# The Impact of Video Analysis on Teacher Perceptions of Self-Efficacy: An Analysis of Reflections and Self-Ratings

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## Abstract

This study explores pre-service early childhood teachers' efficacy for teaching mathematics. Thirty-eight participants completed the short form of the Teacher Efficacy Scale and the Teacher Beliefs Scale before and after they conducted a clinical interview with a child around a mathematical topic. Results indicated a significant increase in Personal Teaching Efficacy as well as significant changes in beliefs about early childhood mathematics.

## Introduction

"I'm not a math person," is something heard too frequently in U.S. elementary classrooms. Perhaps most troubling is that this sentiment is often held not only by students, but also by their teachers. In fact, there is consistent evidence that most early childhood teachers have limited knowledge of mathematics and of the thinking strategies that children use to learn early childhood mathematics (Clements, Copple, & Hyson, 2002, cited in Tsamir & Tirosh, 2009). As these teachers are responsible for children's first formal exposure to mathematics, this ignorance is problematic and serves as a barrier to high quality (and high quantity) early childhood mathematics instruction.

The National Council of Teachers of Mathematics (NCTM) has called attention to the importance of providing high quality early childhood mathematics instruction, saying that, “Developing a solid mathematical foundation from pre-kindergarten…is essential for every child. In these grades, students are building beliefs about what math is, about what it means to know and do mathematics, and about themselves as mathematics learners. These beliefs influence their thinking about, performance in, and attitudes toward mathematics and decisions related to studying mathematics in later years.” (NCTM, 2000, p. 98) Thus, a critical question is: What can be done to promote high quality early childhood mathematics instruction?

One route to improved early childhood mathematics instruction is through enhancing teachers’ confidence and competence in teaching math. To do this, early childhood teacher training must focus not only on mathematics content and its concomitant pedagogical content knowledge, but also on teachers’ dispositions towards math (Sarama & DiBiase, 2004, cited in Tsamir & Tirosh, 2009), which is referred to as “efficacy” for teaching mathematics. This is an especially important focus in pre-service training because the efficacy of this population has been found to be even lower than the already low efficacy levels found with in-service teachers.

This study examines a potential way of improving early childhood teachers’ efficacy for teaching math. Participants designed and conducted a clinical interview with a child around a mathematical concept. A one-group pre-posttest design was employed in which pre-service teachers’ efficacy for teaching mathematics and their general beliefs about early childhood mathematics were measured before and after the clinical interview experience. The major research question asked whether conducting a clinical interview changes the interviewer’s efficacy for teaching math. Secondarily, this study set out to examine variables that might correspond with this change in efficacy, such as general beliefs about early childhood mathematics instruction. The hypothesis is that carrying out a clinical interview will increase pre-service teachers’ efficacy for teaching math. Furthermore, it is expected that general beliefs about early childhood math will also change as a result of this experience, but that this change will be partly independent of the change in efficacy, demonstrating that efficacy for teaching is a separate construct from general beliefs.

### *Teacher Efficacy*

Bandura (1977) says that teacher efficacy is simply a type of self-efficacy. It is a cognitive process in which teachers construct beliefs about their capacity to perform a given teaching task at a given level. Others have expanded upon this definition by relating beliefs about teaching ability to the outcome of student learning. For example, Guskey and Passaro say that teacher efficacy is "teachers' belief or conviction that they can influence how well students learn, even those who may be difficult or unmotivated" (1994, p. 4, cited in Tschannen-Moran et al., 1998), and Pajares (1996) defines teacher efficacy as the personal belief about one's capabilities to help students learn. Moreover, Tschannen-Moran and her colleagues (1998) argue that teacher efficacy is context-specific in that it is always judged in relation to the available skills and resources required for a specific teaching task. Researchers (e.g., Hoy & Woolfolk, 1993) have also recently differentiated the independent factors of general (GTE) and personal teaching efficacy (PTE). GTE is viewed as teachers' beliefs about the external factors that overwhelm their own power to influence student achievement, while PTE is viewed as teachers' confidence in their abilities as teachers to overcome those external factors that have the potential to interfere with student learning (Tschannen-Moran et al., 1998). As the current study involves an intervention aimed at increasing pre-service teachers' knowledge of how young students learn mathematics (and thereby their ability to teach math to this student population), we are interested in changes in PTE that might occur from this new knowledge.

According to Bandura (1997), teacher self-efficacy should influence the same types of activities that student self-efficacy affects, namely choice of activities, effort, persistence, and achievement. For example, teachers with low self-efficacy may avoid planning activities they believe exceed their capabilities, they may not persist with students who are having difficulties, they may expend little effort to find materials, and they may not re-teach in ways that allow students to better understand the subject matter. Teachers with high self-efficacy, on the other hand, are more apt to develop challenging activities, help students succeed, and persist with students who have problems.

Ashton (1985, cited in Schunk, Pintrich, & Meece, 2008) in fact found evidence to support Bandura's hypotheses. He found that teacher self-efficacy is associated with teachers' choice of instructional activities, the amount of effort expended in teaching, student encouragement, and the degree of teachers' persistence maintained when confronted with difficulties in the classroom. Similarly, teacher efficacy has been linked to teachers' enthusiasm while teaching, commitment to teaching, instructional behaviors and willingness to embrace innovation, resilience in the face of failure, as well as to student outcomes like achievement, student motivation, students' self-efficacy beliefs, and problem solving abilities (Akinsola, 2009). Furthermore, Gibson and Dembo (1984) found that teachers with high self-efficacy are more effective in leading students to correct responses in classroom discussions, and Akinsola (2009) found that high efficacy teachers use a greater variety of instructional strategies and are more likely to use inquiry and student-centered teaching strategies than are low efficacy teachers.

In brief, there are many ways in which teachers' efficacy predicts their teaching behaviors. Teachers with high efficacy are less overtly controlling of student behavior in the classroom (Hoy & Woolfolk, 1990), expend more effort to help students learn, and set challenging goals for their students (Akinsola, 2009), while teachers with low efficacy treat high and low achieving students differently, calling less on low-achieving students, assigning them more busy work, and giving more appropriate praise and feedback to high-achieving students (Ashton & Webb, 1986). In fact, teachers' efficacy is so powerful that students who moved from elementary teachers with high efficacy for teaching math to middle school teachers with low efficacy for teaching math had lower expectancy beliefs about their own math ability than did other students (Midgley et al., 1989).

### *Clinical Interviewing*

As originally developed by Piaget (1976), the clinical interview is a flexible and non-standardized method of inquiry into children's thinking. The interview typically begins with the interviewer communicating a focus on thinking rather than correct responses or evaluation, and then the interviewer poses a specific task or series of questions to the child. Follow up questions and modifications to the initial protocol are then generated according to the child's responses and apparent understandings, and function to probe and challenge the child's convictions. A common question within the clinical interview is: "How did you solve that problem?" (Ginsburg, 1997) During the interview, the interviewer observes very carefully to interpret the students' language, pictures or actions. In fact, the probes and modifications to the original questions or tasks typically arise from these observations. Perhaps obviously, the interviewer must have a deep understanding of the topic of the interview in order to generate appropriate tasks that are complex enough to produce considerable thinking by the child and in order to generate appropriate follow-up questions, anticipating some forms of the child's thinking.

In addition to being an effective technique for probing students' understanding and developing teachers' mathematical content knowledge, the clinical interview has been shown to alter pre-service teachers' ideas about the teaching and learning of mathematics. As a result of developing a deeper understanding of the ways in which children build mathematical ideas, teachers then devise better ways of teaching mathematics (Schorr & Ginsburg, 2000). For example, Schorr and Ginsburg found that prospective teachers became aware of the prevalence and variety of invented strategies among their students when they conducted clinical interviews, and realized that teaching only one mathematical strategy may shut out a method that is more understandable to students. Consequently, these teachers decided they would be more open to the possibility of multiple solution strategies in their classrooms and would attempt to lead discussions around why a particular method might be more appropriate or effective in certain situations than in others.

As teacher efficacy is a significant predictor of student achievement, it appeared worthy of study. This study attempts to enhance teachers' efficacy for teaching mathematics through the completion of a clinical interview hypothesized to improve teaching outcomes in the future. Expecting efficacy to change as a result of conducting a clinical interview seemed appropriate because the strongest source of efficacy is prior performance (Bandura, 1997). In other words, if teachers have a positive prior experience with a student around the mathematical topic to be taught, then perhaps they will feel that their future experiences should also be positive. Similarly, Tschannen-Moran and her colleagues (1998) note that teacher efficacy should rise when students display learning progress. Clinical interviews give children many opportunities to display learning, and may therefore enhance teachers' efficacy for teaching mathematics. Furthermore, teachers' efficacy can increase if they believe they are in control of improving student outcomes in the future, for example by understanding the issues of the teaching and learning situation more fully and having alternative teaching strategies that may address these issues to produce better results. Since preparing for and conducting a clinical interview often provides the interviewer with a new set of teaching strategies, as well as enhanced knowledge of the mathematics and how children understand or misunderstand that content, this is another way for teachers to feel they can be efficacious in teaching math to students. Such a change in efficacy as a result of the clinical interview experience has been supported in prior research (e.g., Schorr & Ginsburg, 2000), which has found that conducting clinical interviews changes pre-service teachers views of teaching and learning.

**Methods**

As mentioned, a one-group pre-posttest design was employed in which pre-service teachers' efficacy for teaching mathematics and their general beliefs about early childhood mathematics were both measured before and after the clinical interview experience. It is important to note, however, that there was no control group for this study. Therefore, this study cannot eliminate threats to internal validity (e.g., maturation, history, regression to the mean, and testing) that might be responsible for the change from pre- to post-test instead of the intervention. Another important caveat is that participants were drawn from a course on the development of mathematical thinking and that the pre-test was conducted just past the mid-point in the semester. Thus, some growth in efficacy is likely to have already occurred from the start of the semester to the pre-test, which cannot be detected in this study. At the same time, this study involves a useful exploration of factors potentially influencing efficacy.

### *Participants*

Students in the Fall 2008 graduate-level course of "The Development of Mathematical Thinking" at Teachers College, Columbia University were recruited to participate in this study. Participation was voluntary, but participants received extra credit in exchange for their participation. Nearly 80% of students participated in the study. All 38 participants were in the early childhood education program and many of them were engaged in their student teaching during the time of the study. Furthermore, approximately half of the students had prior teaching experience, with eight participants having three or more years of teaching experience. As prior teaching experience was not found to interact significantly with efficacy (see Table 1), the results reported below are for all participants as one group.

**Table 1:**
**Regressing Post-Efficacy on Pre-Efficacy, Experience, & Pre-Efficacy X Experience**

**Coefficients[a]**

| Model 1 | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 2.059 | .823 | | 2.501 | .017 |
| PTE_Pre | .554 | .199 | .560 | 2.788 | .009 |
| Experience | .109 | 1.219 | .072 | .089 | .929 |
| Experience X PTE_Pre | .014 | .281 | .041 | .048 | .962 |

a. Dependent Variable: PTE_Post

Aside from the convenience of using pre-service teachers, studying this population has potential benefits. First of all, the more we learn about how teachers develop their classroom practice from their coursework and student teaching experiences, "… the more we are able to construct models or theories of professional growth that will be able to shape the construction of future courses, inform the training and induction of teachers, and serve as guides for action for teacher educators dealing with the complex task of helping student teachers to learn the practice of teaching." (Calderhead & Shorrock, p. 9, cited by Akinsola, 2009) Furthermore, successful interventions should be given to early childhood educators as early in their careers as possible, and this study evaluates the potential of this intervention with educators who, for the most part, have not yet had their own classrooms. Moreover, pre-service early childhood teachers have been found to hold lower self-efficacy beliefs than in-service teachers with regard to classroom instruction and student engagement. Thus, this population is particularly vulnerable to the ill effects of low efficacy for teaching and would benefit from the earliest intervention in this regard.

***Intervention***

As a final assignment in the course on the Development of Mathematical Thinking, students were required to conduct and videotape a clinical interview with a child around his/her thinking and understanding of a particular mathematical concept of the student's choosing. Students first interviewed their subject about their existing ideas on the chosen topic. Then, the students administered a mini-lesson on the topic to the child. Finally, students conducted a closing interview to evaluate whether the mini-lesson promoted the child's understanding of the topic. In this way, the student used the interview as an assessment tool. Students then composed an essay describing the child's knowledge and understanding, using video clips to support their arguments.

Students in the course were able to select a topic of their choosing for this assignment. Fifteen students chose to focus on patterns, 8 students focused on addition and place value, 5 students focused on measurement, 4 students focused on symbols (e.g., the meaning of the equals sign), 3 students focused on shapes, 1 student focused on counting, 1 student focused on multiplication, and 1 student focused on functions. All children who were interviewed were between the ages of 3 and 8 years old.

### ***Measures***

#### *The Teacher Efficacy Scale*

There are several existing measures of teachers' self-efficacy. Most of these measures were only used a couple of times and were not adopted by the research community. For example, the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI; Enochs et al., 2000), which has favorable reliability ($\alpha = 0.88$ for the efficacy subscale and $\alpha = .77$ for the outcome expectancy subscale) and validity results, has had very limited use, mainly due to the subject specificity of the MTEBI. However, two measures have gained more widespread acceptance: the Teachers' Sense of Efficacy Scale (TSES), developed by Tschannen-Moran and Hoy (2001), and the Teacher Efficacy Scale (TES), developed by Gibson and Dembo (1984). Short versions of both of these scales have also been developed, and both have been used with pre-service and in-service teachers. Reliability and validity information, including convergent and discriminant validity, is available for both scales, with values meeting recommended social science standards (Tschannen-Moran & Hoy, 2001), justifying their use in future studies.

The TSES contains items that differentiate between three subsections of efficacy: efficacy in student engagement ($\alpha = 0.87$), efficacy in instructional practices ($\alpha = 0.91$), and efficacy in classroom management ($\alpha = 0.90$). Since this study is concerned with efficacy in instructional practices of teachers, it would make sense to only use this subsection for the study.

But, the authors recommend using all three sections with pre-service teachers because this population tends to distinguish less between these different types of efficacy. Consequently, I decided to use the TES, which has consistently found two independent factors: General Teaching Efficacy ($\alpha = 0.72$) and Personal Teaching Efficacy ($\alpha = 0.84$). As I am primarily interested in PTE, the TES offers greater face validity than the TSES. Items were slightly adapted to be math teaching specific (see Appendix A). Cognitive interviews were conducted to ensure that these minor adaptations did not alter participants' responses to the items. These cognitive interviews entailed asking participants why they chose a particular answer and whether the question was clear. Feedback from cognitive interviews was used to make final adjustments to the items prior to use in the study. Thus, the modified set of items seemed to measure the constructs in question, though the previously reported psychometrics of reliability and validity may vary slightly.

*Teacher Beliefs Scale*

The Teacher Beliefs Scale, developed by Platas (2008a), was used to measure four belief constructs: (1) age appropriateness of math instruction; (2) teacher versus child responsibility for the construction of mathematical knowledge; (3) social-emotional versus academic (specifically mathematical) development as primary goals of preschool education; and (4) teacher comfort in math instruction. The survey consists of 10 questions per construct, for a total of forty questions (see Appendix B). Subjects rate their level of agreement with each statement on a Likert scale from strongly agree to strongly disagree. The Beliefs Scale has proven to have robust Cronbach's alphas, according to the field of education, ranging from .83 to .93. Teachers' levels of experience and education have been shown to be related to the four belief domains assessed (Platas, 2008b).

**Results**

Table 2 provides a summary of all the variables examined in this study. "Pre" refers to pre-test scores while "post" refers to post-test scores. "Locus" refers to beliefs about whether the teacher or the student is the locus of control in the classroom and therefore primarily responsible for mathematics learning in the early childhood classroom. Lower scores on this measure indicate greater agreement that the student rather than the teacher constructs understanding "Age" refers to beliefs about whether mathematics is age appropriate to early childhood. Higher scores on this measure indicate greater agreement that math is age appropriate to preschool. "SE" refers to beliefs about whether social and emotional development is the primary goal of early childhood education or whether academics like mathematics is the primary goal. Higher scores on this measure indicate greater agreement that academics are the primary goal of preschool. "Comfort" refers to beliefs about the participants' comfort teaching early childhood mathematics, and higher scores indicate greater agreement that the participant is comfortable teaching preschool math.

**Table 2: Descriptive Statistics**

| Variable | Mean (Standard Deviation) | Skew (Standard Error) | Kurtosis (Standard Error) |
|---|---|---|---|
| **PTE_Pre** | 4.30 (0.77) | -0.12 (0.38) | -0.61 (0.75) |
| **PTE_Post** | 4.53 (0.76) | -0.10 (0.38) | -0.83 (0.75) |
| **Locus_Pre** | 4.06 (0.65) | -0.72 (0.38)* | 0.56 (0.75) |
| **Locus_Post** | 3.07 (0.65) | 0.76 (0.40)* | 0.94 (0.78) |
| **Age_Pre** | 2.12 (0.68) | -0.03 (0.38) | -0.83 (0.75) |

| | | | |
|---|---|---|---|
| **Age_Post** | 4.92 (0.72) | -0.10 (0.38) | -0.65 (0.75) |
| **SE_Pre** | 2.30 (0.56) | 0.40 (0.39) | -0.34 (0.77) |
| **SE_Post** | 4.68 (0.65) | 0.12 (0.39) | -0.84 (0.77) |
| **Comfort_Pre** | 2.50 (0.82) | 0.11 (0.39) | -0.78 (0.76) |
| **Comfort_Post** | 4.67 (0.76) | -0.23 (0.39) | -0.47 (0.77) |

* $p<.10$

As can be seen, most of the variables had little skew or excess kurtosis and were approximately normally distributed. However, "locus" was moderately negatively skewed in the pre data ($z=1.89$, $p<.10$) while it was moderately skewed in the positive direction in the post data ($z=1.90$, $p<.10$). This means that the pre data had the majority of responses in the upper end of the Likert scale while the post data had the majority of responses in the lower end of the Likert scale. As will be seen, these skews are consistent with the statistically significant change in this variable that occurred over the course of the study. As a result of the non-normal distribution for this variable, a Wilcoxon signed ranks test was used to compare the means from pre- to post-intervention rather than a paired samples t-test, which was used for all other variables.

The primary research question asked whether conducting a clinical interview changes the interviewer's efficacy for teaching math. The hypothesis was that carrying out a clinical interview would increase pre-service teachers' efficacy for teaching math. In this study, we found that personal teaching efficacy did improve significantly ($t=-2.113$, $df=37$, $p<.05$), and that this change was small to medium in size ($d=-0.31$). However, general teaching efficacy did not improve significantly ($t=1.236$, $df=37$, $p=.224$). As the intervention addressed personal rather than general teaching efficacy, this result confirms the hypothesis.

A secondary research question was whether changes in other variables might correspond with this change in efficacy. Specifically, general beliefs about early childhood mathematics instruction were hypothesized to change as a result of the clinical interview experience. This change was expected to be partially independent of the change in efficacy, demonstrating that efficacy for teaching is a separate construct from general beliefs. In fact, beliefs did change. The mean level of agreement that math is age appropriate to preschoolers increased from 2.12 to 4.93 on a 6-point Likert scale. A paired samples t-test indicated that this change was significant ($t=-12.87$, $df=37$, $p<.001$) and that the size of this change was large ($d=-4.00$). Pre-service teachers viewed math as significantly more age appropriate subsequent to their conducting an interview with a child and analyzing it. Furthermore, the mean level of agreement that math should be a primary goal of the preschool classroom increased from 2.29 to 4.72 on a 6-point Likert scale. A paired samples t-test indicated that this change was significant ($t=-12.61$, $df=34$, $p<.001$) and again the size of this change was large ($d=-3.92$). Additionally, the mean level of agreement that students are responsible for constructing math knowledge in the classroom increased. On a 6-point Likert scale in which lower scores indicate greater agreement that the student rather than the teacher constructs understanding, mean levels of agreement changed from 4.06 to 3.07. The Wilcoxon signed ranks test indicated that this change was significant ($Z=-4.18$, $p<.001$) and the size of this effect was moderately large ($d=1.52$). Finally, beliefs about comfort teaching math also increased significantly over the course of the study from a mean score of 2.41 to 4.71 ($t=-9.188$, $df=34$, $p<.001$) on a 6-point Likert scale in which higher scores indicated greater comfort teaching math. This size of this change was also quite large ($d=-2.74$).

After checking that efficacy and belief scores were not significantly correlated (see Appendix C), a $\chi^2$ test of independence was used to determine whether the change in efficacy was partially independent of the change in general beliefs. To do this, participants were categorized as high or low on particular beliefs. The authors of the efficacy and beliefs measures have not defined what qualifies as a high or low score on the measure, even noting that right and wrong answers do not exist and that high or low scores instead indicate different beliefs. Thus, this study used a median split to categorize scores on both scales as high and low scores.

The results (see Table 3) failed to reject the null hypothesis that PTE is independent of each belief construct, indicating that the constructs of efficacy and beliefs are independent. This means that there was not more than the theoretically expected frequency of high efficacy subjects among high or low scorers on a particular belief construct, and similarly that there was not a higher than expected frequency of low efficacy subjects among high or low scorers on a particular belief construct.

**Table 3: $\chi^2$ Test of Independence of PTE and Beliefs**

| | PTE_Pre | Locus_Pre | Age_Pre | SE_Pre | Comfort_Pre |
|---|---|---|---|---|---|
| **Chi-Square** | 0.11 | 0.00 | 0.11 | 0.00 | 0.24 |
| **df** | 1 | 1 | 1 | 1 | 1 |
| **Significance** | p>.05 | p>.05 | p>.05 | p>.05 | p>.05 |

The finding that the general belief about comfort teaching early childhood mathematics and personal teaching efficacy for teaching early childhood math were independent of each other is striking, as beliefs about one's comfort teaching early childhood mathematics were expected to serve as an alternative measure of one's efficacy for teaching mathematics. (It was similarly striking that beliefs about comfort and efficacy were completely uncorrelated.) It thus appears that efficacy is more than just one's comfort teaching math. As Wood and Bandura (1989, cited in Moos & Azevedo, 2009, p. 578) put it, self-efficacy is the "self-perception of one's capabilities to meet situational demands based on current states of motivation, course of actions needed, and cognitive resources." In other words, self-efficacy goes beyond one's comfort to include beliefs about one's ability to perform a task based upon motivation and perceived resources. Thus, examining beliefs, even beliefs about comfort in teaching, will not tap into efficacy and research in this area should view efficacy as an independently important concept.

In addition to the gathering of this quantitative data, clinical interviews were conducted with three of the study participants to further understand the changes that were observed during the study. These interviews were conducted several weeks after the end of the study. Over the course of the these interviews, certain themes began to emerge in regard to the criteria that these pre-service teachers use in determining their beliefs about their own math teaching abilities as well as the experiences and knowledge they would need in order to increase their comfort teaching math. The first major theme was that all participants felt they were not actually prepared to teach math until they were in the classroom and engaged in the act of teaching. For example, one subject said that it was only once she was "forced" to teach math and "couldn't escape it anymore" that she began to feel more able to teach math. Other major themes included: the use of external aids (e.g., lesson objectives) for judging the success of one's teaching; the importance of classroom management in being a successful teacher; the use of (superficial evidence of) student learning as a marker of lesson success; and unfortunately a glaring lack of consideration of children's cognitive development and thinking when evaluating one's ability to be an effective math teacher. As an illustration of the latter two themes, one student noted that she looks at student confusion to see if she did a good job with a lesson, but then explained that she determines student confusion solely based on students' answers to problems she's posed. The interviews suggested that perhaps the pre-service teachers' reliance on student responses or answers on a worksheet without ideas about student strategies or prior understandings in order to determine the success of a lesson might be due to a lack of the pre-service teachers' knowledge of children. In fact, one subject admitted that she is not very able to accurately evaluate if something is too difficult or developmentally appropriate for a child, and another subject admitted to not knowing about alternative strategies that students might use to solve problems.

Fortunately, however, knowledge of children's capabilities was mentioned when the subjects were asked about what they would need in order to feel more successful at teaching mathematics. Importantly, the subjects appeared to view the clinical interview experience as a way of acquiring this knowledge for themselves. Mentions of student thinking were prominent within the context of questioning regarding each participant's clinical interview experience. For example, one participant described how watching the subject of her interview work through various tasks and then questioning the subject about his strategies provided her with knowledge of alternative strategies for solving problems that she was not aware of previously. In this way, the clinical interview experience appears to be empowering to the teachers by providing them with specific knowledge and skills they will need to be effective teachers, and does more than simply provide comfort through experience. Still, the subjects did not seem to integrate these experiences with their beliefs about instruction. For instance, one subject noted the importance of probing students' thinking when discussing her clinical interview experience, but failed to mention any probing or exploration of strategies when discussing her own appraisal of her teaching. Moreover, the subject who had felt unable to judge the difficulty of an assignment when discussing her classroom practice had rated herself as able to do this subsequent to conducting her clinical interview. Thus, the learning that occurred from conducting her interview did not seem to carry over into her teaching.

**Discussion**

This study set out to explore a potential way of enhancing pre-service teachers' efficacy for teaching mathematics, and found that a single experience of conducting a clinical interview with a child around a mathematics topic was enough to produce a statistically significant increase in subjects' efficacy. This promising result suggests that clinical interview experiences are critical to pre-service and in-service professional development experiences.

In addition, this study found that general beliefs about early childhood mathematics education also changed significantly as a result of this single clinical interviewing experience. Each of the four beliefs that were examined changed in the direction desired by current mathematics reformers. That is, math was seen as more age appropriate and as a primary goal of preschool, children rather than teachers were seen as the drivers of learning mathematics, and participants became more comfortable teaching math to preschoolers. Furthermore, these changes were found to be partially independent of the change in teacher efficacy, suggesting that efficacy is a separate entity from general beliefs about early childhood mathematics education.

However, these results must be interpreted with caution due to several key limitations. As already mentioned, the lack of a control group allows for the possibility that the changes that were observed were the result of other factors, such as the participation in the course that students were enrolled in on the development of mathematical thinking. Similarly, there could be a natural "maturation" process for efficacy or general beliefs that pre-service teachers undergo as they progress through their academic program. Furthermore, the short time frame of the study may only capture temporary changes in efficacy and beliefs, and the small, selective sample including only Teachers College students may not accurately represent the population of pre-service teachers. Finally, the fact that the topics of the clinical interviews that students conducted were not standardized may also have impacted the results. Presumably some students chose topics that were more or less comfortable for them and for the students they interviewed, which would likely impact the way they felt about their ability to teach that material.

**Conclusions & Next Steps**

Teachers are crucial change agents in education reform, and teachers' beliefs about themselves and about the content they are teaching are precursors to change. For this reason, additional research should be conducted on what teachers' beliefs are and how they can be changed in a manner conducive to research-based reform.

Efficacy for teaching mathematics is clearly an important topic for additional research. This study can be improved upon by utilizing a larger sample size, a control group, and randomly assigning subjects into a control and experimental group in order to control for extraneous factors that might otherwise mask the results. In addition, future research should explore where teachers' efficacy beliefs come from as well as what teachers define as successful teaching when they evaluate if they are effective teachers. Moreover, it appears that including a measure of knowledge of mathematical development might be important in future research as well since it was found that pre-service teachers often lacked this knowledge and it may have interacted with their efficacy beliefs. Finally, it will be critical to link changes in efficacy to specific instructional changes. That is, what exactly do teachers whose efficacy has increased or decreased change within their instruction?

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**Appendix A: Teacher Efficacy Scale (Short Form)**

A number of statements about organizations, people, and teaching are presented below. The purpose is to gather information regarding the actual attitudes of educators concerning these statements. There are no correct or incorrect answers. We are interested only in your frank opinions. Your responses will remain confidential.

**INSTRUCTIONS: Please indicate your personal opinion about each statement by checking the appropriate box to the left of each statement.**

| Strongly Agree | Moderately Agree | Agree slightly more than Disagree | Disagree slightly more than Agree | Moderately Disagree | Strongly Disagree | |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 1. The amount of math a student can learn is primarily related to family background. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 2. If students aren't disciplined at home, they aren’t likely to accept any discipline. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 3. When I really work at teaching math, I can get through to most difficult students. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 4. A teacher is very limited in what he/she can achieve in teaching math because a student's home environment is a large influence on his/her achievement. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 5. If parents would do more for their children in math, I could do more. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 6. If a student did not remember math information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 7. If a student in my class becomes disruptive and noisy, I feel assured that I know some techniques to redirect him/her quickly. |

| Strongly Agree | Moderately Agree | Agree slightly more than Disagree | Disagree slightly more than Agree | Moderately Disagree | Strongly Disagree | |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 8. If one of my students couldn't do a class math assignment, I would be able to accurately assess whether the assignment was at the correct level of difficulty. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 9. If I really try hard to teach math, I can get through to even the most unmotivated students. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 10. When it comes right down to it, a teacher really can't do much for students' math learning because most of a student's motivation and performance depends on his or her home environment. |

## Appendix B: Teacher Beliefs Scale

Check the box that best describes your agreement/disagreement with the statement (check only one box).

| Strongly Agree | Agree | Somewhat Agree | Somewhat Disagree | Disagree | Strongly Disagree | |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 1. Math is an important part of the preschool curriculum. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 2. It is better to wait until kindergarten for math activities. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 3. Mathematical activities are an inappropriate use of time for preschoolers because they aren't ready for them. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 4. Preschoolers are capable of learning math. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 5. I am knowledgeable enough to teach math in preschool. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 6. Math flashcards are appropriate for preschoolers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 7. Math activities are good opportunities to develop social skills in preschool. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 8. Preschoolers learn mathematics *without* support from teachers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 9. Math activities are a very important part of the preschool experience. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 10. The teacher should play a central role in preschool mathematics activities. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 11. Teaching mathematics to preschools is/would be uncomfortable for me. |

| Strongly Agree | Agree | Somewhat Agree | Somewhat Disagree | Disagree | Strongly Disagree | |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 12. Supporting development in academic subjects such as math is the *primary* goal of preschool education. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 13. Preschoolers learn mathematics *best* through direct teaching of basic skills. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 14. I am unsure how to support math development for young children. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 15. Most preschoolers are ready for participation in math activities. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 16. Social and emotional development is the *primary* goal of preschool and time spent on math takes away from this goal. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 17. Math is/would be a difficult subject for me to teach in preschool. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 18. Teachers can help preschoolers learn mathematics. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 19. In preschool, children should learn *specific* procedures for solving math problems (i.e., 2 + 4). |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 20. Preschool math will weaken preschoolers' self-confidence. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 21. I can think of many math activities that would be appropriate for preschoolers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 22. Children are ready for math activities in preschool. |

| Strongly Agree | Agree | Somewhat Agree | Somewhat Disagree | Disagree | Strongly Disagree | |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 23. In preschool, children construct their mathematical knowledge *without* the help of a teacher. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 24. I don't know enough math to teach it in preschool. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 25. Teachers should help preschool children memorize number facts (for instance, 2 + 3). |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 26. Preschool children are *not* socially or emotionally ready for math activities. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 27. Math would be easy for me to incorporate into preschool curricula. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 28. If a preschool teacher spends time in math activities in the classroom, social and emotional development will be neglected. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 29. Math is confusing to preschoolers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 30. I can create effective math activities for preschoolers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 31. Academic subjects such as mathematics are too advanced for preschoolers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 32. Preschool teachers are responsible for making sure that preschoolers can learn the right answer in mathematics. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 33. Math worksheets are appropriate for preschoolers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 34. I don't know how to teach math to preschoolers. |

| Strongly Agree | Agree | Somewhat Agree | Somewhat Disagree | Disagree | Strongly Disagree | |
|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 35. Mathematical activities are age-appropriate for preschoolers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 36. Teachers should show preschoolers the correct way of doing mathematics. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 37. Very *few* preschoolers are ready for math in preschool. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 38. Before kindergarten, preschool teachers should make sure preschoolers memorize verbal counting numbers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 39. Math is a worthwhile and necessary subject for preschoolers. |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 40. I know how to support math learning in preschool. |

## Appendix C: Correlation Matrix

| | **PTE_Pre** | **Locus_Pre** | **Age_Pre** | **SE_Pre** | **Comfort_Pre** |
|---|---|---|---|---|---|
| **PTE_Pre** | 1.0 | | | | |
| **Locus_Pre** | .13 | 1.0 | | | |
| **Age_Pre** | .14 | -.13 | 1.0 | | |
| **SE_Pre** | .22 | .09 | .82** | 1.0 | |
| **Comfort_Pre** | .02 | -.29 | .68** | .56** | 1.0 |

** Correlation is significant at the .01 level (2-tailed).
* Correlation is significant at the .05 level (2-tailed).