"I DON'T THINK I WOULD TEACH THIS WAY": INVESTIGATING TEACHER LEARNING IN PROFESSIONAL DEVELOPMENT

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Can professional development (PD) have a profound and lasting effect on participating teachers? The purpose of this study was to understand how teachers learn new mathematics content in professional development in order to contribute to the open question of how PD affects teachers' actual instructional choices in the classroom. Teachers were followed from a content-based PD program into their classrooms and their content knowledge was probed in each context. Data was analyzed from the perspective of motivation theory. Findings show compelling links between teachers' motivations, their conceptions of their students, and the nature of their knowledge of algebra. These links have broader implications for conceptualizing in-service teacher learning.

Keywords: Teacher Education-Inservice; Teacher Knowledge

Research on the professional development (PD) of mathematics teachers depends heavily on the question of what kinds of knowledge teachers need in order to teach mathematics effectively. After Shulman's (1986) introduction of the idea of pedagogical content knowledge and its subsequent refinement, researchers interested in both preservice and inservice teacher education have developed a clearer idea of what types of knowledge teachers needed to develop (Grouws & Shultz, 1996). However, defining the types of mathematical knowledge teachers need is only the first step in fostering that knowledge in teachers. Although the field has struggled to define and measure the effectiveness of PD without using teacher self-reports or student achievement data, there is no doubt that such an endeavor relies on understanding how teachers use concepts learned in professional development in their own classrooms. The purpose of this study was to investigate the ways in which teachers participating in content-based professional development made connections between the mathematical content of the PD program and their own mathematics instruction.

Background

The professional development of teachers is just one stage in the overall education of teachers and often comes at a time when teachers have settled comfortably into their practice (Feiman-Nemser, 2010). According to Feiman-Nemser, research has viewed teachers at this stage in two ways, either having already settled into a basic style and resistant to efforts aimed at change or constantly changing (with or without the help of professional development) in order to become more effective with students and to gain professional satisfaction. This study is done with the second view in mind, positing that professional development is one way of guiding or channeling the change teachers already are invested in making. However, according to previous research, the effectiveness of any program aimed at changing instructional practice must rely on how well such programs align with a teacher's preexisting beliefs about teaching, learning and mathematics (Arbaugh, Lannin, Jones, & Park-Rogers, 2006; Chapman, 2002; Thompson, 1984).

Due to the increasing diversity of teachers' mathematical backgrounds, educating inservice teachers produces issues very similar to those faced when educating diverse learners (Adler, Ball, Krainer, Lin, & Novotna, 2005). However, while some facets of professional development reflect the dynamics of a mathematics classroom, such as an instructional triangle consisting of interactions between nodes representing the professional development instructors, the participating teachers and the mathematics content (Borko, 2004), teachers constantly consider their own students–even while

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attending to their own learning–creating an instructional rhombus with the fourth node representing the teachers' real or hypothetical students (Nipper et al., 2011). However, Nipper et al. found that tension between the teachers and the content of the professional development arose as teachers realized that the mathematics content of the program was not content that they could directly use in their own classrooms.

Previous research has identified particular design features that characterize effective professional development: sustained learning over a period of time, active learning by teachers, examples from classroom practice, collaborative activities, modeling effective pedagogy, opportunities for reflection, practice and feedback, and focus on content (Boyle, White & Boyle, 2004; Hill, 2004). Ross, Hogaboam-Gray, and Bruce (2006) found that a professional development program which incorporated all these features resulted in a significant increase in student achievement on an external assessment. However, Marra et al. (2010) argue that individual design features are not as important the interactions between these features. Thus, they propose the orientations framework for classifying professional development programs. Based on their framework and the meta-study they conducted, they conclude that the most effective orientations of professional development are either completely or partially content-driven. This conclusion is echoed by Sowder, Philipp, Armstrong, and Schappelle (1998), who found that teachers appreciated when attention was paid to learning mathematics content. Sowder et al. found that changes in mathematical knowledge prompted changes in instruction, but this was mediated by teachers' comfort level with the content. Moreover, increased understanding of the mathematics they were teaching prompted the teachers to have greater expectations for their students' mathematical learning and changed their views about the centrality of curriculum materials and the quality of the classroom discourse. Content-driven professional development has also been shown to support student achievement (Hill, Rowan, & Ball, 2005; Saxe, Gearhart, & Suad Nasir, 2001).

However, while much research has been done to identify effective professional development, most of it relies on teachers' self-reporting of aspects of professional development that they liked and what instructional changes they have made (Marra et al., 2010). Less work has been done in understanding how teachers use the knowledge gained in professional development and how that knowledge leads to instructional change.

Theoretical Frameworks and Research Question

This study adds to the existing knowledge by applying the frameworks of motivation theory to analyze teachers' participation in and engagement with professional development. There are four major frameworks that make up the foundation of motivation theory as applied to the classroom: expectancy-value theory, self-efficacy beliefs, goal orientation and attribution theory (Karabenick & Conley, 2011). In the context of education, these describe students' willingness to engage with school tasks. According to expectancy-value theory, the effort a student expends on a task depends on whether he thinks he will be successful at the task and on whether he believes that success on the task will result in a valued reward – either internal or external. A student's self-efficacy determines her assessment of her own abilities, interpreting her past failures and successes in order to set her own personal goals and define success for herself based on those self-determined goals. The character of the goals set by the student for himself also affects the student's level of effort. Two different goal orientations produce different patterns of effort and perseverance: performance goals are goals that rely on affirmation from others and can result in low effort from students with low-self efficacy, while learning (or mastery) goals are goals defined by gaining new skills or new knowledge, potentially prompting students with low self-efficacy to learn from failure and try again. Finally, a student's attribution of failure or success to either effort or ability also affects her motivation to attempt or to persevere in completing a task.

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However, as teacher learning is different in character than student learning, applying motivation theory to teacher learning narrows the focus of this framework in order to allow for a more nuanced discussion of how teachers' self-efficacy and subjective task values can influence their participation in professional development. Karabenick and Conley (2011) use motivation theory to investigate teachers' motivation to participate in professional development, situating teacher motivation within the context of a PD program by tying motivation to the ways in which teachers participate in the program and enact the practices recommended by the program. They extend a framework for teachers' choices developed by Watt and Richardson (2007). The studies by Karabenick and Conley (2011) and Watt and Richardson (2007) both rely on a framework for value developed by Wigfield and Eccles (2000), which classifies four different types of value:

> *interest value* is the enjoyment the individual derived from performing the task; *utility value* is how the task relates to future goals; *attainment value* is the importance to the self of doing well on a task, linked with identity (in this case teacher identity); and *cost*, which refers to the accumulated negative aspects of engaging in the task, including anticipated emotional states (performance anxiety, fear of failure), and the amount of effort required to succeed at the task. (Karabenick & Conley, 2011, p. 11).

Expectancy-value theory relies on the intertwined concepts of self-efficacy and value, both of which have been studied extensively with regard to students, but are only beginning to be explored with teachers. This study, like others that apply a motivation theory framework to the processes and concerns of teaching (Karabenick & Conley, 2011; Watt & Richardson, 2007), primarily relies on the lenses of expectancy-value theory and self-efficacy theory, with other constructs in motivation theory referenced if relevant.

This study attempts to contextualize the choices teachers make with respect to their own learning within professional development, as well as their use of content from PD in their own classrooms. This paper will address the findings related to the following research question: what influences mediate teachers' alignment with the mathematics content of professional development and connections they make between that and the mathematics content of their classrooms?

Methods

These qualitative case studies were conducted within a three-year part-time degree for middle school mathematics teachers with elementary certification run by a large research university in the southwestern United States. This program had a heavy focus on mathematical content and included four required mathematics courses: number & operation, algebra, geometry, and probability and statistics, each of which was team-taught through the university by a research mathematician and a high-school teacher. After completing the program, participants are awarded a Master of Arts degree in Middle School Mathematics Teaching Leadership from the university. The general orientation of the program would be classified as content-driven (Marra et al., 2010). Three participating teachers, each of whom had at least five years of teaching experience in either middle or elementary school, were chosen from a single cohort of the professional development program after that cohort had finished the program's algebra course.

Data was collected in four major stages: 1) during the Spring 2012 semester as teachers participated in the professional development algebra course, 2) after the end of the algebra class, 3) during the 2012-2013 academic year as the teachers began their first year of teaching after finishing the algebra course, and 4) during the Fall 2013 semester. Data collected from the first stage of the study was made up of observations of the PD algebra course at the university. Special attention was paid to the instructors' mathematical decisions and perspectives of algebra. Stage two of the study included a post-class task-based interview where teachers were asked to reflect on the experience of

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the algebra class and their attitudes about the content, as well as the program as a whole up to that point and then to pedagogically unpack five mathematical content questions taken from the algebra course. The third stage of the study asked teachers to open their practice and their classrooms to observation by the researcher. Teachers were asked to identify lessons for observation which they saw as connected to the content covered in the professional development algebra class. Teachers participated in pre- and post-observation interviews in order to chart the teacher's intentions more specifically by focusing on a particular mathematical topic. Also, the teacher was asked to identify explicitly the connections she saw between the lesson she was teaching and the content covered in the professional development algebra class. The final stage of the study was a follow-up interview that asked teachers to contextualize this PD experience with their other PD experiences and within the greater narratives of their careers.

Non-task-based interview data from the second and fourth stages of data collection and relevant tangential comments from the third stage were analyzed within the value framework developed by Wigfield and Eccles (2000) in order to produce a motivational portrait of each teacher. This was done by isolating references teachers made to their reasons for participating in the PD program, statements that revealed their attitudes toward particular concepts, and any other remarks that revealed aspects of their affect. While many of these pieces of data were explicitly prompted by actual interview questions, some telling comments arose amidst other portions of the interviews. The task-based portion of the second stage of data collection and the mathematical observations and interview excerpts from the first and third stages were analyzed for the algebraic perspectives put forward by the teachers or PD instructors. This was done by placing solutions within contrasting frameworks for algebra established by Pimm (1995), Kaput (2008) and Kieran (2007). Teachers' written work from the task-based interviews was used in conjunction with the interview transcripts to provide further clarification.

The importance of motivation theory to this study became apparent after a cursory analysis of the data. Teachers' reasons for participating in the PD program appeared relate strongly with their initial expectations for the program and its usefulness to their teaching, prompting the explicit use of motivation constructs in analyzing the data.

Findings

This paper will focus on one teacher: Felicia. At the start of her progress through the content-based PD program, Felicia was beginning her tenth year in the profession. Her confidence in her mathematical ability was very high, often referring to herself in interviews as a "math person," and saying that, as a teacher, "Math has always been my thing. And I think I'm really really strong in it, so I teach to my strength." Felicia did not think the mathematics in the PD program would be much of a challenge for her, an opinion she retained throughout most of the program. Felicia's motivations for enrolling in the PD program were a mix of personal and professional goals. Her eventual career goal was to move into administration, and she was hoping that a Master's in Middle School Mathematics Teaching Leadership, paired with a Master's in Educational Leadership, would help propel her into more leadership positions. Although her interest in mathematics created some amount of interest value in the PD program, Felicia mostly held utility value for the program, as she felt it would help her career. Felicia also had a high level of self-efficacy as a teacher of mathematics: "I think the level that I'm at and where I am with classroom management and building those relationships with the kids, I think I'm there. There's a lot of things I can still learn from older teachers, but then again too, I have a different – better – different way of doing it that I think is better."

Felicia's overall contentment with her mathematical abilities (especially in algebra) and instructional style led her to expect that she would not be prompted to change as a mathematics teacher due to her participation in the PD program. The nature of the utility value that she held for the PD program – professional, not practical – also signals her expectation that the content of the PD program (and specifically the PD Algebra course) would hold mainly interest value for her. Moreover, her idea of "relevant" content was very narrow: the mathematics had to directly mirror the mathematics her students would be expected to learn. Felicia referred multiple times to the fact that she taught sixth grade and that most of the content of the PD Algebra course was not appropriate for sixth-grade students. Moreover, Felicia viewed her own ongoing mathematical development mainly as an opportunity to develop more and better "tricks" or solution strategies for traditional algebraic tasks. Otherwise, Felicia described her gains from the PD program as mostly personal: "I like math... I mean, honestly, that's what it comes down to. I like math, and I like some of the times it was a challenge and I was like, ooh! Something new let's go find out how to do it, it was for me. Because I'm a math nerd. It's a challenge. Some of the things were challenges."

While the PD instructors emphasized certain perspectives of the algebraic concepts and encouraged teachers to explore those perspectives, during the task-based interview, Felicia fell back on her previous understandings of algebra to solve the given problems. For example, consider the following item from the task-based interview:

> Construct a function with the following properties if possible or explain why it would not be possible.
> 1. One element in the domain and four elements in the range.
> 2. Four elements in the domain and one element in the range.
> 3. Four elements in the domain and four elements in the range.

Felicia's solution to this item relied heavily on her visualization of functions in the Cartesian coordinate plane. She concluded that the first set of properties could not describe a function, since "technically, if you're graphing it, it'd be a vertical line, and it won't pass the vertical line test, so it won't be a function." Similarly, she identified the second set of properties as a horizontal line, so it would describe a function that was not one-to-one. The third set of properties described a one-to-one function, "because for every unique domain there's a unique range." In her pedagogical analysis of this task, Felicia connected her solution strategy with how she thought students would approach the task, asserting that seeing (or knowing) graphical representations of the sets of properties given would make this task easier for students to complete. Although she brought up the "circles" representation of functions (i.e. the map-between-sets representation) that was emphasized in the PD Algebra course as another possible visual representation that might be meaningful for students, Felicia admitted that she did not find much meaning in that representation herself, and that she was unlikely to present it to students. She explained her conception of functions as follows: "When it comes to functions, I automatically think of something that can be graphed or can't be graphed. I don't think of the circles like we were taught in class." Although she said that the more abstract visual representation of functions was new to her, it is clear that this representation held little meaning for her, since she followed the previous statement by saying, "I don't think I would teach it this way because I'm not comfortable with it. I would go directly to the graph, because graphing is an easy way to see it." Felicia referred multiple times to graphical representation being "easier" to understand – either for herself or for her students.

Felicia's work on and reflection about all the tasks in the task-based interview diverged a great deal from the PD instructors' presentation and development of the concepts. For three of the tasks, Felicia used or advocated the use of numerical solution strategies, making her mathematical perspective of those tasks non-algebraic (Kaput, Blanton, & Moreno, 2008). In general, the PD instructors did not encourage the teachers to use numerical solutions, choosing instead to focus teachers' attention on algebraic structure. In fact, Felicia's work only reflected the mathematical perspective of the PD Algebra course on one task, possibly because she had no other solution strategy outside of the one she had learned in the PD Algebra course. Even her emphasis on the Cartesian-coordinate-graph-representation of functions to the exclusion of the more abstract map-between-sets representation placed more weight on a representation that the PD instructors introduced almost as an afterthought in that unit. Felicia's lack of alignment with the development and presentation of mathematics in the PD Algebra course provides an important context for understanding how she viewed algebraic content in the PD Algebra course and its relevance to the algebraic content of her own classroom.

Felicia's conception of her role as a teacher (and especially in her role as an interventionist) was as a provider of different strategies for her students. She considered her job to be finding different ways of teaching the material, stating that the "traditional" methods and algorithms "don't really work for this generation." She also equated "better ways" of teaching the material with showing students different strategies for approaching problems. As a result, Felicia considered the main utility of content-based professional development to be as a way to help her learn or create different strategies and algorithms to teach her students:

> *Felicia*: [The PD courses] have helped me realize the reason why it works, or the reason behind the actual math, the algorithms or the operations or whatever. So it helps me develop a trick, per se, that the kids might get a little bit easier than the traditional here's how you do it type of thing.

In turn, she would then present the alternate algorithm or strategy to her students. Unfortunately, Felicia did not see many opportunities in her classroom to develop different strategies or alternate explanations with respect to the content of the PD Algebra course.

In one episode from the observations of Felicia's classroom, a student asked her for help with the one-step equation: $v - 3.7 = 8.78$. Felicia's interaction with the student around this problem reflected this belief about professional development, since she did not in any way mirror the PD instructors' approach to similar problems, which were discussed extensively in the PD Algebra course:

> *Felicia*: I explained to her: a number minus this number is going to give me this number right? And she's like, yeah. I'm like, okay, so what are we going to do with this number that we're minusing? And at first, she said subtract. And I'm like, so wait a second, if I subtract that number from [the answer], I'm gonna get a smaller number right? She said yeah. And I'm like, but if we have a smaller number over here, for the variable, is that gonna make sense that you subtract something and get a bigger number? She's like, no. And I'm like, so... She said we were going to add it to it, and I'm like, okay why? And she was like, because we want a bigger number over in the variable spot than we do over in the equals spot. In other words, of course.

Notice that Felicia emphasizes the relative sizes of the known numbers, implying that the operation of subtraction should diminish the unknown.

> *Felicia*: So, I'm like, good, good, good. So I'm like, well look at this, it's the opposite of the operation that's happening to that number, to the variable, to other side, right? She's like, yeah. I said, so whenever you do this, you're going to do the opposite of what's in there to isolate the variable…and I'm like, what's negative 3 point blah blah blah plus that same number, and she's like zero. I said, okay, well that's gone. All we have left over here is the variable, and then we add this over here and that's how we get our answer.

Felicia uses this emphasis to highlight the use of opposite operations in order to isolate the unknown. The PD instructors' emphasis throughout the first unit of the PD Algebra course was on

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the importance of equivalence when working with equations, a concept that Felicia barely uses in her explanation of the problem. In the PD Algebra course, the PD instructors emphasized the *transformational* aspects of tasks involving solving equations (Kieran, 2007). In this transcript, Felicia conceptualizes the task as a *generational* one for the student; although the equation in question is already formed, Felicia focuses the student on the unknown *v* in order for the student to reason about the relationship between *v* and the other two numbers. In essence, she prompts the student to reason backwards from the given equation to the formation of the equation. Although the PD instructors encouraged meaning-building with expressions in the PD course, they did not emphasize meaning in the solving of algebraic equations. Moreover, Felicia prompted the student to do some numerical reasoning with respect to the possible size of the unknown. This reflects Felicia's own work in the task-based interviews, where she would diverge from the presentation and development of algebra from the PD Algebra course in favor of numerical reasoning.

Discussion and Implications

These examples, when put into the context of Felicia's motivational structure, have serious implications for understanding how teachers learn new mathematics content in content-based professional development. Sowder, et al (1998) recognized that teachers' retention and usage in the classroom of new content relied in part on how comfortable they were with the content to begin with. However, the example of Felicia introduces a new dimension to our understanding of how teachers learn. Although Felicia's mathematical self-efficacy was very high and she was comfortable with particular approaches to the content, her largely utility value for the PD course seemed to strongly influence how she approached new and unfamiliar content. Her tight focus on her students (which reflects the findings of Nipper, et al (2011)) prompted her to filter all the content in the PD Algebra course through her perception of what would be useful to her students.

The frameworks of motivation theory present us with a different perspective through which to examine teachers' participation in professional development. Further study on professional development done through this lens may illuminate new considerations for the designers and facilitators of content-based PD programs.

References

Adler, J., Ball, D., Krainer, K., Lin, F-L., & Novotna, J. (2005). Reflections on an emerging field: researching mathematics teacher education. *Educational Studies in Mathematics, 60*, 359-381.

Arbaugh, F., Lannin, J., Jones, D. L., & Park-Rogers, M. (2006). Examining instructional practices in Core-Plus lessons: implications for professional development. *Journal of Mathematics Teacher Education, 9*(6), 517-550.

Borko, H. (2004). Professional development and teacher learning. *Educational Researcher*, *34*(8), 3-15.

Boyle, B., White, D., Boyle, T. (2004). A longitudinal study of teacher change: What makes professional development effective? *Curriculum Journal, 15*(1), 45–68.

Chapman, O. (2002). Belief structures and inservice high school mathematics teacher growth. In Leder, G. C., Pehkonen, E., & Torner, G. (Eds.), *Beliefs: a hidden variable in mathematics education?* (pp. 177-193). The Netherlands: Kluwer Academic Publishers.

Feiman-Nemser, S. (2012). *Teachers as learners*. Cambridge, MA: Harvard Education Press.

Grouws, D., & Schultz, K. (1996). Mathematics teacher education. In J. Sikula (Ed.), *Handbook of research on teacher education.* New York: Simon & Schuster Macmillan.

Hill, H. C., Rowan, B., & Ball, D. L. (2005).Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406.

Hill, H. C. (2004). Professional development standards and practices in elementary school mathematics. *Elementary School Journal, 104*(3), 215-231.

Kaput, J. J. (2008). What is algebra? What is algebraic reasoning? In J. J. Kaput, D. W, Carraher, & M. L. Blanton (Eds.), *Algebra in the early grades* (pp. 5-17). Mahwah, NJ: Lawrence Erlbaum Associates.

Karabenick, S. A. & Conley, A. (2011). *Teacher motivation for professional development*. Ann Arbor, MI: Math and Science Partnership – Motivation Assessment Program, University of Michigan.

Bartell, T. G., Bieda, K. N., Putnam, R. T., Bradfield, K., & Dominguez, H. (Eds.). (2015). *Proceedings of the 37th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*. East Lansing, MI: Michigan State University.

Kieran, C. (2007). Learning and teaching algebra at the middle school through college levels: Building meaning for symbols and their manipulation. In F. K. Lester, Jr. (Ed.), *Second Handbook of Research on Teaching and Learning Mathematics*. Greenwich: CT: Information Age Publishing.

Marra, R. M., Arbaugh, F., Lannin, J., Abell, S., Ehlert, M., Smith, R., Merle-Johnson, D., & Park-Rogers, M. (2010). Orientations to professional development design and implementation: understanding their relationship to PD outcomes across multiple projects. *International Journal of Science and Mathematics Education, 9*(4), 793-816.

Nipper, K., Ricks, T., Kilpatrick, J., Mayhew, J., Thomas, S., Kwon, N. Y., Klerlein, J. T., & Hembree, D. (2011). Teacher tensions: expectations in a professional development institute. *Journal of Mathematics Teacher Education, 14*(5), 375-392.

Pimm, D. (1995). *Symbols and meanings in school mathematics.* London, UK: Routledge.

Ross, J. A., Bruce, C., & Hogaboam-Gray, A. (2006). The impact of a professional development program on student achievement in grade 6 mathematics. *Journal of Mathematics Teacher Education, 9*(6), 1-27.

Saxe, G. B., Gearhart, M., & Suad Nasir, N. (2001). Enhancing students' understanding of mathematics: A study of three contrasting approaches to professional support. *Journal of Mathematics Teacher Education, 4*(1), 55-79.

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

Sowder, J. T., Philipp, R. A., Armstrong, B. E., & Schappelle, B. P. (1998). *Middle-grade teachers' mathematical knowledge and its relationship to instruction: a research monograph*. Albany, NY: SUNY Press.

Thompson, A. G. (1984). The relationship of teachers' conceptions of mathematics and mathematics teaching to instructional practice. *Educational Studies in Mathematics*, *15,* 105-127.

Watt, H. M. G. & Richardson, P. W. (2007). Motivational factors influencing teaching and career choice: development and validation of the FIT-Choice scale. *The Journal of Experimental Education, 75*(3), 167-202.

Wigfield, A. L. & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25*, 68-81.

Bartell, T. G., Bieda, K. N., Putnam, R. T., Bradfield, K., & Dominguez, H. (Eds.). (2015). *Proceedings of the 37th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*. East Lansing, MI: Michigan State University.