# The Impact of Professional Development in Mathematics on Teachers' Individual and Collective Efficacy:
## The Stigma of Underperforming

**By Ron Zambo & Debby Zambo**

Professional development is an ongoing need for teachers especially in the area of mathematics, a domain that is the focus of state testing programs. Professional development for teachers of mathematics has been shown to have potential positive effects for both changing teachers' beliefs about mathematics instruction and the instruction they provide (Harwell, D'Amico, Stein, & Gatti, 2000; Loucks-Horsly & Matsumoto, 1999; Nelson, 1998; Vacc, Bright, & Bowman, 1998). In particular, professional development has the potential to change teachers' beliefs about their individual and collective efficacy. Both types of efficacy are important to teachers' persistence, drive, and success (Zimmerman, 1995).

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Individual efficacy is highly associated with teacher motivation, which in turn affects student achievement (Bandura, 1993, 1997). Teachers with a strong sense of individual efficacy tend to spend more time planning, designing, and organizing what they teach. They are open to new ideas, willing to try new strategies, set high goals, and persist through setbacks and times of change (Goddard, Hoy & Woolfolk Hoy, 2000). In other words, teachers with a strong sense of individual efficacy

believe they can and do make a difference in the lives of their students and that their students can and will achieve. Research into individual efficacy shows that it is a complex construct composed of two distinguishable components: *personal competence* and *personal level of influence* (Hoy & Woolfolk, 1993).

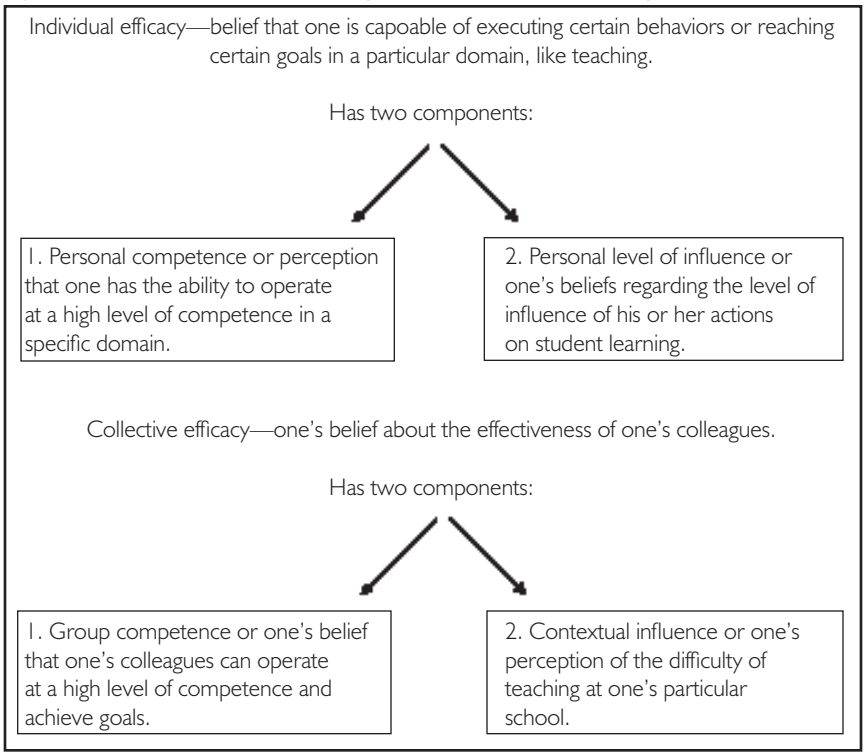
Personal competence is a teacher's perception of his or her ability to operate at a high level of proficiency in a specific domain. Researchers like Hoy and Woolfolk (1993) found that the personal competence of prospective teachers tends to get stronger after they complete their final internship, especially if it contained mastery experiences. We extend this idea to inservice teachers and the professional development they receive. If teachers attend workshops that provide them with mastery experiences or direct experiences that lead them to believe they can master a domain, their personal competence level will rise (Bandura, 1997; Pintrich & Schunk, 2002). The second component of individual efficacy is personal level of influence, or a teacher's beliefs regarding the level of influence of his or her actions on student learning. Teachers with a high personal level of influence believe that their efforts can and will affect learning in their students in a positive way.

Due to the fact that teachers work in a complex setting, they also have another type of efficacy called collective efficacy. Like individual efficacy, collective efficacy affects achievement but in a broader sense. Collective efficacy, or a teacher's belief about his or her colleagues' effectiveness, goes beyond the individual teacher to focus on the faculty as a whole (Bandura, 1993, 1997). Just as individual efficacy has two components, so does collective efficacy. The first is *group competence*, which is a teacher's belief that his or her colleagues can operate at a high level of competence and achieve goals. The other component is *contextual influence* or a teacher's perception of the difficulty of teaching at his or her particular school, taking into account the nature of the students, availability of supplies, and so forth (Goddard, Hoy & Woolfolk Hoy, 2000). Both individual and collective efficacy and their two components are summarized in Figure 1.

## Rationale for the Study

The *No Child Left Behind* legislation requires states to classify schools based on students meeting the state's academic standards. A combination of factors, including scores on state specific tests and nationally normed tests, can result in a school being awarded a low classification or a high classification. In our state, schools in the low classification are labeled *underperforming*, and schools that are persistently classified as underperforming can eventually be taken over by the state. Although *No Child Left Behind* was only recently passed, many states have been using both state-specific and nationally standardized tests for years. Teachers have been aware of their students' achievement levels based on those scores, but now that access to information is quick and public via the Internet and other media, that information is rapidly and widely disseminated. However, the implications of

Figure 1. The Two Forms of Efficacy Teachers Have and Components of Each.




this public and open display of student achievement on teacher efficacy have not been investigated. The purpose of this study was to investigate the components of individual and collective efficacy within and between two groups of teachers attending a summer workshop who came from two different types of school districts. One group, which we call *low,* came from a district where many of the schools had been labeled as underperforming and the other group, which we call *high,* came from a district with few underperforming schools.

Given the public nature of school classification, the threat of being taken over by the state, and the potential impact of professional development on teacher efficacy, we set out to investigate the individual and collective efficacy of teachers working in these two different settings. Our hypotheses were: (1) For both groups, scores for personal competence and personal level of influence would increase from pre-to posttest, whereas, scores for group competence and contextual influence would not. We reasoned that the workshops would directly influence teachers' skills and knowledge related to mathematics teaching, which would change their perceptions of both their effectiveness and their influence on students. Conversely, we thought that the professional development would

have no direct influence on teachers' views of their colleagues or the difficulty of teaching at their school. (2) Teachers in both groups would score higher on personal competence than on group competence. We reasoned that teachers who had the initiative to participate in the workshops related to mathematics instruction would already have an affinity towards mathematics. We speculated that this affinity would influence their perceptions of themselves as being more effective in teaching mathematics when compared to their colleagues. (3) Teachers in the high group would have higher scores for group competence than teachers in the low group. We suggest this hypothesis because teachers in both groups were aware of the labels put on schools in their districts and, because of this, we believe that teachers in the high group would feel more positive about their colleagues' effectiveness than teachers in the low group. Our rationale for this hypothesis was that teachers in the low group would feel less positive because they were influenced negatively by the stigma of having schools in their district labeled as underperforming.

## Methodology

### *Participants*

The participants were 63 4$^{th}$ through 10$^{th}$ grade teachers who voluntarily participated in two-week, summer professional development workshops on mathematics problem solving. The workshops focused on helping teachers increase their own problem solving ability as well as improve their classroom problem-solving instruction. Thirty-two of the teachers were from a school district with a low incidence (5.3 percent) of schools labeled underperforming. The other 31 participants came from a district with a high incidence (37.5 percent) of schools labeled underperforming.

### *Instruments and Analysis*

Group competence and contextual influence, subscales of collective teacher efficacy, were measured before and after the workshops using the 21-item Likert scale *Collective Efficacy Questionnaire* designed by Goddard, Hoy, and Woolfolk-Hoy (2000). The questionnaire was adapted for mathematics by adding the word "mathematics" where appropriate. For example, one original item related to group competence was, "Teachers in this school have what it takes to get children to learn.' The item was modified to, "Teachers in this school have what it takes to get children to learn mathematics." An item related to contextual influence was modified to, "Teachers in this school really believe that every child can learn mathematics." This questionnaire used a 6-point scale, where a 6 indicated the highest efficacy and a 1 the lowest.

Personal competence and personal level of influence, subscales of individual efficacy, were measured with the 25-item, Likert scale *Enoch & Riggs Elementary Science Efficacy Questionnaire* (1990). The questionnaire was adapted for mathematics instruction by replacing the word "science" with the word "mathematics."

A modified item related to personal competence was, "I understand mathematics concepts well enough to be effective in teaching mathematics." A modified item related to personal level of influence was, "Increased effort in mathematics teaching produces little change in some students' mathematics achievement." An additional modification to this questionnaire was that the original 5-point scale was changed to a 6-point scale, where a 6 indicated the highest efficacy. This change was made in order to facilitate better the direct comparisons of scores between collective and individual efficacy. Analysis of the questionnaires was completed using *SPSS*.

In addition to having the teachers complete the questionnaires, we interviewed them using the following five questions:

> What is the incentive that motivates you to participate in professional development?
>
> What makes an inservice program good for you?
>
> What makes an inservice program bad for you?
>
> Why don't other teachers you know attend as many professional development activities as you do?

Comments to these questions were recorded on audiotape and transcribed. We, the two researchers, read through the interview transcripts to locate patterns in words, phrases, and events. We formed initial categories and went on to formulate themes. As researchers, we constantly shared our interpretations and discussed any differences until agreement was reached. We met bimonthly as critical friends to confirm and disconfirm our findings.

## Results

### *Within Groups Comparisons*

In regard to the first hypothesis, paired-sample *t* tests indicated that the teachers in the low group showed a significant increase from pre-to posttest on personal competence, with means and standard deviations of 4.96 (.66) and 5.40 (.51) respectively ($t$ (30)=4.88, $p < .01$). Teachers in the high group also had significant gains for personal competence from pre-to posttest with means and standard deviations of 5.18 (.62) and 5.50 (.37) respectively ($t$ (31)=3.24, $p < .01$). However, only teachers in the low group had significant gains pre-to posttest on group competence, with means and standard deviations of 3.91 (.80) and 4.23 (.70) respectively ($t$ (30)=2.76, $p < .01$). There were no significant pre-to posttest differences by groups for any other variables. (Means and standard deviations of all four variables by group pre-and posttest are shown in Table 1.)

In regard to the second hypothesis: teachers in the low group scored significantly higher on personal competence than on group competence on both pretest [4.96(.66)

compared to 3.91(.80): $t$ (30)=6.32, $p < .01$] and posttest [5.40(.51) compared to 4.23(.70): $t$ (30)=8.03, $p < .01$]. Teachers in the high group also scored significantly higher on personal competence than on group competence on both pretest [5.18(.62) compared to 4.56(.60): $t$ (31)=4.71, $p < .01$] and posttest [5.50(.37) compared to 4.68(.60): $t$ (31)=8.6.47, $p < .01$].

### *Between Groups Comparisons*

In regard to the third hypothesis: analysis of variance was used to determine the effect of group (low or high) on the four variables. There was a significant effect for group on group competence both pretest and posttest. Means and standard deviations preworkshop for the low and high group respectively were: 3.91(.80) and 4.56 (.60); $F$ (1, 61)=3.32, $p < .01$. Scores postworkshop were 4.23 (.70) and 4.68 (.60); ($F$ (1, 61)=7.466, $p < .01$. There was no significant effect for group on any of the other three variables.

### *Responses to the Interview Questions*

While surveys can supply much insight into teachers' perceptions, surveys are also subject to bias and distortion. Therefore, to enhance the reliability and credibility of this study, interview questions were also asked. Due to space limitations not all interview questions will be discussed. However, the answers to two questions; What is the incentive that motivates you to participate in professional development? and Why don't other teachers you know attend as many professional development activities as you do? were of particular interest. The results of the analysis of those questions follow.

Teachers in general stated that they attended professional development op-

Table 1. Within Group Means and Standard Deviations of all Components for Individual and Collective Efficacy, Pre and Post.

| | | Pre | Post |
|---|---|---|---|
| ***Individual Efficacy*** | | | |
| Personal Competence | low | 4.96 (.66) | 5.40 (.51)* |
| | high | 5.18 (.62) | 5.50 (.37)* |
| Personal Level of Influence | low | 4.26 (.47) | 4.46 (.53) |
| | high | 4.31 (.48) | 4.33 (.58) |
| ***Collective Efficacy*** | | | |
| Group Competence | low | 3.91 (.80) | 4.23 (.70)* |
| | high | 4.56 (.60) | 4.68 (.60) |
| Contextual Influence | low | 3.55 (.99) | 3.70 (.90) |
| high | 4.04 (.96) | 3.91 (1.06) | |

* Significant at the .01 level.

portunities so that they could be better teachers and, as a result, that students could learn more. For example, one 6th-grade teacher said,

> I take these [workshops] for my benefit so I can learn more information to improve teaching. It is important to improve my teaching because I'm not someone who could do the same thing a year after year . . . . I try to make it better for them [students] to learn the concept . . . we are working on or new ideas.

Similarly, a 2nd-grade teacher said, "I like to be a little ahead of the ball game in my building, and if I take these classes I will learn more and I'm going to learn things that I can use with my students to improve their achievement." A 7th-grade teacher said, "I want to give the kids the best education I can!" Whereas a 1st-grade teacher said,

> Everything I do and every class I take, I get one new idea that kind of gets me enthused again about something that I've taught over and over. It gives me a chance to see other approaches that hopefully I can use to catch some kids that aren't getting it.

Teachers in this group also generally believed that their colleagues were not involved in professional development because of other obligations. Along these same lines, they believed that that their colleagues probably felt that they already did a good enough job teaching mathematics and so attending the workshops would be an inefficient use of their free time. For example one 4th-grade teacher said, "Maybe they [teachers not attending] have different commitments, more family commitments." A 3rd-grade teacher noted, "It's because of family obligation and time also other commitments because some teachers have to work in the summer and they just can't do it." Likewise, a 4th-grade teacher said, "For a lot of people it is probably time, kids or a second job. Some people feel they are doing an OK job [teaching mathematics] so they don't care to commit themselves to more development."

## Discussion

A strong sense of efficacy influences teachers' expectations, attributions, and goals. It makes a difference in teacher motivation, which in turn affects how well their students achieve (Bandura, 1997; Goddard, Hoy & Woolfolk Hoy, 2000). This study was conducted with teachers attending two-week summer professional development workshops on mathematics. Additional comparative research using larger samples sizes, different groups, various settings, and a longitudinal approach is needed to definitively answer the initial hypothesis posed. However, with these cautions in mind, we offer some general insights that may be helpful to others interested in teacher efficacy.

Regarding our first hypothesis, pretest scores were relatively high on personal competence for both the low and high group and they improved significantly for each of the groups. Similar to Hoy and Woolfolk (1993) we found that the per-

sonal competence of teachers tends to get stronger as they gain experience and learn more about a domain. Interview data substantiate that the intent of teachers in participating in the workshops was to learn more about mathematics teaching. Teachers who attended these workshops had a mastery orientation. They wanted to improve their mathematics teaching for the benefit of their students and believed that they could. They perceived themselves as capable teachers of mathematics and were interested in learning new ideas, skills, and strategies. Several of the quotes in the response to interview questions address this issue along with this one from a 5th-grade teacher:

> I'm a pretty good math teacher, but I'm always looking for new ways of teaching and ways to get things across better. There are always children you can't reach, but the more I learn, the more ideas I have, and the more opportunities or ways I have to help children.

Another interesting finding regarding group competence was that there was a significant difference pre-to posttest but only for teachers in the low group. The low group's significant increase may be due to the fact that these teachers had the opportunity to work with their colleagues and that this shared time increased their perception of each other's competence. The stigma of working at an underperforming school seemed to be temporarily overcome when teachers worked with colleagues collectively.

There were no significant increases for personal level of influence or contextual influence. This indicates that teachers tended to believe that even though they had become better teachers through participation in professional development, there were still students who they would not be able to affect. The workshops increased teachers' beliefs regarding their actions on student learning but not significantly. Perhaps teachers at the adequately performing school felt their influence or some other factor was already affecting their students, whereas teachers in the low group felt that their personal influence would have little affect on students' learning. This finding leads to insight into teacher expectations. The workshops helped teachers learn new strategies and gain personal efficacy, but they did little to raise teachers' beliefs that their students would achieve. Future professional development in mathematics should not only offer strategies to improve teaching but it should raise teacher expectations as well.

Regarding contextual influence or one's perception of the difficulty of teaching at a particular school, there was no significant difference, and surprisingly scores fell slightly for the high group. It is reasonable that attendance at a workshop would not affect teachers' perceptions related to environment factors related to the school and community in which they teach.

Regarding our second hypothesis, teachers in both groups indicated higher levels of personal competence compared to collective competence. Comments during interviews support the view that high levels of participation in professional development programs increased their Personal Competence for teaching mathematics. However,

a rise in personal competence did little to affect their beliefs of their colleague's competence to operate at a high level and achieve goals. This self-centered perception is interesting and might stem from the fact that they were giving up precious summer free time. The words of one of the participants, an 8th-grade teacher, reinforce this idea, "It takes effort to stretch yourself and it takes sacrifice. It's much easier not to bother to attend summer workshops and continue to do the same old things."

In regard to the third hypothesis we found that teachers in the high group had significantly higher ratings for group competence compared to teachers in the low group. We believe that this effect could indeed by an artifact of the stigma of underperforming. Teachers in the low group were well aware that more than one-third of the schools in their districts had been labeled underperforming, and this knowledge could affect their responses to items such as, "Teachers in my school have what it takes to get children to learn mathematics." The high group was aware that their district was virtually free of underperforming schools. For them, the logical assumption was that teachers are doing a good job.

The workshops attended by the teachers in this study increased their personal competence, presumably by increasing their knowledge of mathematics and mathematics instruction, but they did little to increase teachers' perceptions that they could affect their students' achievement. Data collected in this study are not adequate to answer that question.

Many factors influence the effectiveness of schools as measured by student test scores, which are the basis for classifying schools for the No Child Left Behind legislation. Those factors include (but are not limited to) the community environment, SES of students, accessibility of resources, school level and district level leadership, and quality of teaching. Professional development opportunities can help individual teachers to improve their teaching skills and result in gains in their beliefs of individual efficacy. However, having several teachers from the same school participate in the same professional development may result in "group thinking" that can heighten collective efficacy as well. This conclusion is reiterated in a 7th-grade teacher's words,

> It's important to be with a group you can learn with. It's important to be with other teachers at my school who can help me learn some of the harder concepts. It's best when we see who is strong in what area. That gives us confidence even though our school was underperforming.

Professional development in mathematics has the potential to affect teachers' personal competence whether they work at a low or high performing school. It also has the potential to raise the group competence of teachers in underperforming districts when they come together and work as a team. Raising teachers' beliefs about personal competence and group competence could have a positive effect on student performance. However, they are only part of the answer because personal level of influence and contextual influence also play an important role. Teachers need to

believe in their students and hold high expectations for each and every one. Additionally, unless the negative effects of other related factors, for example, the stigma of underperforming, resources, leadership, and so forth are alleviated, underperforming schools will be hard pressed to improve to acceptable levels. Professional development has the potential to affect teacher efficacy and it does so for some groups of teachers more than others. To raise teachers' efficacy it is important to understand the complexity of teacher efficacy and keep these ideas in mind.

## References


Bandura, (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117-148.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: W. H. Freeman.

Enochs, L., & Riggs, I. (1990). Further development of an elementary science teaching efficacy belief instrument: A pre-service elementary scale. *School Science and Mathematics, 90,* 694-706.

Fullan, M., & Miles, M. (1992). Getting reform right: What works and what doesn't. *Phi Delta Kappan, 13,* 745-752.

Goddard, R. D., Hoy W. K., & Woolfolk Hoy, A. (2000). Collective teacher efficacy: Its meaning, measure, and impact of student achievement. *American Educational Research Journal, 37*(2), 479-507.

Harwell, M., D'Amico, L., Stein, M. K., & Gatti, G. (2000, April). The effects of teachers' professional development on student achievement in Community School District #2. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA.

Hoy, W.K., & Woolfolk, A.E. (1993). Teachers' sense of efficacy and the organizational health of schools. *Elementary School Journal, 93,* 355-372.

Loucks-Horsley, S. & Matsumoto, C. (1999). Research on Professional Development for Teachers of Mathematics and Science: The State of the Scene. *School Science and Mathematics, 99*(5), 258-71.

Miller, E. (1995). The old model of staff development survives in a world where everything else has changed. *The Harvard Educational Letter, 11*(1), 1-3.

Nelson, B. S. (1998). Lenses on Learning: Administrators' Views on Reform and the Professional Development of Teachers. *Journal of Mathematics Teacher Education, 1*(2), 191-215.

Owen, J., Loucks-Horsley, S., & Horsley, D. (1991). Three roles of staff development in restructuring schools. *Journal of Staff Development, 12*(3), 10-14.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and application* (2nd ed.). Upper Saddle River, NJ: Merrill/Prentice-Hall.

Schwahn, C., & Spady, W. (1998). Why change doesn't happen and how to make sure it does. *Educational Leadership, 55*(7), 45-47.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage.

Vacc, N. N., Bright, G. W., & Bowman, A. H. (1998, April). Changing teacher's beliefs through professional development. Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA.

Zimmerman, B.J. (1995). Self-regulated learning and academic achievement: An overview. *Educational Psychologist, 21,* 3-8.