SCHOOL OF MATHEMATICAL & STATISTICAL SCIENCES
ARIZONA STATE UNIVERSITY

January 24, 2012

TO THE INDIANA SENATE

Dear Senators,

I was asked to write a comparative statement between the Indiana Standards for Mathematics and the Common Core State Standards and express my view about which ones are superior.

First let me provide you with a very brief background about my involvement with each. I was a Professor of Mathematics at Purdue University from August 1983 to June 2008. My fields of expertise lie in applied mathematics and mathematics education, especially in standards-based education and assessment. Beginning in 2002 I worked regularly with the Indiana Department of Education on the development and revision of the Mathematics Standards and on the development and benchmarking of the End-of-Course assessments for Algebra I and Algebra II. The revision process of the High School standards (Algebra I, Geometry, Algebra II, and Precalculus) was completed during the last months of my stay in Indiana. Also beginning in 2002, I worked (and continue to do so) for the American Diploma Project that resulted in an assessment of the gap between the mathematical knowledge provided by high school curricula and that expected from colleges for students to avoid the need for remedial mathematics classes. I then worked with Achieve, Inc. and the Education Trust on the benchmarking of State Standards of twelve different states and several other education-oriented projects concerning assessment of K-12 mathematics curricula and assessments. In 2009 I was invited to form part of the Feedback Committee for the Common Core State Standards for Mathematics (CCSS-M) and participated in their development at every stage until their release in June 2010.

During the development of the CCSS-M the Indiana Standards were frequently considered with others as "golden standards." Internationally, the Indiana Mathematics Standards came to be known as state-of-the-art as indicated, for example, when in 2004 the Emirate of Qatar contracted me and other educators to benchmark their new standards for mathematics and science against the best in the world, and chose Singapore's and Indiana's). It should be noted that the 2008 revision made the Indiana standards even better. As it turns out, the CCSS-M

were constrained by the guiding premise that led their development of finding the *minimal common core knowledge of mathematics topics and skills that would provide all graduating high school students who had mastered them, with the necessary background to be successful in College Algebra classes and/or at employment in positions that require no specialized knowledge of mathematics.* The Indiana Standards were developed with the italicized requirement as just a basis that was then broadened to a full curriculum including topics of mathematics that form part of what is perceived in much of the rest of the world as *general culture* rather than a "need" for practical application in daily life.

I list below several Indiana Mathematics Standards (just in the domain of algebra) that go beyond the CCSS-M in depth or explicit expectations, or that do not appear altogether among the latter set of standards.

- Understand the binomial theorem and use it to expand binomial expressions raised to positive integer powers.
  Example: Expand $(x + 2)^4$.
- Factor polynomials completely and solve polynomial equations by factoring.
  Example: Solve $x^3 + 27 = 0$ by factoring.
- Use graphing technology to find approximate solutions for polynomial equations.
  Example: Approximate the solution(s) of $x^4 - 3x^3 + 2x - 7 = 0$ to the nearest tenth.
- Write and solve polynomial equations that model real world situations, interpret the solutions, and determine whether the solutions are reasonable.
  Example: You want to make an open-top box with a volume of 500 cubic inches from a piece of cardboard that is 25 inches by 15 inches by cutting squares from the corners and folding up the sides. Find the possible dimensions of the box.
- Write a polynomial function of lowest degree with real coefficients given its zeros.
  Example: Write an equation that has solutions $x = 2$, $x = 5i$ and $x = -5i$.
- Multiply, divide, and simplify rational expressions.
  Example: Simplify $\frac{x^2-4}{x^5} \div \frac{x^3-8}{x^8}$.
- Add and subtract rational expressions with linear and quadratic denominators.
- Solve equations involving rational expressions.
  Example: Solve $\frac{10}{n} + \frac{5}{n^2-4} = \frac{7}{n-2}$.
- Write and solve equations based on rational functions that model real world situations, interpret the solutions, and determine whether the solutions are reasonable
  Example: Two students, working independently, can complete a particular job in 20 minutes and 30 minutes, respectively. How long will it take to complete the job if they work together?
- Model and solve problems using direct, inverse, joint, and combined variation and understand the relationship to certain types of linear and rational functions.

Example: One day your drive to work takes 10 minutes and you average 30 mph. The next day the drive takes 15 minutes. What is your average speed that day?

- Identify patterns of change in sequences and characterize the sequences as arithmetic, geometric, or neither.
- Understand and apply counting principles to compute combinations and permutations.
  Example: There are 5 students who work in a bookshop. If the bookshop needs 3 people to operate, how many days straight could the bookstore operate without the same group of students working twice?
- Use the basic counting principle, combinations, and permutations to compute probabilities.
  Example: You are on a chess team made up of 15 players. What is the probability that you will be chosen if a 3-person team is selected at random?

In summary, I hold the firm belief that, even though the CCSS-M form a very focused, coherent, and rigorous set of standards, the ones from Indiana share those same qualities but at a higher level. I can unequivocally recommend that Indiana *not* adopt the CCSS-M if the State wants to require high school graduates from the State to excel by design to a higher level than average.

Respectfully,

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