Comments Regarding the Proposed Revisions to
19 TAC Chapter 111.
Texas Essential Knowledge and Skills for Mathematics
Overall Review

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The proposed changes to the mathematics TEKS standards represent a critical effort to demonstrate that states are capable of building on their own experience and writing curricula that reflect their own academic expectations; and at levels equal to or exceeding the federally-sponsored Common Core (CC) standards. Given the extraordinary significance of Texas' effort, it is important to review the proposed TEKS with a sober and critical eye. In normal times Texas would be evaluated as just one of many states. This time, however, TEKS will be the focus of intense scrutiny from both promoters of a national curriculum and proponents of strong content-based curricula who find the CC standards mediocre. Another important aspect of the proposed TEKS is to demonstrate the value of states' continued ability to add meaningful, localized content which would otherwise be eliminated by the centralized standard-setting effort driven from Washington, D.C.

Regarding the proposed changes, one is struck first and foremost by the uneven nature of the overall mathematics standards. While some expectations are clear, meaningful, and rigorous, others are couched in muddled language or reflect trivial and undemanding goals. Worse, many of the standards are written in a mathematically incoherent way. All in all, the impression that one receives is of reasonably coherent core standards augmented by an excruciatingly long and tedious list of minor, questionable additions wrapped in stilted and garbled language.

The proposed, good core standards include memorizing addition facts to 20 by grade two, and the multiplication table by grade three; they include a reasonable set of key standards dealing with time, money, and measurement in the early grades; they expect students to perform up to grade five without calculators; and they include strong high school course definitions. Unfortunately, the good news stops there.

To start, fluency with arithmetic is expected somewhat late in the proposed draft. The standards expect fluency with addition and subtraction of integers in grade five (CC expects it in grade four); multiplication and division of integers in grade six (CC expects multiplication in grade five and division in grade six); multiplication and division with decimals in grade six (CC also in grade six). Worse, the proposed draft never clearly requires fluency with the standard algorithms used to perform these basic operations, which the CC does require; the TEKS proposal throws in "strategies and algorithms, including the standard algorithm" in the few places where the standard algorithms are mentioned. This is unfortunate, as experience has shown that one of the biggest obstacles to students' mathematical progress is trying to expose them to a variety of strategies and algorithms rather than focusing on mastering one. If standard algorithms are expected at some point, they ought to be singled out rather than left mixed up with other intermediate methods.

I have already mentioned the problematic language of the draft. The linguistic faults vary from unnecessary verbosity and awkwardness to opacity and blatant errors. While they are too numerous to detail here, many more can be found in the lengthier "Grade-by-Grade" document. Here are a few of the more atrocious examples—they need to be read and reread very carefully.

- *decompose two congruent two-dimensional figures into parts with equal areas and express the area of each part as a unit fraction of the whole and recognize that equal shares of identical wholes need not have the same shape*; (Gr. 3)
- *compose and decompose a fraction a/b with a numerator greater than zero and less than or equal to b as a sum of parts 1/b*; (Gr. 3)
- *represent and solve addition and subtraction of fractions with equal denominators and referring to the same whole using objects and pictorial models that build to the number line such as strip diagrams and properties of operations*; (Gr. 4)
- *decompose angles such as complementary and supplementary angles into two non-overlapping angles to determine the measure of an unknown angle;* (Gr.4)
- *recognize a cube with side length of one unit as a unit cube having one cubic unit of volume and the volume of a three-dimensional figure as the number of unit cubes (n cubic units) needed to fill it with no gaps or overlaps if possible*; (Gr. 5)
- *use prior knowledge of all four operations, including whole numbers and positive decimals, fractions, and mixed numbers not having fractions and decimals, within the same problem*; (Gr. 6)
- *generate equivalent numerical expressions using order of operations, including positive exponents and prime factorization*; (Gr. 6) (incidentally, the only place "prime factorization" appears in the draft)
- *determine the area of composite figures containing any combination of rectangles, squares, parallelograms, trapezoids, triangles, semicircles, and quarter circles*; (Gr. 7) ("any combination"? Really?)
- *solve exponential equations of the form* $y = a^{bx}$ *where a is a nonzero real number and b is greater than zero and not equal to one and single logarithmic equations have real solutions*; (Alg. II)

As one can see, the language problems are numerous and not limited to K-8. Cleaning--up the draft will require a serious effort on the part of someone who possesses both excellent language skills and a significant understanding of mathematics. It is unreasonable to expect another committee to be able to clean-up such an extensive document in a reasonable time period.

Another major deficiency of the K-8 portion of the draft is a pronounced lack of coherence and focus. Many topics appear early, sometimes even too early, but they do not go away until the end of the elementary or middle grades. This results in the infamous "mile-wide, inch-deep" syndrome that severely afflicts this draft. For example, the standards repeatedly insist that students convert to and from expanded decimal notation and use "strategies" for arithmetic operations, up to grade five. Yet, one hopes that by then students will already be familiar with the decimal system and will be well-versed in the standard algorithms. Similarly, one can see little progression in some geometry topics across

elementary grades where students are repeatedly asked to classify similar 2D and 3D shapes across multiple grades. This same phenomenon is also observed in the Data Analysis strand, where little progression seems to occur across multiple grades.

This proliferation of repeated, process-oriented arithmetic standards across grades is not without costs, as it displaces other topics that would normally be present in the curriculum. Negative numbers are introduced only in grade six, and their development apparently warrants only a single word in the standards: "identify a number, its opposite, and its absolute value." Calculating the area of a triangle is unmentioned, yet in grade six students are already expected to master it. While the Common Core at least expects students to "explain the proof" of the Pythagorean Theorem, the TEKS draft simply asks them to use models and diagrams "to explain" the Pythagorean Theorem—not an unimportant difference. Prime factorization is mentioned only once, in passing, in grade six and, consequently, finding the least common denominator is never mentioned in the draft. In fact, the draft does not even mention any common denominators, except that one assumes students somehow learn them since they are expected to "*add, subtract, multiply, and divide rational numbers fluently*" by grade seven.

Another manifestation of the lack of focus is the poor specificity of many of the standards. One such example of the standards from grade seven requires students to "*generate equivalent forms of fractions, decimals, and percents using real-world problems, including problems that involve money*". This provides little guidance either to teachers or to test-makers about the type, complexity or the range of numbers that students are expected to handle.

The Personal Financial Literacy strand, finally, is an intriguing and rather unique way Texas addresses financial literacy. While it is certainly a worthwhile subject, it is an application of simple mathematics to a lot of social and societal issues, such as the meaning of income versus profit, the implications of savings and expenses, or the difference between credit cards and debit cards. This draft has thus made financial literacy into a full-blown mathematics strand, on par with geometry or algebra, where it does not seem to fit well, adding to the lack of focus and coherence of the draft. Personal financial literacy is a worthy example of a local addition to the curriculum, but its goal would be better served by only a few, larger units carefully placed in selected grades rather than in every grade.

Conclusions

The current draft of mathematics TEKS is a problematic document. It picks many nice ideas from the Common Core, yet it also introduces errors and clumsiness in the way it attempts to adjust standards for Texas. The draft adds some extra content which, at several points, seems to have not been sufficiently thought out, yet it leaves out other important content in K-8. The draft creates a wordy, sometimes incoherent and often garbled, document, particularly in K-8, that shows the disparate fingerprints of the various groups and committees that influenced it through its development. As a result, the document, as it currently stands, looks unfavorably, both from the point of coherence and rigor, in comparison not only to the Common Core standards, but also to many of the better state standards. I am hard pressed, indeed, to say that it represents an improvement over the existing TEKS.