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Failure to Launch: Oklahoma's Academic Standards in Mathematics

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ABSTRACT

Teachers' perceptions of written curriculum influence the way in which they use the curriculum. As multiple states begin to implement state specific standards, understanding the perceptions teachers may have of these standards is critical. This study used quantitative and qualitative methods to investigate the perceptions teachers had of one state's new standards a year after implementation. Data was themed and coded for factors that influenced teachers' perceptions, reported changes in teachers' practices, and perceived strengths and weaknesses of the state standards. Professional development emerged as a key factor that influenced teachers' perceptions of the state standards. Lack of resources, uncertainty regard depth of knowledge required by the standards, a quick implementation process, and lack of alignment of standardized test emerged as weaknesses across all teachers. However, the perceived strength differed; teachers who had experienced professional development focused on the standards were more likely to view the included processes standards as strengths, and reported greater change in their focus on these process standards. While the findings show that ongoing professional development is needed, they also point to the influence of even minimal professional development and the need for systematic support for teachers as new standards are implemented.

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Academic standards became the focus of reform efforts in education in the 1990s and continue to be a controversial focus of public discourse on education in the United States (Valverde & Schmidt, 2000). Reform leaders argued that standards would raise outcomes for all students while closing achievement gaps that plagued students from marginalized and low socioeconomic communities for decades (McClure, 2005). By outlining specific expectations for educational outcomes, advocates believed that both curriculum designers and teachers would modify their practices to meet these standards (Brown, 2002). While it is generally the hope that new standards will spark dialogue, reflection, and experimentation with teaching methods, teachers often perceive standards as "stifling their creativity and autonomy" (Nadelson, Pluska, & Moorcroft, 2014, p. 51). However, research conducted during the 1990s in classrooms that had adopted standards-based NSF-funded curriculum materials demonstrated that even in the most controlled environments, teachers retained at least some degree of freedom to determine the content, learning activities, and emphasis of the curriculum in their classrooms (Chval, Chavez, Reys, & Tarr, 2009). With this freedom, teachers make decisions that are based on perceptions of the curriculum materials (Ben-Peretz, 1990; Shulman, 1986) and the degree to which the materials align with their beliefs about mathematics and mathematics teaching and learning (Remillard & Bryans, 2004). Thus, teachers' knowledge and

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perception of standards often influence the learning experiences of students and, therefore, it is critical to examine these perceptions. This study seeks to illuminate elementary and secondary mathematics teachers' perceptions of newly adopted state standards a year after implementation.

Teachers' Curricular Reasoning

Depending on how they are used, standards and other curriculum materials may either constrain teachers' practices or expand them (Brown, 2009). Curricular reasoning, the processes by which teachers use curriculum materials to "plan, implement, and reflect on" the curriculum of their classes (Breyfogle, McDuffie, & Wohlhuter, 2010, p. 308), involves the ability to comprehend and analyze materials, map cohesive instructional plans, evaluate their effectiveness, and revise those plans (McDuffie & Mather, 2009; Shulman, 1987). Based on curricular reasoning, teachers make choices about what tasks and activities are appropriate and what elements should be emphasized, included, excluded, or adapted (Ben-Peretz, 1990; Cuoco, Benson, Kerins, Sword, & Waterman, 2010). The intended curriculum is the result of these daily decisions and significantly impacts the learning of students (Thompson & Senk, 2010). Therefore, when considering the use of new standards, it is important to consider the factors that influence teachers' reasoning about and use of the standards.

To anticipate the thinking and actions of their students, teachers must understand the skills, experiences, and knowledge students already hold (Breyfogle et al., 2010). As teachers gain experience, they are better able to anticipate the knowledge and needs of their students, more able and likely to focus on big goals for their classrooms, and better equipped to make adaptations to curriculum materials to meet the needs of their students (Ben-Peretz, 1990). Thus, it is important to consider how their level of experience influenced teachers' perceptions.

Studies suggest that a teacher's professional identity can also influence their perceptions and use of standards and other curriculum materials. In particular, feelings of self-efficacy greatly influence the decisions about how to adapt curriculum materials. Adapting to new ways of teaching requires teachers to reform their identity as a teacher (Remillard, 2005). Teachers who lack confidence may resist changing their practice and/or gravitate towards more scripted curricula (Ben-Peretz, 1990). As a result, it is important to explore teachers' feelings of confidence related to the standards when investigating their perceptions of them.

Purpose and Research Questions

Oklahoma was one of the first states to create and enact state-specific academic standards for mathematics after rejecting the Common Core State Standards for Mathematics (CCSSM). Given the relationship between teachers' perceptions and their use of resources discussed above, it is important to investigate the perceptions teachers formed of the new state standards in mathematics after the state rejected CCSSM. This was particularly interesting to us, as the standards development and implementation process in Oklahoma was unusually quick; teachers in the state were asked to implement the new standards only four months after adoption by the legislature. This required teachers to implement the standards before resources had been developed and with little to no professional development focused on the standards. In other words, most Oklahoma teachers were left to their own devices to interpret and implement the new standards. In this study, we investigated teachers' perceptions of new state standards that were implemented in Oklahoma in the 2016–2017 school year. Specifically, we asked:

(1) What factors influenced the teachers' perceptions of the Oklahoma academic standards in mathematics (OASM) and how did these factors influence teachers' perceptions of practice?
(2) How did these factors influence teachers' perceptions of the strengths and weaknesses of the Oklahoma academic standards in mathematics?

Positionality

Both researchers in this study work within the state in which the study occurred and interacted routinely with both pre-service and in-service teachers as the new state standards were developed, revised, and implemented. The first author began to work in the state as the writing process for the standards began and was in no way involved in the standards writing process. The second author served as the chair of the writing team and was intimately involved in the standards development process. While mathematics teacher in the state were largely unaware of the second author's involvement in the process, working as a team allowed the data to be analyzed from both an emic and etic perspective (Geertz, 1974). Below, we present a brief emic description of the development of the standards before describing the methods used in this study.

The Development of the Oklahoma Academic Standards in Mathematics

In 2010, the state of Oklahoma adopted CCSSM, which were to be first implemented in the 2014–2015 school year. Public debate about the use of CCSSM was contentious in the state, and in 2014, the state repealed the legislation adopting CCSSM just months before implementation. The state mandated that the Oklahoma State Board of Education (OSBE) consult with the Oklahoma Regents for Higher Education (OSRHE), the Oklahoma Board of Career and Technology Education (OBCTE), and the Oklahoma Department of Commerce (ODC) to develop standards that would be significantly different from CCSSM and be "college and career-ready" in time to implement the standards by the 2016–2017 school year. By the end of May 2015, a team of 20 nominated mathematics educators, mathematics teachers, and mathematicians began collaborating on a first draft of new standards. This draft was shared with the Oklahoma State Department of Education (OSDE), OSRHE, OBCTE, and ODC in June of 2015. A second draft was presented to teachers and the public throughout the state through a series of town hall meetings in July. Based on feedback received from these meetings, a third draft was completed in August and made available for further comment via the internet. A final draft was presented to the OSBE in October and to the Oklahoma State Legislature in January of 2016.

The new standards were guided by the belief that mathematics is about both process and proficiency. Focused on the key skills of problem solving, reasoning and proof making, communicating, representing, and connecting promoted by the National Council of Teachers of Mathematics (NCTM), the writing committee sought to ensure that these process skills were well integrated into the standards and highlighted as the central, overarching goals of the standards. As such, they developed seven mathematical actions and processes (MAPs) to serve as the core of the standards. The MAPs include: developing a deep and flexible conceptual understanding; developing mathematical reasoning; developing a productive mathematical disposition; developing the ability to make conjectures, model, and generalize; developing the ability to communicate mathematically; developing strategies for problem solving; and developing an accurate and appropriate procedural fluency. The writing committee not only included a description of each of these actions and processes in the standards, but also included a list of them at the beginning of each of the grade level standards, as shown in Figure 1 (Oklahoma State Department of Education, 2016).

Because the state legislature failed to vote on the new standards, the standards were adopted by inaction in April 2016 and were expected to be implemented by August 2016. The State then decided, against the wishes of many on the writing team, to implement standardized testing protocols on the new standards in April 2017. With little financial or programming support from the state, teachers across the state attempted to make meaning from the new standards and implement a mathematics curriculum that would support the standards and prepare students for the standardized tests, which were yet to be developed.

Develop a Deep and Flexible Conceptual Understanding	Develop Accurate and Appropriate Procedural Fluency	Develop Strategies for Problem Solving	Develop Mathematical Reasoning	Develop a Productive Mathematical Disposition	Develop the Ability to Make Conjectures, Model, and Generalize	Develop the Ability to Communicate Mathematically

Number & Operations (N)	
4.N.1 Solve real-world and mathematical problems using multiplication and division.	**4.N.1.1** Demonstrate fluency with multiplication and division facts with factors up to 12.
	4.N.1.2 Use an understanding of place value to multiply or divide a number by 10, 100 and 1,000.
	4.N.1.3 Multiply 3-digit by 1-digit or a 2-digit by 2-digit whole numbers, using efficient and generalizable procedures and strategies, based on knowledge of place value, including but not limited to standard algorithms.
	4.N.1.4 Estimate products of 3-digit by 1-digit or 2-digit by 2-digit whole numbers using rounding, benchmarks and place value to assess the reasonableness of results. Explore larger numbers using technology to investigate patterns.
	4.N.1.5 Solve multi-step real-world and mathematical problems requiring the use of addition, subtraction, and multiplication of multi-digit whole numbers. Use various strategies, including the relationship between operations, the use of appropriate technology, and the context of the problem to assess the reasonableness of results.
	4.N.1.6 Use strategies and algorithms based on knowledge of place value, equality and properties of operations to divide 3-digit dividend by 1-digit whole number divisors. (e.g., mental strategies, standard algorithms, partial quotients, repeated subtraction, the commutative, associative, and distributive properties).
	4.N.1.7 Determine the unknown addend(s) or factor(s) in equivalent and non-equivalent expressions. (e.g., $5 + 6 = 4 + \square$, $3 \times 8 < 3 \times \square$).
4.N.2 Represent and compare fractions and decimals in real-world and mathematical situations; use place value to understand how decimals represent quantities.	**4.N.2.1** Represent and rename equivalent fractions using fraction models (e.g. parts of a set, area models, fraction strips, number lines).
	4.N.2.2 Use benchmark fractions ($0, \frac{1}{4}, \frac{1}{3}, \frac{1}{2}, \frac{2}{3}, \frac{3}{4}, 1$) to locate additional fractions on a number line. Use models to order and compare whole numbers and fractions less than and greater than one using comparative language and symbols.
	4.N.2.3 Decompose a fraction in more than one way into a sum of fractions with the same denominator using concrete and pictorial models and recording results with symbolic representations (e.g., $\frac{3}{4} = \frac{1}{4} + \frac{1}{4} + \frac{1}{4}$).
	4.N.2.4 Use fraction models to add and subtract fractions with like denominators in real-world and mathematical situations.
	4.N.2.5 Represent tenths and hundredths with concrete models, making connections between fractions and decimals.
	4.N.2.6 Represent, read and write decimals up to at least the hundredths place in a variety of contexts including money.

Figure 1. A sample from the Oklahoma academic standards for mathematics.

Methods

After the first year of implementation, we conducted a case study of Oklahoma mathematics teachers. The study was bound both geographically and in time; because teachers' belief structures are subject to change, we aimed to capture teacher perceptions a year into the implementation of the new standards. Thus, all data were collected between May and September of 2017. Data collection began with an online survey sent to all Oklahoma mathematics teachers. An email inviting the state's 15,742 kindergarten teachers, elementary teachers, secondary mathematics teachers was sent to recruit participants in late May of 2017. In June, follow-up e-mails were sent to teachers who did not yet responded to the initial invitation. Teachers were invited to complete an online consent form and participate in an online survey. Using Likert scales, the survey asked participants for demographic data; the kind and amount of professional development they received on the new standards either before or during the first year of implementation; their feelings of confidence with the standards both before and after the first year of implementation, and their perceptions of changes in their practice due to the new standards (see Figure 2 for example questions). We were particularly interested in the extent to which teachers changed their emphasis on the MAPs identified in the new state standards, since these actions and processes differed from the CCSSM or the previous state standards and were of central significance to the developers of the state standards.

Finally, participating teachers were asked if they would be willing to participate in a telephone interview to further investigate their perceptions of the new Oklahoma Academic Standards in Mathematics (OASM). Using semi-structured protocols (Seidman, 2005), phone interviews elicited participants' perceptions of the OASM and changes they made to their practice as a result of the new standards. We asked participants about their familiarity and confidence with the standards at the beginning of the year, their experiences teaching with the standards throughout the year, what changes in their practice they either made or planned to make because of the standards, the strengths and weaknesses of the standards, the changes they would make to the standards, and what remaining

How prepared did you feel to teach students what they needed to know to succeed with the new Oklahoma Academic Standards at the beginning of the school year?	Not at all prepared ○	Slightly prepared ○	Somewhat prepared ○	Quite prepared ○	Extremely prepared ○
Since the adoption of the new standards, how have you changed your emphasis on developing a conceptual understanding?	Decreased significantly ○	Decreased somewhat ○	No Change ○	Increased somewhat ○	Increased significantly ○
To what extent do you agree that the new Oklahoma Academic standards improve the standards of teaching and learning mathematics in Oklahoma?	Strongly disagree ○	Disagree ○	Neither agree nor disagree ○	Agree ○	Strongly agree ○

Figure 2. Sample survey questions.

questions they had about the standards. The semi-structured interview protocol allowed researchers to ask follow-up questions when necessary or appropriate.

Using SPSS, means of participants' responses were calculated for each Likert scale question on the online survey. Additionally, to investigate the factors most influencing the teachers' perceptions about the OASM, the respondents to the online survey were segmented in three ways based on the review of the literature (Ben-Peretz, 1990; Breyfogle, 2010; Remillard, 2005): by years of experience (more or less than 15 years, the mean number of years of experience across the sample), by grade level taught (elementary or secondary), and by whether the participant received professional development on the standards either before or during the first year of implementation. Grade level taught and professional development were used as proxies for feelings of self-efficacy in mathematics. Literature has shown that elementary teachers have lower feelings of self-efficacy in mathematics than content specialist counterparts in secondary levels (Bursal & Paznokas, 2006; Gresham, 2008), and has also documented the positive effects quality professional development has on feelings of self-efficacy (Ingvarson, Meiers, & Beavis, 2005; Ross & Bruce, 2007). For each segmentation of the data, two-sample t-tests were conducted at an alpha level of 0.05 to determine if the perceptions of the segmented groups differed significantly.

Each interview was audio-recorded and transcribed verbatim. Transcripts were then subjected to coding and theming using inductive analysis by both researchers independently (Boyatzis, 1998). Following the initial independent coding, we discussed the coding and engaged in reflective conversations on coding and emergent themes until we reached full agreement across all interviews and all codes. After reviewing and creating open codes for the interviews, axial coding that answered specific research questions was created (Merriam, 2009). Axial coding allowed the data from different sets to be compared and, ultimately, findings to emerge.

Because the quantitative results were used to inform our qualitative analysis, the above procedures were conducted twice. During the first analysis, qualitative data from all the teachers who

participated were themed and coded. No axial codes describing strengths of the standards emerged. Because quantitative analysis suggested that experiences of professional development was a factor in teachers' perceptions of their changes in practice, a second analysis was conducted after dividing the participating teachers into two groups; those who had experienced at least one day of professional development and those who had not. Each subset of data was then re-themed and recoded to identify themes that emerged either for only one group, or differently for each of the two groups.

Participants

A total of 569 teachers across the state accepted the invitation to participate in the online survey. While we note a slight overrepresentation of third-grade teachers in the sample, the participating teachers were representative of the state's teaching profession, both in terms of grades taught and years of experience (see Table 1).

Table 1. Participant demographics.

Grades Taught		Years of experience	
PK −2	128 (22.5%)	<6	126 (22%)
3–5	184 (32%)	6–15	134 (24%)
6–8	111 (19.5%)	>15	203 (36%)
9–12	65 (11%)	No Response	104 (18%)
No Response	82 (14%)		

Additionally, participating teachers were asked to supply the name of the district in which they taught. Using the address of the central office for the district, we generated a map showing the location of participants. Compared to a population density map of Oklahoma, the sample appears to be geographically representative of Oklahoma teachers as well, with significant representatives from rural as well as urban areas (see Figure 3) (Irwin, 2011; US Census Bureau, 2012).

Of the 569 respondents to the online survey, 114 teachers initially indicated they would be willing to participate in telephone interviews further investigating their perceptions of the OASM. Due to time limitations before the second year of implementation began and the desire to ensure that the participating teachers were representative of the larger population, ten teachers were chosen to participate. To most closely resemble the demographic data of the respondents to the survey, we chose five elementary and five secondary teachers. Because only 30% of the respondents indicated that they had experienced professional development focused on the standards, our sample included seven teachers without professional development experiences and three teachers with professional development experiences. Finally, we wanted our sample to represent a variety of experience levels and therefore chose three teachers with fewer than six years of teaching experience, four teachers with between six and fifteen years of teaching experience, and three teachers with more than 15 years

Figure 3. Generated map showing the location of participants and population density map.

Table 2. Demographic data of teacher participants for interviews.

Participant number	Level	Region	Years of Teaching Experience	Professional Development on OASM
1	Elementary	Northeast	3–6	0 days
2	Elementary	Southwest	12–15	0 days
3	Elementary	Northwest	12– 15	4–6 days
4	Elementary	Metro 1	9–12	1–2 days
5	Secondary	Northeast	> 15	0 days
6	Secondary	Metro 1	6–9	1–2 days
7	Secondary	Metro 2	>15	0 days

of teaching experience. The resulting sample of ten teachers was also geographically representative of the state. Three of the teachers chosen were ultimately unable to participate due to personal matters or time constraints. The need to complete interviews before the second year of implementation curtailed our ability to replace these participants. Table 2 summarizes the demographic data of the seven teachers who participated in phone interviews.

Results

Quantitative results reveal three distinct findings; that years of experience, grade level taught, and professional development experiences influenced teacher perceptions of the OASM. However, of these findings, professional development seemed to be the biggest factor in teacher perceptions, generating greater mean differences and smaller *p*-values. Qualitative results supported these findings; those who had professional development experience reported more significant changes in their emphasis on the MAPs and differed in their views of the strengths of the standards. While those with professional development often cited particular MAPS or the general emphasis on these processes as a strength, those without professional development focused on particular content or strands or struggled to identify strengths. The weaknesses identified by both teachers with and without professional development were largely the same; participating teachers described uncertainty about depth of knowledge required, a lack of available resources, the quick implementation process, and the lack of professional development opportunities as weaknesses.

Factors that Influenced Teachers' Perceptions

The factors that influenced teachers' perceptions of the changes in their practice and of the strengths and weaknesses of the standards were first identified using both qualitative and quantitative methods. Quantitative findings suggested that while grade level and experience informed teachers' perceptions, professional development experience played a more significant role.

The Factor of Grade Level Taught

There were 149 participants in the survey who reported being secondary teachers (middle or high school), and 259 participants reported teaching kindergarten or elementary grades. The remaining 161 participants did not respond to the questions about grade level taught. Participants were asked to rate the change in their emphasis on the seven MAPs defined in the OASM, on a scale from −2 (decreased significantly) to +2 (increased significantly), where a rating of 0 represented no change. For six of the MAPs, elementary and kindergarten teachers reported significantly different amounts of emphasis on the processes (see Table 3).

Note that, for each of these six MAPs, kindergarten/elementary teachers reported greater levels of positive change than their middle and high school counterparts; that is, kindergarten/elementary teachers reported increasing their emphasis on the MAPs more than middle and high school

Table 3. Significant differences in perceptions of actions and processes by grade level taught.

Mathematical Action and Process	Kindergarten/Elementary Teachers mean (n = 259)	Middle/High School Teachers mean (n = 149)	Mean difference	p-value
Develop conceptual understanding	0.70	0.58	.12	0.004
Develop procedural fluency	0.57	0.34	.23	0.005
Reason mathematically	0.76	0.48	.28	0.001
Make conjectures, models, and generalizations	0.65	0.45	.20	0.013
Communicate mathematically	0.71	0.50	.21	0.012
Develop problem solving	0.78	0.48	.30	0.001

teachers. However, the last action and process, develop a productive mathematical disposition, did not demonstrate significant differences between the two groups.

The Factor of Experience

Like grade level, differences in years of experience produced statistically significant differences in the perceived changes in emphasis of many of the MAPs. However, differences were only significant for five of the seven practices; neither changes in emphasis on procedural fluency nor on developing conceptual understanding were significantly different for the two groups. Table 4 summarizes reported changes in emphasis for the remaining five MAPs.

In general, teachers with 15 years of experience or less reported greater positive changes in their emphasis on the MAPs than teachers with more than 15 years of experience. In addition to differences in perceptions of emphasis on the MAPs, analysis revealed another significant difference in the perceptions of these two groups; teachers with 15 or fewer years of experience were statistically more likely to agree that the "new standards will improve mathematics education".

Table 4. Significant differences in perceptions of actions and processes by years of experience.

Mathematical Action and Process	15 years or less (n = 233)	More than 15 years (n = 181)	Mean difference	p-value
Develop positive mathematical dispositions	0.49	0.26	0.23	0.01
Reason mathematically	0.72	0.56	0.16	0.05
Make conjectures, models, and generalizations	0.65	0.47	0.18	0.016
Communicate mathematically	0.70	0.53	0.17	0.033
Develop problem solving	0.76	0.54	0.22	0.007

The Factor of Professional Development

The most wide-sweeping statistically significant results, however, occurred when we compared teachers who had one or more days of professional development on the standards before the first year of implementation to those teachers who reported having less than one day of professional development on the standards before the first year of implementation (see Table 5). Not only did professional development influence teachers' perceptions of the change in their practice because of the new standards, it also influenced their feelings of understanding and confidence with the new standards and their belief that the standards would improve mathematics education.

Note that, for the six MAPs above, the mean differences that resulted when participating teachers were grouped by level of professional development were, in general, larger than those produced when teachers were grouped by grade taught or years of experience. In addition, the resulting *p*-values were smaller, indicating a smaller probability that the differences found when grouping teachers by professional development experience would occur if the null hypothesis (there were no difference between the two groups of teachers) was true when teachers were grouped by level of

Table 5. Significant differences in perceptions of actions and processes by professional development.

Mathematical Action and Process	One or more days of professional development (n = 143)	Less than one day of professional development (n = 329)	Mean difference	p-value
Develop conceptual understanding	0.80	0.53	0.27	0.001
Develop productive dispositions	0.59	0.30	0.29	<0.001
Reason mathematically	0.88	0.55	0.33	<0.001
Make conjectures, models, and generalizations	0.73	0.49	0.24	0.003
Communicate mathematically	0.92	0.49	0.43	<0.001
Develop problem solving	0.89	0.55	0.34	<0.001

professional development. In addition, grouping teachers by level of professional development produced statistically significant results not found when grouping the participating teachers in other ways. Of note, when teachers were asked whether they agreed that their teaching practices changed because of the new standards, teachers with one or more days of professional development agreed more strongly with the statement than those teachers with less than a day of professional development focused on the new standards (see Table 6).

It is important to note the difference in the number of teachers with and without professional development: only 143 of 472 teachers, approximately 30.3%, who responded to the questions about their experiences with professional development reported receiving one or more days of professional development about the standards. Thus, while even limited professional development seemed to positively impact teachers' perceptions of the new standards, only a small proportion of Oklahoma teachers were able to engage in such professional development.

Changes in Practice

Differences in the extent to which teachers perceived changes in their practice emerged from qualitative findings as well as quantitative findings. In qualitative analysis, teachers with and without professional development differed significantly in their perceptions of how the new standards influenced their teaching practices. Those who had no professional development reported very little change in their practices. While some simply replied "it wasn't" when asked how their teaching practices have been changed, others referred to superficial change like "rearranging our curriculum a bit." Participant 2 responded that she did not truly engage with the new standards until halfway through the first year of implementation:

Table 6. Comparison of perceptions of standards by professional development.

Statement (Strongly disagree = -2 to strongly agree =+2)	Teachers with one or more days of professional development (n=143)	Teachers with less than one day of professional development (n=329)	Mean difference	p-value
"I have changed my teaching practices because of the new standards"	0.61	0.05	0.56	<0.001
"I understand the new Oklahoma Academic Standards in Mathematics"	0.80	0.50	0.30	0.012
"I was prepared to teach with the new standards at the beginning of the 2016-2017 school year"	-.76	-1.17	0.41	<0.001
"I believe the new standards will improve mathematics education"	0.44	0.03	0.41	<0.001

> I made more changes last year, after probably January towards the standards … that's when I really started focusing on the standards to tell you the truth was in January. I went through and I went … okay check, check, check, and I need to hit, you know, this, this, this.

Teachers who had professional development on the new standards reported more significant changes to their practices. All three of these teachers remarked that they were moving away from an "checkmark" view of standards and objectives. Some perceived themselves to be making small steps in that direction. For example, one participant said she believed herself to be "a little more thoughtful in my teaching and a little more open for discussion during math time between the students, making sure that you listen to every way that they could have solved the problem and not just the standard algorithm." Another participant felt she was undergoing bigger changes, referring to the standards as "a whole new way to teach."

Weaknesses of the Standards

When asked about weaknesses and challenges of the new standards, teachers with and without professional development expressed similar concerns about depth of knowledge, lack of resources, the implementation process, and a lack of professional development opportunities.

Progressions and Depth of Knowledge

Two of the elementary teachers interviewed referred to standards about volume from third grade. The third-grade objectives state that students will "build a three-dimensional figure using unit cubes when picture/shape is shown" and "count cubes systematically to identify number of cubes needed to pack the whole or half of a three-dimensional structure" (OSDE, 2016). However, the concerns teachers raised with volume standards did not seem well aligned to the content objectives. For example, participant 1 said:

> they can understand the idea but understanding length times width times height, where you're actually having to teach … then you have to teach a two-digit number times a one-digit number. So, there are a lot of things you have to get a prerequisite to in a firm base on before you can teach something like volume.

In particular, "understand length times width times height" seems more aligned to the fifth-grade standard that students "recognize that the volume of rectangular prisms can be determined by the number of cubes (n) and by the product of the dimensions of the prism ($a \times b \times c = n$)" (OSDE, 2016). This misalignment seems to point to another concern often raised by participating teachers; many of the participating teachers expressed uncertainty about the "depth of knowledge" required by standards, like Participant 6:

> It is written in sometimes an unclear way or like it's not … there are no bounds … so it's almost like "Be able to find the greatest common factor of two numbers" and it's like Common Core had boundaries like you know …, "up to a certain amount" you know … things like that whereas in the Oklahoma standards it's just kind of gives it. And to me I see it as like … well that's because they don't want us to limit, they're not trying to say, only up to this point. But they see that as too much like … well then, I don't know how far I go? What's too far? Do I go up to a thousand and a thousand? What's the greatest common factor? Or do I still stop at like … you know … 10 and 10. Where do I really stop?

In addition to concerns about the depth of knowledge required by the standards, teachers were also concerned about their breadth. While there was recognition that the number of standards in most grade levels had decreased, teachers felt the decrease was not sufficient to allow teachers to explore each concept to the depth they desired. One participant summarized this tension: "it was a little bit of a challenge to cover them all, still, which is crazy because they're actually … um, less I think than previously, or at least they seem to be." Thus, although most teachers felt the standards were still too broad, they also acknowledged that the standards represented progress and identified the issue of depth and breadth as minor concerns. The participating teachers' major concerns were not about the standards themselves, but about the implementation structures around standards.

Textbooks and resources, professional development, state tests, and rapid implementation schedules were of major concern to teachers.

Textbooks and Resources

The teachers interviewed believed that the textbooks currently in use in their schools did not align well with the new state standards. Most teachers reported being both open to and used to collecting and developing their own resources for teaching mathematics, but many lamented the lack of online resources that aligned with the state standards. Teachers perceived the need to gather their own resources as both frustrating and time consuming. One participant compared Oklahoma teachers to "scavengers, here looking for whatever we can, piecemeal together, to teach what we need" while another expressed frustration at needing to "become our own textbook, worksheet maker." Still others expressed their belief that the state needs to do more work in developing and providing the resources teachers needed. Many expressed appreciation for the state frameworks, "curricular resources developed by Oklahoma teachers to help educators translate the Oklahoma Academic Standards into classroom practice." (OSDE, 2018). However, participants were frustrated that these resources were not put in place before teachers were expected to implement the new standards, stating that until the frameworks were provided "it was just kind of up to us to figure it out."

Implementation Process

Beyond the lack of resources for support, some teachers expressed frustration that in the past few years, teachers had to contend with three different sets of standards: the previous Oklahoma standards, the CCSSM standards, and the new standards. Teachers reported that such rapid changes disrupted the education of their students. They perceived gaps in their students' prior understandings due the shifting of concepts between grade levels. While teachers generally recognized that, assuming standards were not changed again, this would become less of a problem over time, they expressed both fear that the standards would be changed yet again and frustration at needing more time to both assess and develop what they felt should be prior knowledge for their students.

Testing

By far, the greatest concern about the implementation of the standards was the procedures used for standardized testing. One participant stated, "to use your standards and to be tested on them in the same year that they're introduced is pretty much unheard of, but we did it anyway." However, in addition to the implementation timing, participating teachers also perceived a misalignment between the state tests and the standards themselves. "When I do my benchmarks, everyone's on grade level, and in the past, we used STAR. STAR has correlated great with the state assessments, and it didn't this year. And it's … it's frustrating, you know?" Many of the participating teachers felt that the results of the state tests were "shocking a little bit and a little bit disheartening" and attributed poor results to the misalignment of the standards and the tests. They felt that the tests not only were misaligned to the content of the state standards but also to the philosophy of the standards: "if we're supposed to do all this hands-on learning and all, then let's try to get our testing with that as well."

Professional Development

In addition to the disruptions caused by the rapid changes in standards and the misalignment between state tests and standards, teachers also felt that there had been insufficient professional development on the new standards. Multiple participants expressed the need for informal professional development time for teams of teachers, both within and across school districts, to discuss ideas and develop materials for their classes. The teachers who had formal professional development on the standards expressed a desire for more professional development, explaining that "we need a shift in our instructional strategies." Many felt that this shift would occur if more teachers had

professional development on the new standards "so that teachers could see the … the beauty of what's there inside those standards, of the mathematics and what it really is."

Strengths of the Standards

Unlike weaknesses, the strengths identified by teachers who had participated in professional development on the standards differed from those who did not. Those with no professional development on the standards identified specific content or content strands as strengths of the standards. These strands often aligned with the content with which the participating teacher already felt most confident. For example, one such teacher reported that she "really like[s] the number sense and operation. […] That is what I think is so important, and I know that's where my strengths lie, are the number sense, developing that number sense, operations and the algebraic reasoning." Further, when we specifically asked about these participants' perceptions of the MAPs, it was clear that these participants were not familiar with the MAPs; three of the participants asked for clarification about what the MAPs were, while the fourth indicated that she was familiar with them, but then went on to talk about pedagogical concepts not related to the MAPs.

On the other hand, teachers who had received professional development on the standards focused more on the MAPs when speaking about the strengths of the standards. Some cited the MAPs specifically, while others implicitly referenced the MAPs while speaking about the strengths of the standards. Participant 3, who received professional development reported:

> I've become even more familiar with the math actions and processes, so I'm seeing how those are connected. Before, I completely kind of ignored those. Like when Common Core and their math practices, I was like 'Okay great. Moving on. What is the content I need to teach them?' Um … but now I'm actually seeing those are really the goal and these are more of the tool.

Participant 4 specifically cited a focus on problem solving as a strength of the standards:

> We're not sitting here like, "how do we distribute electricity to rural areas" we've already solved that problem, we haven't solved is "how do we make sure we have renewable electricity in the future to where we don't have to keep building out of fossil fuels." That's a big complex issue that's not an easy thing to solve. That's the type of problem they need to solve, it's hard so they need to be practicing solving hard things, not easy stuff.

Finally, all three of the participants who received professional development also discussed the emphasis on conceptual understanding and the connections between concepts as strengths of the standards. Participant 3 explained how this emphasis was at the root of her changes in teaching practices: "I'm not just focused on things that are rote memorization or things like that I'm really looking at, do they understand the concept?".

Discussion and Implications

Both the quantitative and qualitative data collected in this study point to significant differences in the experience of teachers with and without professional development experiences when implementing new standards. In both phases of the study, teachers with one or more days of professional development reported greater changes in their practice and more confidence in the standards. However, it is also clear that professional development did not negate the negative impact of the rushed and poorly planned implementation of the standards, nor the extreme lack of resources (both in terms of professional development and in terms of written curriculum) most participating teachers faced.

While quantitative data points to significant differences between teachers who experienced professional development and teachers who did not, the qualitative data specifically suggests that the teachers who had experienced professional development differed in two important ways. First, these participants focused more on the MAPs. Second, these participants reported more changes to their practices aligned with the standards and the learning philosophies implicit in the standards. We know that

"teacher professional development plays an integral role in standards-based accountability by building teachers' capacity for addressing both basic content knowledge and higher order thinking and problem-solving skills to meet state standards and improve student achievement" (Hochberg & Desimone, 2010). These results indicate the even more critical role professional development plays when standards and expectations are changed. Little change occurs when change is sought through investment in policy only; investment in people is necessary if real change is to occur.

It is also important to note that at no time during this study were participants asked specifically about the accessibility of resources, state testing policies, or the standards implementation process. Yet, these themes emerged when participants were asked about weaknesses of the standards. In part, these themes may belie the effects of multiple changes in policies and standards over a relatively short amount of time. Grossman and McDonald (2008) agree that "The summative effect of too many policy demands coming too fast often resulted in teacher discouragement, role ambiguity, and superficial responses to administrative goals." Clearly, many of the participants who did not experience professional development reported only superficial responses to the standards, if any. Yet, even those teachers who had experienced professional development expressed their frustrations with the state's rollout of the standards. Often, their view of the standards themselves was influenced by their experiences with the rollout; participants clearly conflated the standards with the state's frameworks and standardized tests. Thus, participants' overall views of the standards (and therefore their motivation for implementing standards) were negatively impacted by the state's implementation processes.

While our findings indicate that even limited professional development has a positive impact on teachers' perceptions of state standards, we are by no means suggesting that one day of professional development is sufficient. Indeed, the questions participants both with and without professional development had about progressions and depth of knowledge illustrate the need for additional professional development. We believe that professional development should be "sustained, ongoing, intensive, and supported by modeling, coaching, and the collective solving of specific problems of practice." (Darling-Hammond & McLaughlin, 1995). Yet, the results of this study show that even minimal professional development can influence teachers' perceptions and use of state standards. This result is highlighted by the participating teachers' awareness and perceptions of the developed process standards. Despite the best efforts of the standards writing committee to imbue process through the standards, those teachers who were left on their own to interpret the standards had little to no awareness of the process standards and were more likely to interpret the standards as a scripted checklist, as Ben-Peretz (1990) suggested.

As more states seek to withdraw from or revise CCSSM, it is essential that serious consideration is given to the timeline of standards and assessment implementation, the development of teacher resources, and opportunities for teachers to participate in professional development. These considerations are critical in light of publishers' failures to well align textbooks and resources to standards; given that publishers failed to do so for CCSSM (Dingman, 2010; Polikoff, 2015), there is little hope they will successfully align to individual state standards. As a result, more responsibility for curriculum development is placed on the already overburdened shoulders of teachers, making professional development more critical.

Disclosure statement

No potential conflict of interest was reported by the authors.

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