Comments on the April 14, 2007 draft of revision of Minnesota Academic Standards in Mathematics

SUMMARY

SciMathMN recommends the final draft of the Minnesota Academic Standards for Mathematics be approved as a means of moving Minnesota students forward in mathematics. But moving these standards from a document on paper to a vehicle that creates a passion for high quality mathematics is the next important step. This will mean supporting educators in implementing the standards through extended professional development; making parents, caregivers, and the public aware of what constitutes high quality mathematics; and realigning assessment to more closely measure what we really want Minnesota students to achieve in mathematics.

Strengths of Final Draft of Minnesota's Academic Standards for Mathematics

1. **The Standards incorporate a focused approach at each grade level.**
2. **The Benchmarks detail the big ideas stated in each standard.**
3. **The Standards are more coherent than the 2003 Standards.**
4. **There is evidence that current research and key documents assisted the developers of the Standards in placement of topics and strands.**
5. **The high school standards define a core of content for post secondary success and positive contributions to the workforce.**

Concerns

1. **Mathematical Reasoning disappeared as a strand, and appropriately, was to be embedded across the standards and benchmarks. But will teachers use reasoning as strongly as is needed to create mathematically powerful students?**
2. **Reducing the number of benchmarks is supported by lessons learned from international assessments but may not be the conventional wisdom of the public.**
3. **It is important to support success in gaining credit for Algebra I in eighth grade by having the Algebra strand develop across the elementary grades.**
4. **How will reporting out be done with only four strands and no substrands? Will reporting be specific enough to guide effective instruction?**
5. **The Data Analysis strand may be appropriately delayed but is missing an essential element of statistical knowledge – the ability to ask a valid question.**

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The Oxford English Dictionary traces the development of the term "standard" to medieval times, when soldiers quickly lost sight of their leaders. When going into battle, leaders began to carry with them "standards" – tall stakes to which a pennant was attached. During times when neither side could tell who belonged to whom, leaders planted these standards, which, by virtue of their height, stood out in the landscape, provided a direction for the soldiers, and showed what ground had been captured.

Likewise, Academic Standards represent key mathematical ideas that stand out in the "mathematics landscape", providing direction for creating mathematically powerful students and against which we can measure what mathematical knowledge has been "captured" by the students.

Mathematical standards ought to be the key mathematical ideas around which we can all rally and which drive mathematics learning, teaching, and assessment.

SciMathMN recommends the final draft of the Minnesota Academic Standards for Mathematics be approved as a means of moving Minnesota students forward in mathematics. But moving these standards from a document on paper to a vehicle that creates a passion for high quality mathematics is the next important step. This will mean supporting educators in implementing the standards through extended professional development; making parents, caregivers, and the public aware of what constitutes high quality mathematics; and realigning assessment to more closely measure what we really want Minnesota students to achieve in mathematics.

Strengths of Final Draft of Minnesota's Academic Standards for Mathematics

1. **The Standards incorporate a focused approach at each grade level.**
    a. While often quite general, the standards give each grade level a small number of mathematical ideas to form the core of instruction.
    b. Focus is one characteristic of world class standards and a hallmark of the highest achieving countries in international comparisons.

c. Learning in depth has been shown to increase retention and application of the learning and allows for time to effectively differentiate for a variety of learners, increasing the number of students achieving the standards at their grade level.

2. **The Benchmarks detail the big ideas stated in each standard.**
   d. The benchmarks begin to inform what may be included in achieving the standard. Teachers may still incorporate other mathematics that supports achieving the specified standard.
   e. The Benchmarks help clarify how a standard changes over grade levels.
3. **The Standards are more coherent than the 2003 Standards.**
   f. It is clear that development across several grade levels was thoughtfully done. For example, the focus on linear functions at grade 8 is preceded by a focus on proportionality at grade 7 and by work with rational number at grade 6.
   g. A coherent sequence among the standards increases the likelihood of students achieving standards and maximizes instructional time at subsequent grade levels.
4. **There is evidence that current research and key documents assisted the developers of the Standards in placement of topics and strands.**
   h. Delaying some topics in the curriculum is not only a hallmark of high achieving countries but also supported by educational research.
      i. For example, fractions are not a focal point until grade 3 (as indicated in the FAQs teachers at earlier grades may introduce them). Research from the multiple-decade, internationally known *Rational Number Project* (http://www.education.umn.edu/rationalnumberproject/) supports the later placement at grade 3 of understanding the meaning of a fraction.
      ii. Delaying probability until grade 6 fits with documentation of the widespread misconceptions in this area and the use of fractions to express probabilities.
   i. Delaying the entire Data Analysis strand until grade 3 will be a change for teachers and parents as creating graphs and charts of data has frequently been a primary activity.
      i. By appropriately delaying this topic for a learning focus until grade 3, it increases the time available to master the foundational strand of number and to integrate number with algebraic ideas.
      ii. The delay also maximizes time for geometry which fits well with primary learners as they are conscious of the space and shapes around them.
5. **The high school standards define a core of content for post secondary success and positive contributions to the workforce.**
   j. Grouping the standards by strand across grades 9, 10, 11 will allow flexibility in course structures to be determined locally.
   k. Achievement of these standards should help students fit more seamlessly into post secondary studies, create a more consistent background among Minnesota students entering post secondary studies, and reduce the need for remediation work at the post secondary level. It is helpful that the committee used the *College and Work Readiness in Mathematics-Minnesota* document and these new standards can be correlated with the expectations in this document.
   l. While the Algebra II requirement is newer legislation, it is essential that the standards in Geometry and Data Analysis be given equal priority in teaching and learning.

Concerns

1. **Mathematical Reasoning disappeared as a strand, and appropriately, was to be embedded across the standards and benchmarks. Likewise, technology and reading and writing were also to be imbedded.**
   a. Embedding is critical as reasoning and justifying is what mathematicians, scientists, and engineers do and clearly is a primary requirement of a productive and creative workforce. Savvy use of technology and communication skills is frequently mentioned in giving businesses a competitive edge.
   b. The current MCA assessments are dominated by cognitive levels 1 and 2 (knowledge and comprehension) with only 10-20% of test items at grades 3-8 and 15-25% of items at grade 11 requiring the higher level of thinking indicated by the top 4 levels (application, analysis, synthesis, and evaluation) of the 6 levels of Bloom's Taxonomy ("Cognitive Levels on the MCA", http://education.state.mn.us, see MCAII General Information). The irony here is that a significant percentage of students do not even attempt open response items which often are the only way to assess higher order thinking. Has logical thinking been routinely neglected in their mathematics education?
   c. While higher order thinking language and examples of technological connections exist in some standards and benchmarks this may need more focus in professional development efforts to guarantee that students are developing the habits of mind for future academic and workforce success. Wide scale testing is not driving the importance of higher order thinking. It is also possible that learning activities for achieving many of the standards can be differentiated along a continuum such as Bloom's Taxonomy to increase the development of higher order thinking.
   d. There is little mention of estimation or judging the reasonableness of results until the later elementary grades. Helping students see that math makes sense begins early with helping students understand and explain why they know their solution is reasonable and being able to justify their thinking in age-appropriate ways, increasing to more formal levels of proof and justification at later grades.
2. **Reducing the number of benchmarks is supported by lessons learned from international assessments but may not be the conventional wisdom of the public.**
   a. In public awareness pieces MDE should reinforce the value of focused standards and how focus and connected learning over time helps student achievement more than a laundry list of skills to be mastered in isolation.
   b. Parents are influenced by results from international assessments such as TIMMS that have shown that focus and coherence are significant differences that exist in high performing countries when compared to the curriculum scope and sequences in average or low performing counties (see video and power point of Bill Schmidt's address on world class standards at http://www.scimathmn.org).
3. **It is important to support success in gaining credit for Algebra I in eighth grade by having the Algebra strand develop across the elementary grades.**
   a. Algebraic ideas such as properties appear in several elementary benchmarks but are not listed in a standard until grade 5 – should this be more overt in the standards themselves?

b. In several standards there is an emphasis on representing numbers by place value. While this is important as our number system is a base 10 system it may strengthen these standards to overtly include the idea of equality. For example, expand the phrase on place value to read "with an emphasis on place value *and equality*". (See standards 1.1, 2.1, 3.1, etc. and benchmarks like 1.1.1.1 where an example such as "Recognize 23 = 20 + 3, 27= 25 + 2 or 27 = 30 – 3" could be included.) Place value is often merely the repetition of digits in a particular place rather than the idea of equivalent expressions for a quantity – a fundamental idea of algebra. This has been show in the Cognitively Guided Instruction (CGI) research in moving students from arithmetic to algebraic ideas (see Carpenter, et al., *Thinking Mathematically,* Henimann, 2003).

4. **How will reporting out be done with only four strands and no substrands? Will reporting be available by individual standards within a strand?**
   a. To influence instruction, data must be useful to educators at the district, school, and classroom levels. The reporting out of data must go beyond the mere measure of how well students might be achieving on a broad strand of the standards to a level of specificity that can actually inform instruction.
   b. Classroom assessments ought to complement and provide a stronger level of detail to inform state-wide assessments. They need to be seen as equally valid assessments that can monitor growth toward mastery of standards.
5. **The Data Analysis strand may be appropriately delayed but is missing an essential element of statistical knowledge – the ability to ask a valid question.**
   a. Most of the Data Analysis standards have students collecting, organizing, displaying and interpreting but omit the important first step of crafting or using a good question that leads to reliable data and avoids skewing or biasing the data.
   b. The Guidelines of the American Statistical Society stress this important part of data analysis as important across all grade levels and it was a key component of the Data Analysis strand in the *SciMathMN K-12 Mathematics Framework* http;//www.scimathmn.org).
   c. It may be worth reviewing this section to strengthen it as the FAQs acknowledge the variety of high school courses that students might take to further their mathematical education and data analysis and statistics is critical to many career paths. It is also essential that educators find opportunities to use statistical skills in real-life situations. This might be achieved by collaboration with other disciplines or by using real-life situations as a means to learn the skills of data analysis.

Moving the Standards from a Document on Paper to a Passion for Learning and Teaching High Quality Mathematics

SciMathMN appreciates the hundreds, even thousands, of hours over which many individuals contributed their expertise in and passion for mathematics. Undertaking the task of defining what mathematics is essential for all students to know is a daunting task but one that has the potential to significantly influence students' personal lives and keenly impacts our future workforce. But implementing these standards; making parents, caregivers and the public aware of what constitutes a high quality education in mathematics; and tying them to strong assessments will require an equally great effort.

In 1995 we had only 20% of our students engaged in Algebra I at grade 8. If we teach the same way we did then, why would 20% instantly become 100%? We clearly have not been reaching all students. If we only do what we have always done, we will only get what we have always gotten. Teachers will need to be supported in multiple ways; parents, caregivers, and community made aware of the standards and assisted in understanding what it means for their children. Most importantly, students need to be helped to see what is expected and then supported with strong convictions by themselves and the adults around them that they are capable of achieving those expectations. And assessments must measure all levels of understanding with a guarantee that higher order thinking will be included.

Need for Extended Professional Development

Long term, frequent professional development will be critical to once again help teachers shape their teaching and assessment with yet a new set of standards. Teachers are professionals who want learning to happen for students and will benefit from external training and learning more mathematics themselves. But internal staff time through professional learning communities, cross grade articulation, and thoughtful planning within teams, will also be necessary if we are to *guarantee* student success under these standards. We must find the methods and vary our instruction to reach all students – we must challenge our brightest and we must make mathematics accessible to all. We must address the gaps in learning for far too many students. If everyone makes equal growth every year the gaps would still exist – just at a higher level. With standards that are more focused, teachers can more effectively develop and use strategies that zero in on the core content needed at each level. They will need to be supported in zealously maintaining the focus the Standards specify and begin to accelerate students through gaps, causing greater success with more students. Teaching used to be the constant and learning the variable; now learning is the constant (as laid out in these Standards), and teaching must become the variable. In addition teachers need to look for ways to show students that mathematics is connected to their lives. Few students will study mathematics in its purest form; most will use mathematics as a tool, albeit an essential and powerful one, in other learning areas and life and work decisions. We can no longer interest only a few students in mathematics; mathematics needs to be seen as engaging and worth the perseverance to study it.

Need for Public Awareness

Public Awareness will likewise be critical. If schools and staff are to be held accountable, the public must know what that mathematics is actually being measured. There are multiple definitions among the public of what constitutes mathematics itself. These standards begin to more broadly define mathematics. There are citizens with strength in mathematics and many who still, without embarrassment, express a phobia for math. We simply cannot afford to create another math phobic generation where it is acceptable to say "I was never good at math."

Need for a Better System of Assessment

It is time to get serious about assessment and what it shows us. More thinking at higher levels needs to be tested, if not at the state level, then at the classroom level. Or the tables could be reversed. Do districts and classrooms have the ability to more efficiently and at a lower cost test and guarantee learning of lower cognitive levels? Should state assessment be only a few higher order items? Both reading and science have higher percentages of test items at cognitive level C than mathematics. Science has crafted an inquiry-based assessment of science. Will the lack of technology side track those efforts to document higher level thinking and to focus assessment on

a smaller set of key ideas? While states have been driven in recent years by NCLB requirements, Minnesota educators and citizens ought to seriously look at what mathematics and level of thinking is being measured. What Minnesotans want for our students and what our workforce needs ought to drive our assessment system more strongly than NCLB requirements.

The Standards are a critical piece in moving our students to stronger achievement in mathematics but they must be supported in their implementation across many audiences so the standards become a reality for the most important audience, Minnesota's students. SciMathMN would welcome opportunities to partner with others in disseminating these standards and in helping lead efforts to guarantee even stronger success for Minnesota students in learning and knowing mathematics.