong	0.32
Belgium(Fl)	0.66
Czech Republic	0.47
Korea	0.53
NGSSS	0.50
SSS	0.75
A+ Composite	0.39
A+ country Minimum	0.32
A+ country Mean	0.50
A+ country Median	0.50
A+ country Maximum	0.66

Number of topics in each grade level. Considering a more focused grade-level and topic-level view, we counted the number of topics listed in the *A+ Composite* matrix at each grade level for each individual country, the *A+ Composite*, the NGSSS, and the SSS. Table 6 contains these data. Examining these data, we see that the NGSSS contain fewer topics per grade level than the SSS at every grade. We note a trend of fewer topics in the primary grades and more topics in the later grades across the board for all countries. Importantly, we note that no individual country matches the *A+ Composite* trend exactly. The number of topics in the NGSSS falls within the range of the number of topics in the six A+ countries at every grade except Kindergarten, where there are few data for comparison, and eighth grade, where the NGSSS contain fewer topics than any individual country (or even the *A+ Composite*).

Table 6. Number of topics at each grade level by country.									
Country	**Grade Level**								
	K	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Singapore	1	5	6	6	14	19	20	30	21
Japan	-	8	10	18	20	26	21	14	19
Hong Kong	3	5	5	5	9	11	11	18	17
Belgium (Fl)	-	7	10	17	21	25	29	29	32
Czech Republic	-	3	12	13	15	21	21	17	19
Korea	-	4	11	15	17	22	22	26	18
NGSSS	5	7	15	14	22	22	17	16	15
SSS	13	16	18	23	23	25	30	29	29
A+ Composite	-	3	3	7	15	20	17	16	18
A+ countries Mean	-	5	9	12	16	21	21	22	21
A+ countries Median	-	5	10	14	16	22	21	22	19
A+ countries Minimum	1	3	5	5	9	11	11	14	17
A+ countries Maximum	3	8	12	18	21	26	29	30	32

Discussion and Conclusions

Based on the GTTM method for analyzing curriculum standards, the Next Generation Sunshine State Standards are more focused and narrower in scope than the previous Sunshine State Standards. Using this transparent and replicable method for analyzing and comparing curricula, we found that the NGSSS appear to indeed be narrower in scope and perhaps more focused than the SSS. Further, GTTM analysis indicates that the focus, rigor, and coherence of the NGSSS are at similar levels with the mathematics curricula of high-achieving nations. The SSS had less focus than the curricula of the high-achieving nations, indicating that Florida has made a positive improvement to the state curriculum standards.

With some variation, particularly related to 3-Dimensional Geometry and Patterns, Functions, and Algebra, the sequencing of topics and number of grade levels each topic is taught align with the scope and sequence of the curricula used in the higher achieving TIMSS countries. Overall, the revised state standards (NGSSS) appear to improve upon the previous standards (SSS).

With many organizations providing subjective and non-transparent analyses and evaluations of state and national curriculum standards, we think the method of GTTM provides an opportunity for analyzing and evaluating curriculum standards through a more scientific approach. Development of a transparent and objective method for evaluating quality and inferring potential effect on student outcomes is an important step in basing analyses and expert opinion about the quality of curriculum standards on science and evidence rather than on politics or the beliefs or ideology of the raters. General Topics Trace Mapping (GTTM) provides a basis for such a method of analyzing state and national curriculum standards. In this paper, we enhanced the method by quantifying several additional variables (e.g., density) and examining not just the *A+ Composite*, but also by comparing the resulting GTTM matrices of the SSS and the NGSSS with the matrices of individual A+ countries to determine a reasonable range for the density and number of topics.

Although we think the GTTM provides an important scientific method for analyzing the quality of state or national curriculum standards, we also recognize an important element of expert opinion in determining scope and sequence of topics, verbiage, and existing state or national conditions. This method provides a more standard metric for comparing curriculum standards, but expert opinion from all stakeholders is still critically important.

Finally, for the GTTM method to be useful in evaluating future revisions of state and national curriculum standards, it is important to update these results with more recent analyses of countries' curricula and TIMSS achievement ranking. We suggest including GTTM analysis in future TIMSS studies. Many states, including Florida, have recently adopted the Common Core State Standards (CCSS) in mathematics. The CCSS might be analyzed using this method, and future international studies might investigate the impact, if any, of adoption of a single, nationwide, formal curriculum in mathematics.

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Editor's Note: This article was prepared over a period of time before the Common Core State Standards were adopted by Florida last fall. This is an indication of the trend in curriculum change in mathematics in Florida, and it would be interesting to see how the Common Core Standards fit this matching process.

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