Examining Personal Teacher Efficacy Beliefs and Specialized Content Knowledge of Pre-service Teachers in Mathematical Contexts

Preliminary Research Report

Jathan Austin

University of Delaware

Abstract: This study addressed the following research question: To what extent are K-8 pre-service teachers' personal mathematics teacher efficacy beliefs aligned with their content knowledge for teaching mathematics? 18 K-8 pre-service teachers enrolled in a teacher preparation mathematics content course completed semi-structured interviews and follow-up written assessments in which efficacy beliefs and content knowledge regarding specific mathematical teaching scenarios were assessed. Preliminary analyses indicate that the efficacy beliefs of pre-service teachers with low content knowledge vary according to the nature of the teaching scenario. Consequently, the extent to which teacher efficacy beliefs and knowledge are aligned for these pre-service teachers depends on the mathematics involved.

Keywords: pre-service teachers, teacher efficacy beliefs, mathematical content knowledge

Teacher efficacy beliefs are considered an important topic of study, in part because of the apparent positive correlations between teacher efficacy beliefs and a variety of desirable outcomes including student achievement (Ghaith & Yaghi, 1997; Riggs & Enochs, 1990; Ross, 1992). While there is an increasing body of literature on teacher efficacy beliefs, few researchers have examined the potential links between pre-service teachers' mathematics teacher efficacy beliefs and mathematical content knowledge. In fact, investigating the extent to which pre-service teachers' teacher efficacy beliefs are aligned with their mathematical content knowledge

for teaching is an important area of research with implications for understanding how teachers reflect on and learn from their teaching practices.

Relation of this work to the research literature

A process of intentional, careful reflection followed by changes in practice is an important part of becoming a more effective teacher (Hiebert et al., 2007). Teachers who already believe that they are highly effective would seem to be less likely to engage in this type of careful reflection. Personal teacher efficacy is defined as "a teacher's belief in his or her skills and abilities to be an effective teacher" (Swars, 2005, p. 139). Then, it is likely that many teachers who exhibit high levels of personal teacher efficacy actually view themselves as highly effective teachers. As such, teachers with high levels of personal teacher efficacy might see little need to engage in careful reflection regarding the extent to which their teaching practices are successful. Indeed, previous studies both indicate the benefits of lower teacher efficacy as a mechanism for fostering teacher reflection and demonstrate the potential downsides of high teacher efficacy (Brodkey, 1993; Wheatley, 2002; Wheatley, 2005).

Specialized content knowledge (SCK) for teaching mathematics (Ball, 2008) is one aspect of teaching about which teachers might need to reflect and improve. Recent research provides empirical evidence that teachers' levels of *mathematical knowledge for teaching*, of which specialized content knowledge is an important subcomponent (Ball, 2008), might be particularly important (Hill, Rowan, & Ball, 2005).

A connection between teacher efficacy beliefs and specialized content knowledge worthy of empirical examination becomes apparent when one considers results from previous empirical work on the relationship between individuals' self-assessments of knowledge and their performance on various tasks. Wheatley (2000) discovered that teachers' efficacy beliefs can be

"poorly grounded" (p. 19), partially because teachers might not be aware of "their own lack of knowledge" (p. 19). Then, it is possible that teachers with low specialized content knowledge for teaching mathematics might be overconfident in their teaching abilities, and thus exhibit high levels of personal teacher efficacy. In other words, teachers' teacher efficacy beliefs might be unaligned with their specialized content knowledge. Indeed, Stevenson et al. (1990) discovered a similar disconnect regarding American children's mathematical knowledge and their mathematical performance, with American students tending to overestimate their mathematical abilities more than students from China or Japan.

One might then ask why it matters whether or not teachers' teacher efficacy beliefs and content knowledge are aligned. To begin, teachers with unaligned teacher efficacy beliefs and specialized content knowledge might have difficulty in recognizing when they are overconfident in their teaching abilities. Kruger and Dunning (1999) found that not only do individuals overestimate their abilities in given situations, but that such overestimation might be due in part to lack of knowledge hampering individuals' abilities to evaluate their own skills accurately. Then, it is possible that teachers with low content knowledge could have difficulty in assessing their teaching abilities realistically.

If this is the case, it is likely that teachers who feel they are highly efficacious yet have low specialized content knowledge will exhibit two characteristics. First, they might be less effective teachers than they actually believe themselves to be. Second, and more importantly, such teachers might not only have insufficient motivation for engaging in reflection on their practices, but also have difficulty in assessing when changes in practice are needed even when reflection takes place (see, e.g., Borko et al., 1992).

Implications for teacher educators

Pre-service teachers are a particularly important population to study, as the teacher efficacy beliefs of these teachers are still developing (Swars, 2005). If it is in fact the case that pre-service teachers with high teacher efficacy beliefs and low specialized content knowledge have insufficient motivation for engaging in reflection on their practices, and also have difficulty in assessing when changes in practice are needed even when they do reflect on their practices, teacher educators would surely want to know that this is the case. That is, an efficacy beliefs-knowledge relationship that hinders rather than promotes teacher reflection is not a relationship that will help teachers improve over time. Studies that explore the extent to which pre-service teachers' efficacy beliefs and content knowledge are aligned have the potential to uncover potentially unhelpful relationships between teacher efficacy beliefs and content knowledge, and consequently can inform teacher educators' understandings of how to help pre-service teachers develop more helpful efficacy beliefs-knowledge relationships.

Thus, the research question of interest in this study is the following: To what extent are K-8 pre-service teachers' personal mathematics teacher efficacy beliefs aligned with their content knowledge for teaching mathematics?

Research methodology

The participants were 18 sophomore undergraduates enrolled in a K-8 teacher preparation program in a medium-sized state university in a Mid-Atlantic state. All of the participants in this study were enrolled in the third course of a three-course sequence of mathematics content courses at the time of their participation. These 18 pre-service teachers were selected randomly from the total 47 pre-service teachers enrolled in the third content course.

Pre-service teachers first participated in a 90-minute semi-structured interview in which they were asked to respond to four written mathematical teaching scenarios, the *teaching scenario tasks*. Each scenario consisted of a written student question about a given fractions task. For each of the teaching scenarios, pre-service teachers were first asked to write a written response regarding what they would do as the teacher in the given situation. Then, they were asked to rank the effectiveness of their response on a scale of one to five, and to list any factors that contributed to their rating. Finally, the author asked participants to explain their responses verbally. All interviews were audio-recorded, with the recordings used to supplement written pre-service teacher responses. Following the semi-structured interview, pre-service teachers completed a 60-minute written assessment containing *SCK written tasks*. These tasks contained the same mathematical content as those used in interviews but contained no teaching context.

Pre-service teachers' personal teacher efficacy beliefs were operationalized in two ways. For each interview task, pre-service teachers' reported rankings of their effectiveness were taken as a measure of their personal mathematics teacher efficacy. Additionally, pre-service teachers' rankings were coded according to the factors pre-service teachers mentioned as contributing to their teacher efficacy. Four categories emerged from the interview data: *content knowledge*, *pedagogy*, *students,* and *other*. Pre-service teachers both mentioned factors that made them feel more efficacious and factors that made them feel less efficacious in their responses to teaching scenario tasks.

Specialized content knowledge (SCK) was operationalized with an approach similar to that used in Morris et al.'s work (2009). That is, the author constructed a list of mathematical subcomponents relevant to each teaching scenario task. Participants then received a score of 0, 1, or 2 for each subcomponent based on the quality of their responses. Five mathematical

subcomponents were identified for each of tasks 1 and 2, so SCK scores could range from 0 to 10 on these tasks. Four subcomponents were identified for tasks 3 and 4, so SCK scores could range from 0 to 8 on these tasks. This scoring was computed for both the teaching scenario and SCK written tasks.

Based upon their scores on the teaching scenario tasks, pre-service teachers were separated into *higher* and *lower* SCK groups for each task using a median split in order to examine alignment of beliefs with level of SCK. The same was done for scores on the SCK written tasks. Then, pre-service teachers were grouped into four categories for each task: *higher/higher*, *higher/lower*, *lower/higher*, and *lower/lower*. The groups of particular interest were the higher/higher and lower/lower groups, as these pre-service teachers displayed a more reliable level of SCK across the two assessments. Additionally, for each task, Spearman's rho was computed to examine potential correlations between pre-service teachers' efficacy rankings and their SCK scores.

Inter-rater reliability scores for 20% of scores were obtained. The percent agreements reported here were computed across the interview and parallel written assessment tasks. The agreements for tasks 1, 2, 3, and 4 were 80%, 80%, 81%, and 81% respectively.

Results of the research

Only preliminary results are given here as this study is a work in progress. More detailed analyses are currently underway. For task 2, efficacy rankings and SCK scores were significantly negatively correlated ($rho = -0.486$, $p = 0.041$). That is, apparently, pre-service teachers tended to be somewhat overconfident regarding their responses on this task, as pre-service teachers with higher confidence ratings tended to exhibit lower levels of SCK in their responses to the teaching scenario.

Additionally, the nature of the task apparently influenced the extent to which lower SCK pre-service teachers mentioned content knowledge as making them feel less efficacious in their teaching scenario responses. The percents of pre-service teachers in the lower/lower SCK group that mentioned content knowledge factors making them feel less efficacious on tasks 1-4 were 50%, 17%, 100%, and 83% respectively. Pre-service teachers with relatively low SCK presumably should not mention their own math content knowledge as positively contributing to their sense of efficacy, so one could say low SCK pre-service teachers who cited content knowledge as making them feel more efficacious exhibit efficacy beliefs that are not aligned with their SCK. This might indicate that the extent to which the efficacy beliefs of pre-service teachers with lower SCK are aligned with their content knowledge depends upon the contextual features of the teaching scenario.

Questions for the audience

- What might be the implications of this work for researchers of teacher efficacy beliefs? for teacher educators? for designers of professional development?
- To what extent are the data presented convincing?
- What additional data would be useful to collect in future work in order to address the research question more thoroughly?

References

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389-407.

Borko, H., Eisenhart, M., Brown, C. A., Underhill, R. G., Jones, D., & Agard, P. C. (1992). Learning to teach hard mathematics: Do novice teachers give up too easily? *Journal for Research in Mathematics Education, 23*(3), 194-222.

Brodkey, J. J. (1993). Learning while teaching: Possibilities and problems. *Teacher Education Quarterly, 20*(1), 63-70.

Ghaith, G., & Yaghi, H. (1997). Relationships among experience, teacher efficacy, and attitudes toward instructional innovation. *Teaching and Teacher Education, 13*(4), 451-458.

Hiebert, J., Morris, A. K., Berk, D., & Jansen, A. (2007). Preparing teachers to learn from teaching. *Journal of Teacher Education, 58*(1), 47-61.

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.

Kruger, J., & Dunning, D. (1999). Unskilled and unaware of It: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology, 77*(6), 1121-1134.

Ma, L. (1999). *Knowing and teaching elementary mathematics : Teachers' understanding of fundamental mathematics in China and the United States*. Mahwah, NJ: Erlbaum

Morris, A. K., Hiebert, J., & Spitzer, S. M. (2009). Mathematical knowledge for teaching in planning and evaluating instruction: What can preservice teachers learn? *Journal for Research in Mathematics Education, 40*(5), 491-529.

Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education, 74*(625-637).

Ross, J. A. (1992). Teacher efficacy and the effects of coaching on student achievement. *Canadian Journal of Education, 17*, 51-65.

Stevenson, H. W., Lee, S.-Y., Chen, C., Stigler, J. W., Hsu, C.-C., Kitamura, S., et al. (1990). Contexts of achievement: A study of American, Chinese, and Japanese children. *Monographs of the Society for Research in Child Development, 55*(1/2), 1-119.

Swars, S. L. (2005). Examining perceptions of mathematics teaching effectiveness among elementary preservice teachers with differing levels of mathematics teacher efficacy. *Journal of Instructional Psychology, 32*(2), 139-147.

Wheatley, K. F. (2000). Positive teacher efficacy as an obstacle to educational reform. *Journal of Research and Development in Education, 34*(1), 14-27.

Wheatley, K. F. (2002). The potential benefits of teacher efficacy doubts for educational reform. *Teaching and Teacher Education, 18,* 5-22.

Wheatley, K. F. (2005). The case for reconceptualizing teacher efficacy research. *Teaching and Teacher Education, 21*(7), 747-766.