DEPARTMENT OF MATHEMATICS

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November 24, 2015

Dear Superintendent Hoffmeister,

I am writing this letter in support of the proposed Oklahoma State Standards for Mathematics. As an assistant professor of mathematics at Oklahoma State University, my research field is undergraduate mathematics education -- particularly, issues related to how students learn and understand concepts in undergraduate mathematics courses. As such, the lens through which I assessed the standards centered on the extent to which the standards prepare students to be (1) successful in college-level mathematics, and (2) informed consumers of information in the modern world, while also examining the potential for (3) stimulating further interest in mathematics. I am happy to report that the standards show excellent promise on all counts.

First, the standards generally focus not only on the observable behaviors that we expect from students, but also on encouraging students to reason in ways that the mathematics education research literature have shown to be foundational. For example, standard A1.F.1 states:

> Apply mathematical *actions* and *processes* to understand functions as descriptions of *covariation* (how related quantities vary together) in real-world and mathematical problems. (italics mine)

Covariational reasoning has been well-documented as a powerful method of reasoning about changing quantities, both at the K-12 and undergraduate level. Moreover, the distinction between *actions* and *processes* is another key contribution from the research literature. Briefly, an *action* is typically associated with an ability to apply a procedure one step at a time, whereas a *process* often involves the ability to coordinate multiple actions at once and has been shown to be a key feature in generalizing and looking beyond a single calculation or algorithm. Not coincidentally, a *process* conception of a function is thought to be necessary for reasoning covariationally. In terms of examining the proposed standards, the infusion of such constructs is reflective of the authors' use of the valuable lessons afforded by the mathematics education literature, perhaps the most important of which is the recognition that *how* students reason en route to a solution is just as (if not more) important than the solution itself. Moreover, the utility of these foundational ways of mathematical reasoning are not limited to the K-12 level, but have been shown to extend to college algebra, trigonometry, calculus, and beyond. To this end, the standards show great potential in preparing Oklahoma's students for college-level mathematics.

Second, the standards have great potential to engender robust understandings of statistical concepts. Such understandings are of paramount importance in today's 'big data' age. The proposed standards allow for the cultivation of what might be called 'statistical intuition' by introducing data analysis techniques from an early age. Moreover, the research literature in this area has shown that students greatly benefit from the use of real-world data and situations

because it encourages meaningful interpretation of their results. Accordingly, the standards (e.g. 7.D.2, PA.D.2) reflect such suggestions with constant attention to the importance of interpretations of real-world data. Furthermore, another consequence of today's 'big data' age is that most real-world data sets are unmanageably large without the use of technology, highlighting a critical need for students to be proficient with technology. The authors behind the standards clearly recognized this as well, as the standards encourage (and require) use of appropriate technology to assist with and enhance statistical analyses (e.g. A2.A.1.2).

Third, these standards also promote continuing interest in mathematics. For example, standard 6.GM.4 states:

> Apply mathematical actions and processes to use translations, reflections, and rotations to establish congruency and understand symmetries.

Studying the mathematics of symmetry, in addition to fulfilling important curricular requirements, opens the door to a beautiful area of mathematics. Moreover, challenging students as early as sixth grade with such content (and then revisiting it in subsequent grades) provides ample time to develop and foster conceptual understanding of these important and endlessly interesting notions.

In summary, I am happy to provide my recommendation that these proposed standards be accepted. While I concede that I have not commented on important issues that are outside my expertise (e.g. how such standards will be implemented and assessed), I can say with confidence that these standards, in principle, provide the necessary structure to support students as they proceed through the K-12 mathematics curriculum and, eventually, to college.

If I can be of any assistance (including providing references for any of the above claims about the mathematics education literature), I would be most happy to oblige.

Sincerely,

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