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# Overcoming a common storm: Designing the PD teachers need for successful common core implementation

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# OVERCOMING A COMMON STORM: DESIGNING THE PD TEACHERS NEED FOR SUCCESSFUL COMMON CORE IMPLEMENTATION

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*Classroom implementation of the Common Core State Standards (CCSS) requires significant professional development that is sustained over time, develops teachers understanding of the Standards for Mathematical Practice, and begins with the content and professional needs of the teachers it serves. This study examines elementary and middle school teachers' perceived content needs related to the CCSS mathematics content domains, their perceived professional needs, and the connection between these perceptions and statewide assessment data. K-5 teachers indicated a great need in Operations and Algebraic Thinking and Numbers and Operations on Fractions. Middle school teachers expressed a major need in better understanding modeling, statistics and probability, geometry and measurement, and proportional reasoning. K-9 teachers perceived professional needs and implications for designing professional development for inservice teachers are discussed.*

The recent adoption of the Common Core State Standards (CCSS) by 45 of the 50 states will lead to major instructional changes in K-9 classrooms. Proper implementation of the CCSS demands much more than revised textbooks. Standards of Mathematics Content and Mathematical Practice are different from prior state standards (Chief Council of State School Officers, 2010), hence instructional materials and practices must adapt to these new expectations. Sustained professional development (PD) for teachers will help them acquire the mathematical knowledge necessary to fully instantiate the intent of the CCSS to facilitate these changes (Wu, 2011). The purpose of this paper is to examine teachers' perceptions of needed PD as they move toward implementing the CCSS.

## Related Literature

Teachers are the critical instructional element in the classroom (National Council of Teachers of Mathematics [NCTM], 2000). They manage instructional norms, discourse, tasks, and tools (Franke, Kazemi, & Battey, 2007). They are also expected to deeply understand mathematics, mathematics pedagogy, and potential outcomes for students (Mewborn, 2003). PD aims to support teachers to maintain effective instructional contexts and adapt to new challenges. Sustained PD like QUASAR (Stein, Silver, & Smith, 1998) that goes on for over a period of months and gives teachers a safe, supportive environment to explore pedagogical and content issues has led to meaningful student and teacher outcomes (Mewborn, 2003). Sustained PD that aims to support K-12 mathematics teachers' pedagogical content knowledge is likely to enhance

students' outcomes and leads to long lasting teacher change (Ball & Bass, 2000). Results from large scale survey research with teachers indicated that PD focusing on (a) content knowledge, (b) opportunities for active inquiry-based learning, and (c) coherence within this PD leads to positive changes in teachers' classroom practices (Garet, Porter, Desimone, Birman, Yoon, 2001). In light of this evidence, teachers need support to refine and improve their instructional practices to implement the recently adopted CCSS.

The CCSS emphasize student reasoning and understanding of mathematics throughout K-9 instruction (CCSSO, 2010). NCTM has advocated for reasoning and sense making throughout K-9 mathematics instruction as well as effectively assessing students' mathematical understanding (NCTM, 2010; 2009; 2007; 2006; 2000). Knowing that teacher educators have these and other resources from which to design rich professional developments to enhance teachers' pedagogical content knowledge (Shulman, 1986), we intended to design PD for teachers focusing on the CCSS and were interested to use teachers' perceived needs as a key rationale for its structure and content. Toward this aim the Standards for Mathematical Practice are seen as a vital element that must be included, collectively, within any PD that is designed to help teachers implement the CCSS. Teaching any of the Standards for Mathematical Practice separately from the context of content is likely to not have lasting effects much like the heuristic instruction movement (Lesh & Zawojewski, 2007). These practices for mathematics learning were derived from NCTM's (2000) five process standards and the National Research Council's (2001) five strands of mathematical proficiency and provide the important lens through which the teaching and learning of particular mathematics content should be viewed. Therefore, the Standards of Mathematical Practice should be the unifying thread that runs throughout PD as teacher educators deepen and enrich practitioners' content knowledge on particular common core topics.

The Standards for Mathematical Practice will be the inherent focus in each piece of the PD, yet there still remain important delineations to consider before design. The full breadth of content knowledge in either the elementary or middle grades CCSS would require vastly more time than most PDs can offer. Furthermore teachers may want help in particular professional areas as they relate to the CCSS. Again, the feasibility of teacher educators to incorporate the many needs is strained by the typical duration and scope of PD. Noting these time constraints we sought to better understand teachers' perceived needs during this transition to CCSS in order

to design meaningful, coherent, and relevant PD for the teachers we serve. Our research questions are (1) Which of the K-9 content standards do teachers perceive the greatest need for professional development? and (2) What specific professional content features do teachers perceive they need the most from PD?

## Method

### Participants

The participant population was K-9 teachers of mathematics spread across four different counties of a state in the Midwest Region of the United States. The participant population was further stratified K-5 (Elementary Cohort) and 6-9 (Middle Cohort) in order to better group the CCSS mathematical domains. The four counties exhibit a wide range of population types including urban with low median income/high poverty and rural/agricultural with high poverty.

The Middle Cohort in this study included ninth-grade teachers due to statewide licensure factors of the state in which the research was conducted.

In the Elementary Cohort all 469 teachers were asked to voluntarily participate in the survey by their administrators. Nearly one third of that cohort responded and answered the survey (n=148). There are twenty-two grades 6-9 mathematics teachers in the Middle Cohort. All of them volunteered to complete the survey. The number of teachers participating in the survey at each grade level can be found in Table 1.

Table 1.
*Number of Participants by Grade Level*

| Grade | n |
|---|---|
| K | 25 |
| 1 | 31 |
| 2 | 30 |
| 3 | 21 |
| 4 | 22 |
| 5 | 19 |
| 6 | 6 |
| 7 | 2 |
| 8 | 1 |
| 9 | 13 |

Throughout the year prior to the study each of our partnering districts provided information to the teachers about the CCSS and the degree to which they aligned with current state standards in use. Teachers were familiar with the common core domains, clusters, and standards.

**Instrumentation**

Two different surveys were created to ascertain perceived needs from teachers in Elementary and Middle Cohorts. This was done after examining the CCSS mathematics domains and determining that standards were fairly consistent for K-5 and 6-8 grade bands.

The data collected for this study focused on teachers' perspectives on mathematics content and professional needs via an anonymous survey. Survey items asked participants about their district, grade levels taught, and years of teaching experience. Participants also rank ordered the K-9 CCSS mathematics domains and desired professional development focus. Finally, they indicated their level of interest in participating in sustained professional development about these topics.

The participants in the Elementary Cohort were asked:

1) In which school area do you teach?
2) How many years of mathematics teaching experience do you have?
3) What grade level(s) are you currently teaching?
4) Rank the following K-5 Common Core Mathematics Content Standard areas IN ORDER, where "1" is the Standard you feel that you need the MOST and "6" means you need the LEAST help in implementing that standard: Counting and Cardinality, Operations and Algebraic Thinking Operations, Numbers and Operations in Base 10, Numbers and Operations - Fractions, Measurement and Data, Geometry.
5) Rank the following 7 areas of mathematics professional development IN ORDER, where "1" is the topic of MOST interest/value to you and "7" means you currently have the LEAST need for help in that area: Enhancing or deepening my understanding of the Common Core, Helping students to reason and make sense of mathematics, Use of technology in teaching mathematics, Improving instructional strategies for student conceptual development, Collaboration with other mathematics teachers, Web Sites useful for planning and teaching mathematics, Diagnostically assess students' understanding in order to plan lessons or interventions.
6) A grant is being written to provide professional development for teachers of mathematics throughout 2012. How likely would you be to participate: Definitely Interested – count me in, Greatly Interested – depends on some factors but very likely, Somewhat Interested – I would need to think about it, Probably Not – I'm not sure I have the time or interest to participate at this time, No – count me out (Matney, 2011).

The survey questions for the Middle Cohort were similar except for questions four and five. This choice was due to different levels of instructional content and different potential

professional needs. We worked with the school districts to include items the curriculum specialists, who have professional contact with the participants, thought would be of interest to the teachers at differing levels of elementary and middle school. The modified content and professional needs for the Middle Cohort were:

1) Ratios and Proportional Reasoning, Geometry, Statistics and Probability, Number System/Number and Quantity, Algebra, Functions, Modeling.
2) Using technology in mathematics, The Common Core State Standards, Supporting students to reason and make sense of mathematics, collaborating with other mathematics teachers, Instructional Strategies (Bostic, 2011).

**Data Collection**

The surveys were sent to district administrators (e.g., superintendents, curriculum coordinators, and principals) to disseminate to mathematics faculty in their district. Teachers were encouraged to complete the survey during a two-week window.

District-level data were also collected to examine the degree to which teachers' perceived needs matched students' performance on statewide mathematics assessment from the prior academic year. Students' statewide assessment performance is collected from third through eighth grade. The mathematical subgroupings found on the statewide mathematics assessment closely align with the CCSS mathematics domains.

**Data Analysis**

The following approach was used to determine an overall score for the two questions focusing on mathematics content and professional needs based on the percentage of participants selecting that rank. First, the ratio of responses to total responses was calculated for each content and pedagogical domain and each rank order. This ratio was multiplied by 100 to determine the percentage of participants indicating that response. Next, the percentage was multiplied by its rank order (e.g., six for definite need, five for great need, four for some need, …, one for no need) and these values for a particular content or professional needs domain were summed to determine an overall score.

## Results

### Perceived Needs of the K-5 Elementary Cohort

#### Content

The K-5 group of teachers rank ordered the following CCSS mathematical domains from greatest need to least need and percentages for each response are presented in Table A1 of

Appendix A. Teachers indicated that the two most important areas for content development were Operations & Algebraic Thinking and Numbers & Operations on Fractions. The domain of Measurement and Data was a close third choice. These perceived needs align with students' statewide assessment performance in that they represent content choices in which the students of these teachers have been shown to struggle via statewide assessments. Approximately 18% of third-grade students failed to meet the state required proficiency. However, the fourth- and fifth-grade failure rates were much higher; 24% and 42, respectively. When the level of mathematical sophistication increases on the state assessment, in the areas of algebra and fractions, the students' failure rate on the overall exam also increases.

**Professional Needs**

The overall professional needs score (see Table A2 of Appendix A) gives a strong sense that teachers desire (a) a better understanding of the CCSS, (b) ways to encourage students' reasoning and sense making, and (c) improving their instructional strategies to facilitate conceptual development. Teachers perceived their need for better understanding of the CCSS as the highest. The next two highest choices of *student reasoning* and *conceptual development* support teachers' first choice since they are closely associated with the CCSS and are pertinent to understanding its implementation through the Standards for Mathematical Practice. Finally, 58% of the teachers surveyed indicated that they were "definitely" or "greatly" interested in long term professional development over these perceived needs.

**Perceived Needs of the 6-9 Middle Cohort**

**Content**

Teachers overwhelmingly asked for PD focusing on modeling, which is woven throughout the CCSS (see Table A3 in Appendix A). Statistics and probability, geometry and measurement, and proportional reasoning were also perceived as areas of great need. The statewide assessment results from the previous year indicate that approximately 15% - 29% of grades 6-8 students were not proficient on data-related tasks and 14% - 46% of grade 6-8 students did not meet passing criteria on geometry and measurement tasks. Modeling tasks were embedded throughout the assessments as word problems that require making sense of text, creating suitable models, and solving the task. Thus, no data were available from statewide assessments indicating students' modeling or problem-solving performance.

**Pedagogy**

Middle school teachers clearly valued PD focused on some professional topics more than others, as shown in table A4 of Appendix A. Teachers were most interested in learning about ways to help students reason and make sense of mathematics. PD focused on instructional strategies to promote students' conceptual development and enhancing their knowledge about the CCSS was also perceived as valuable. Finally, 59% of participants stated they would "definitely" participate in sustained PD.

## Discussion and Implications

K-5 and 6-9 teachers indicated different content-specific needs. K-5 teachers perceive needing PD focused on topics typically taught during later elementary years, such as algebraic thinking and operations with fractions. Middle school teachers expressed clear need for a better understanding of modeling. Modeling impacts one's understanding and ability to solve word problems, which is embedded throughout nearly every content strand. The CCSS for Mathematics Content frequently reference applying one's knowledge to solve real-world problems, which requires modeling. Finally, participants tended to respond in ways that were similar to their students' outcomes on statewide tests.

Statewide assessments involve progressively more sophisticated mathematics content as grade levels increase. For the Elementary Cohort the two lowest content needs were Counting and Cardinality and Numbers and Operations in Base 10 which are in large part completed by third grade. Therefore it is noteworthy that students performed the best on the third grade state assessment with 82% meeting state proficiency while fourth and fifth grade state proficiency rates were 76% and 58% respectively. This indicates that students' ability to demonstrate proficiency with lower elementary grade ideas matches the teachers ranking these as low priorities.

On the other hand, the highly requested content topics are deeply developed during the latter elementary and middle grades. These topics are also given richer treatment on the statewide assessment in grades 4 and 5. Only 14.9% and 12.8% of the participants surveyed were fourth and fifth grade teachers. The vast majority of the teachers (i.e. 72.3%), in the Elementary Cohort taught primary elementary grades yet still recognized the need for PD focusing on preparing students for intermediate elementary content. Thus, elementary teachers' perceived needs for PD

about CCSS mathematics content domains align with their students' prior performance on statewide assessments.

There was a noticeable increase in the number of students not meeting proficiency on high stakes tests from sixth- to seventh- and eighth grade. The districts' average sixth-grade below-proficiency score was 21% whereas 35% and 34% of seventh- and eighth-grade students on average did not meet proficiency on their mathematics tests. A cursory inspection of the data also suggests some tentative association between students' proficiency scores and the content areas teachers requested. The average below-proficiency score related to geometry and measurement increased as grade levels increased from grades six through eight (i.e., content is more complex): 19%, 31%, and 32% respectively. Data and analysis below-proficiency average scores were more consistent across sixth-, seventh- and eighth-grade: 21%, 24%, and 24%. Curriculum coordinators remarked that modeling was woven throughout the high-stakes tests in the form of word problems that drew on a variety of content areas. For example, one coordinator reported that data analysis tasks typically require students to read a problem's stem, interpret a table and graph, and make judgments about appropriate procedures and conclusions. Thus, middle grades teachers' expressed desire for PD focusing on instruction that supports students' problem solving and reasoning and sense making within the context of these content areas seems aligned.

K-9 teachers have similar perceived professional needs for PD. That is, both cohorts want PD focused on understanding the CCSS, helping students to reason and make sense of mathematics, and to explore instructional strategies focused on students' conceptual development. These needs align with the CCSS, which indicate that positive problem-solving behaviors are necessary to learn mathematics deeply. The adoption of new standards also provides teacher educators an opportunity to support instructors teaching to the new standards, and there is a fervent perceived need for PD focusing on these topics.

Teacher educators developing CCSS-focused PD should consider teachers' perceived needs. Teachers and curriculum coordinators should also be a part of the PD planning process. There is clearly a demand from teachers to learn more about ways to support students' reasoning and sense making, which includes teaching strategies that support student-centered, inquiry-focused instruction. As a result of this work, we crafted a grant funded PD program for K-9 teachers and will implement PD focusing on teachers' perceived needs.

## References


Ball, D., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J. Boaler (Ed.), *Multiple perspectives on mathematics teaching and learning* (pp. 83 – 104). Wesport, CT: Ablex.

Bostic, J. (2011). Pre-Grant Teacher Survey. Retrieved from http://www.surveymonkey.com

Council of Chief State School Officers. (2010). *Common core standards for mathematics.* Retrieved from http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

Franke, M., Kazemi, E., & Battey, D. (2007). Mathematics teaching and classroom practice. In F. Lester, Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 225-256). Charlotte, NC: Information Age.

Garet, M., Porter, A., Desimon, L., Birman, B., & Yoon, K-S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*, 915-945.

Lesh, R., & Zawojewski, J. (2007). Problem solving and modeling. In F. Lester Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 763-804). Charlotte, NC: Information Age Publishing.

Matney, G. (2011). Pre-Grant Teacher Survey. Retrieved from http://www.surveymonkey.com

Mewborn, D. (2003). Teaching, teachers' knowledge, and their professional development. In J. Kilpatrick, W. Martin, & D. Schifter (Eds.), *A research companion to Principles and Standards for School Mathematics* (pp. 45-52). Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2006). *Curriculum focal points for Prekindergarten through grade 8 mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2007). Mathematics teaching today: Improving practice. In T. Martin (Ed.), *Improving student learning* (2nd ed.). Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2009). *Focus in high school mathematics: Reasoning and sense making.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2010). *Making it happen: A guide to interpreting and implementing common core state standards for mathematics.* Reston, VA: Author.

National Research Council. (2001). *Adding it up: Helping children learn mathematics*. J.Kilpatrick, J. Swafford, and B.Findell (Eds.). Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.

Stein, M., Silver, E., & Smith, M. (1998). Mathematics reform and teacher development: A community of practice perspective. In J. Greeno & S. Goldman (Eds.), *Thinking practices in mathematics and science learning* (pp. 17-52). Hillsdale, NJ: Erlbaum.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Wu, H. (2011). Phoenix rising: Bringing the common core state mathematics standards to life. *American Educator, Fall 2011.* Retrieved at: http://www.aft.org/pdfs/americaneducator/fall2011/Wu.pdf

## Appendix A

Table A1
*Perceived Mathematics Content Needs of the Elementary Cohort*

| CCSSM Domain | Definite (%) | Great (%) | Some (%) | Fair (%) | Little (%) | No (%) | Overall Score Max = 600 |
|---|---|---|---|---|---|---|---|
| Operations and Algebraic Thinking | 37.16 | 20.27 | 10.81 | 18.24 | 10.81 | 2.70 | 446.62 |
| Numbers and Operations – Fractions | 14.19 | 26.35 | 27.03 | 13.51 | 11.49 | 7.43 | 395.95 |
| Measurement and Data | 17.57 | 18.24 | 20.95 | 23.65 | 12.16 | 7.43 | 383.11 |
| Geometry | 10.14 | 18.92 | 12.16 | 26.35 | 20.95 | 11.49 | 336.49 |
| Numbers and Operations in Base 10 | 6.08 | 12.84 | 22.97 | 12.16 | 41.89 | 4.05 | 316.89 |
| Counting and Cardinality | 14.86 | 3.38 | 6.08 | 6.08 | 2.70 | 66.89 | 220.95 |

N = 148

Table A2
*Perceived Professional Needs of the Elementary Cohort*

| Professional Need | Definite (%) | High (%) | Great (%) | Some (%) | Fair (%) | Little (%) | No (%) | Overall Score Max = 700 |
|---|---|---|---|---|---|---|---|---|
| Teaching CCSS | 38.51 | 9.46 | 9.46 | 8.78 | 10.81 | 8.11 | 14.86 | 472.30 |
| Supporting reasoning and sense making | 24.32 | 16.89 | 12.84 | 18.92 | 9.46 | 10.81 | 6.76 | 468.24 |
| Using technology | 10.81 | 18.92 | 16.22 | 12.84 | 16.22 | 11.49 | 13.51 | 406.76 |
| Instructional strategies | 11.49 | 21.62 | 29.73 | 12.16 | 13.51 | 9.46 | 2.03 | 468.92 |
| Collaborating | 1.35 | 8.11 | 10.81 | 14.86 | 11.49 | 25.68 | 27.70 | 285.14 |
| Web Support | 5.41 | 8.78 | 12.84 | 18.92 | 14.86 | 20.27 | 18.92 | 334.46 |
| Diagnostic Assessment | 8.11 | 16.22 | 8.11 | 13.51 | 23.65 | 14.19 | 16.22 | 364.19 |

N = 148

Table A3
*Perceived Mathematics Content Needs of the Middle School Cohort*

| CCSSM Domain | Definite (%) | High (%) | Great (%) | Some (%) | Fair (%) | Little (%) | No (%) | Overall Score Max = 700 |
|---|---|---|---|---|---|---|---|---|
| Modeling | 22.22 | 16.67 | 16.67 | 16.67 | 22.22 | 5.56 | 0.00 | 483.33 |
| Statistics and Probability | 11.11 | 11.11 | 16.67 | 27.78 | 22.22 | 11.11 | 0.00 | 427.78 |
| Geometry | 16.67 | 11.11 | 11.11 | 27.78 | 16.67 | 5.56 | 11.11 | 422.22 |
| Proportional Reasoning | 7.14 | 14.29 | 14.29 | 21.43 | 35.71 | 7.14 | 0.00 | 414.29 |
| Algebra | 10.53 | 0.00 | 31.58 | 0.00 | 21.05 | 26.32 | 10.53 | 357.89 |
| Functions | 11.11 | 0.00 | 5.56 | 33.33 | 5.56 | 27.78 | 16.67 | 327.78 |
| Number and Quantity | 6.25 | 0.00 | 12.50 | 18.75 | 6.25 | 37.50 | 18.75 | 293.75 |

N = 22

Table A4
*Perceived Professional Needs of the Middle School Cohort*

| Professional Need | Definite (%) | Great (%) | Some (%) | Fair (%) | Little (%) | No (%) | Overall Score Max = 600 |
|---|---|---|---|---|---|---|---|
| Supporting Reasoning and Sense Making | 44.44 | 44.44 | 11.11 | 0 | 0 | 0 | 533.33 |
| Using technology | 55.56 | 22.22 | 16.67 | 0 | 5.56 | 0 | 522.22 |
| Teaching CCSS | 44.44 | 27.78 | 11.11 | 16.67 | 0 | 0 | 500 |
| Collaborating | 27.78 | 16.67 | 44.44 | 5.56 | 5.56 | 0 | 455.56 |
| Instructional strategies | 11.11 | 27.78 | 33.33 | 16.67 | 0 | 11.11 | 400 |

N=22