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Effective Difference of Research Projects on Secondary Mathematics Preservice Teachers' Sense of Efficacy

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THE EFFECTIVE DIFFERENCE OF RESEARCH PROJECTS ON SECONDARY MATHEMATICS PRESERVICE TEACHERS' SENSE OF EFFICACY

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The purpose of this quantitative study was to investigate the difference in teacher efficacy measures of two groups of preservice teachers who were given modified research projects and were enrolled in a secondary mathematics methods course. The participants were divided into two groups doing modified research projects related to the field of mathematics education. The modification of research projects were grounded in one of Bandura's (1997) sources of self-efficacy: vicarious experience. Two possible vicarious experiences that inform preservice teachers' sense of teacher efficacy are reading professional literature and watching others teach followed by discussing the results. These two contexts are the basis of the research projects modifications. Data revealed that there were statistically significant differences between the two groups' teacher efficacy measures. Those who did the research project involving observations and discussion of mathematics teaching had significantly higher measures of teacher efficacy over those who did their research purely through professional literature.

Introduction

The engagement and preparation of preservice teachers in the profession is of vital importance since preservice experiences can have significant consequences as graduates face their first five years of teaching. Educators need to examine what experiences are needed, how these experiences are offered, and why they are valuable. The mathematics education community wrestles with higher teacher attrition rates more than other fields (Guarino, Santibanez, & Daley, 2006), with reports of high stress levels among teachers, and with the surge to produce teachers that are highly qualified. One part of solving these widespread difficulties could be determining and implementing ways of engaging preservice teachers that act to increase their teacher efficacy.

Tschannen-Moran, Hoy, and Hoy (1998) report that the research has established a relationship between teacher efficacy and "teachers' classroom behaviors, their openness to new ideas, and their attitudes on teaching. In addition, teacher efficacy appears to influence student achievement, attitude, and affective growth (p. 10)." Furthermore, it has been found that higher levels of teacher efficacy connect to lower levels of teacher stress. Because of this relationship between teacher efficacy and stress, it has been suggested that the education community work to increase teacher efficacy as a solution to stress and teacher burnout (Parkay, Greenwood, Olejnik, & Proller, 1988).

While many relationships have been discovered between teacher efficacy and elements of education, there are very few studies aimed at determining what types of experiences and academic engagements influence the growth in teacher efficacy of preservice teachers. Although studies have been done examining teacher efficacy growth during mathematics methods courses

(Utley, Moseley, & Bryant, 2005), after methods courses (Huinker & Madison, 1997), and before and after clinical and student teaching experiences (Utley et al., 2005; Vinson 1995) there is little research that examines with great specificity what is done during these times in a teacher's development that would promote higher levels of teacher efficacy. While it is known that mathematics methods courses contribute to a preservice teacher's growing sense of teaching efficacy, what elements of those courses contribute most to teacher efficacy? It is important to consider particular preservice teacher experiences and examine the effect on teaching efficacy. This study is a focused examination of the relationship between preservice teachers' efficacy and two types of research assignments given in methods courses.

Literature Review and Theoretical Framework

Teacher efficacy has been defined as the extent to which teachers believe they can strongly influence student achievement and motivation in learning (Ashton, 1985; Tschannen-Moran, Hoy, & Hoy, 1998). For a little more than three decades educational researchers have been working to define the construct of teacher efficacy, clarify its conceptual underpinnings, and measure its relationships. An historical accounting of teacher efficacy understanding follows.

The construct of teacher efficacy has its theoretical beginnings in Rotter's (1966) social learning theory. Rotter's work was the inspiration for a small part of a study done by the Rand Corporation (Armor, Conroy-Oseguera, Cox, King, McDonnell, Pascal, Pauly, & Zellman, 1976) in which they measured teacher efficacy by summing scores of two items on a survey. The first item asked teachers whether environmental and motivational factors of students could be overcome by teachers, as a general group, measuring what is now referred to as general teaching efficacy (GTE). The second item asked, from the first person perspective, about the degree to which the teacher was confident in getting through to the most difficult students, measuring what is now referred to as personal teaching efficacy (PTE). Throughout the 1980's and 1990's teacher efficacy was further influenced by Bandura's social cognitive theory (Bandura 1977, 1986, 1993, 1997).

In 1984, Gibson and Dembo applied Bandura's psychological construct of self-efficacy to the teaching field and foresaw that teachers' sense of efficacy could account for variations in teaching ability. Bandura defined self-efficacy as a person's judgment of how well he or she could perform an action to deal with a situation. He claimed that when one has low self-efficacy, less effort might be given and one will encounter more stress from the demands of having to perform the action. When applied to the act of teaching, efficacy is more specifically thought of as the teacher's beliefs about his or her ability to influence student learning. These beliefs can affect the amount of effort a teacher gives and the amount of stress a teacher encounters.

From these theoretical bases, research on teacher efficacy has been found to have significant influence on teacher practice and student learning (Smith, 1996). Early research found a positive correlation between a teacher's sense of efficacy and whether or not the teacher stayed in the field (Glickman & Tamashiro, 1982), the amount of teacher change and project methods integrated into the classroom from grant workshops teachers attended (Berman, McLaughlin,

Bass, Pauly, Zellman, 1977), a teacher's production of higher measures of student achievement (Allinder, 1995; Ashton & Web, 1986), a teacher's persistence in working with struggling students (Ashton & Webb, 1986; Gibson & Dembo, 1984), and willingness to try innovative curriculum (Guskey, 1988).

As efficacy research grew, evidence and refinements to the construct indicated a necessity to look more closely at the role played by the context and subject matter as well as the appropriate level of specificity for measuring teacher efficacy (Tschannen-Moran et al., 1998). Furthermore, it is important to understand the effects of preservice teacher training on teacher efficacy and what aspects appear to be rigid or malleable in a particular subject domain. Reliable and valid instruments were made in mathematics and science to better investigate subject matter specific teacher efficacy (Enochs & Riggs, 1990; Enochs, Smith, P., & Huinker 2000). Using these content specific instruments researchers have found that preservice teachers' sense of personal efficacy and outcome expectancy increased significantly in science when taking an integrated mathematics/science course while those students in a non-integrated course had no change (Moseley & Utley, 2006). Another study by Utley, Moseley, and Bryant (2005) showed an increase in teaching efficacy as preservice teachers participated in mathematics methods coursework but a slight decline in teaching efficacy by the end of student teaching.

More often than not, research has supported Gibson and Dembo's (1984) prediction that teachers who continue to wrestle with the difficulties of the teaching profession have high measures of general and personal teaching efficacy, while those with low measures do not persist and often leave the profession. Teaching efficacy has been connected with what mathematics the teachers teach and what their students end up learning (Peterson et al., 1989). Furthermore, low teaching efficacy acts as a factor in preservice teachers' reluctance to teach mathematics (Wenner, 2001). Determining what kinds of professionally engaging tasks to give to preservice teachers to allow for growth in their teaching efficacy is important, yet remains under researched. Knowledge about such tasks can inform education programs about better equipping preservice teachers for a longer and more fruitful duration in the profession.

Purpose

Bandura (1986, 1997) suggested four broad categories by which knowledge of the act of teaching and self-perceptions of teaching are constructed. Preservice and in-service teachers use mastery experiences, physiological and emotional states, vicarious experiences, and verbal persuasion to inform self-efficacy beliefs. While all four contribute to preservice teachers developing beliefs of competence for the task of teaching mathematics, *vicarious experiences* were used as the source of comparison for the research tasks in this study. Vicarious experiences are those in which a teacher or preservice teacher is informed about the teaching task by observing others teach, reading professional literature, or engaging in tasks given in teacher education courses. From these experiences preservice teachers develop ideas about what the results of successful teaching look like, what actions lead to successful outcomes, and whether or not they are capable of such actions. These ideas led to the research question: In what kinds of

tasks and vicarious experiences can preservice teachers be engaged that will encourage them to develop a strong sense of personal and general teaching efficacy?

A common vicarious experience given in preservice course work is the assignment of research papers meant to allow preservice teachers to use professional literature to inform themselves about the act of teaching, its measures, and attributes. The purpose of this study is to investigate whether or not there is a difference in the teaching efficacy of two groups of mathematics preservice teachers which were given different research tasks both oriented toward the overcoming of difficult teaching situations.

Method

Participants and Study Sampling

The population of the study was undergraduate students majoring in middle level or secondary mathematics education and attending a university in the mid-south United States. All sixteen (n = 16) participants were enrolled in the same mathematics methods course. The primary investigator served as the instructor in the mathematics course.

Throughout the mathematics methods course the participants were all given the exact same assignments, except one. The assignment of exception was a research project from which participants had two options:

a) *Text-Based Research* - Starting from a literature review on the teaching of mathematics in schools located in urban areas of poverty, each student chose a topic and prepared a paper on how mathematics teachers are best adapting to overcome difficulties encountered in this school context. From this research they discussed actions they would take (and why) to ensure significant mathematics learning in their classroom.
b) *In-Field Research* - Starting from a literature review on the teaching of mathematics in schools located in urban areas of poverty, students designed a set of interview questions for mathematics teachers from which to analyze and produce a paper on how mathematics teachers are best adapting to overcome difficulties encountered in this school context. From this research they discussed actions they would take (and why) to ensure significant mathematics learning in their classroom. For this research the participants missed three days of class to travel out of state to visit, observe, and interact with teachers and students at an urban middle and high school located in an area of poverty. The interview questions were asked by the participants to teachers at the urban school after observations of teaching and interactions with students.

At the beginning of the research task all sixteen participants were asked to brainstorm issues they believed teachers of mathematics in urban areas of poverty might face. From this exercise the participants came up with 27 issues which they put into 5 categories: working with diversity, discouraging truancy and dropping out, motivating teaching strategies, accounting for mathematical deficiencies, and overcoming apathy in the mathematics classroom. Each participant then chose a different topic located within a category to further research, chose two articles in the literature over their topic, and shared the findings with their peers.

All participants were given the opportunity to complete the project as either an in-depth text-based research project or attend the in-field research project. Participants self-selected the way they would complete the project based on their own school schedules and life obligations.

This resulted in eight participants choosing the text-based research paper and the other eight choosing the in-field research. Those doing the in-depth text based research completed an exhaustive study on their topic about what is known about effective teaching in this context and what they would apply to their own teaching and why. Those doing the in-field research worked to create interview questions for mathematics teachers, conduct the interviews, and then analyze the findings for the paper. While both groups of students started from the same set of categories and base literature review, those doing the field research spent additional time learning about interviewing as a research tool.

Urban School Context for In-Field Research

Due to the requirements of the research project a public school in an urban area of poverty was chosen for the research trip. This school was chosen not only for the challenges presented by serving students in urban poverty but also for the history of positive results of its mathematics faculty in dealing with these issues and their high sense of collective efficacy. Participants could use this experience to increase understanding of systemic approaches to overcoming a challenging teaching environment.

The school is an inner-city school located in a metropolitan area of more than 1.2 million residents. The school is located in a section of the city with a historically low economic level as indicated by an 86% free and reduced lunch rate. The ethnic diversity at the school from largest population to lowest is 73% Hispanic, 15% Caucasian, 7% Native American, and 5% African American. The school is noted for its creative scheduling to discourage truancy issues and allow for flexibility in teaching. The school has a creative program to assist highly at-risk students and dropouts in finishing their education and receiving a diploma. The school out-performs its neighboring schools academically by significant margins while at the same time has cut the percentage of dropouts to nearly half the number of students that drop out of neighboring schools.

The faculty at the school has a strong collective teaching efficacy. Educators believe that this is partly the result of the teachers being allowed to participate in decision-making at the school, often receiving positive feedback from peers, and the principals' strong leadership which constantly encourages innovation to push the students to better learn mathematics. The effect of these characteristics is supported by several studies done on teacher efficacy. According to Bandura (1993), how a school performs academically is related to the teacher's collective beliefs in their instructional efficacy in that the stronger the collective belief the greater the results academically. In turn, a school's collective sense of efficacy was shown to be higher when principals were perceived as caring and encouraged innovation (Newmann, Rutter & Smith, 1989). Higher general teaching efficacy occurs when principals inspire a common sense of purpose (Hipp & Bredeson, 1995). Higher personal teaching efficacy has been found among teachers who felt they have influence in school-based decisions (Moore & Esselman, 1992). The school in the context of this study has principals who exhibit these characteristics and a school ecology which nurtures high teacher efficacy.

Teaching Efficacy Instrument

The instrument used in this investigation was the Teacher Efficacy Scale Short Form (Hoy & Woolfolk, 1990). The instrument consists of ten items which can be found in Appendix A.

Respondents rated each item on a six point Likert-scale. On questions 1, 2, 4, 5, and 10 responses were assigned a number from 1 (Strongly Agree) to 7 (Strongly Disagree), whereas the scale for the remaining questions was reversed so that a higher score consistently corresponds to a higher sense of efficacy. Questions 3, 6, 7, 8, and 9 are pooled together to measure personal teaching efficacy (PTE) and the remaining five questions are pooled together to measure general teaching efficacy (GTE). This short form resulted from modifications of Gibson and Dembo's (1984), 30-item measure of teacher efficacy where only 16 of the items produced adequate reliability, further reduced to ten items to eliminate cross loading of PTE and GTE items while still retaining the appropriate measure. Hoy and Woolfolk (1993) used this shortened form and found reliabilities of alpha 0.77 for PTE and 0.72 for GTE.

Results

Minitab was used to generate stacked dot plots; see Figures 1 and 2. The individual responses are separated by personal teaching efficacy and general teaching efficacy and grouped by the two groups of students: those performing the field experience research and those who perform the text based research.

A visual inspection of the plots indicates that three of the graphs have data that is fairly symmetric, but the dot plot of GTE by those with the field experience was somewhat skewed to the left. More importantly, there appears to be a significant difference in the center of the two groups in both GTE and PTE.

Figure 1. GTE Stacked Dot Plots of Individual Responses

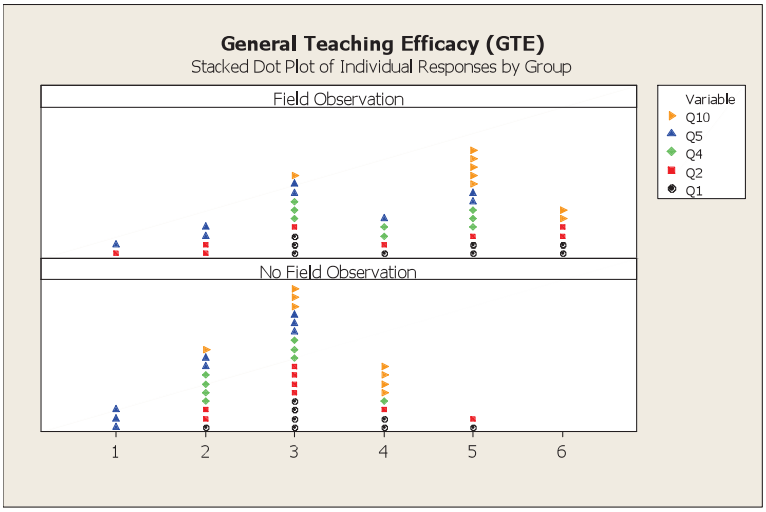
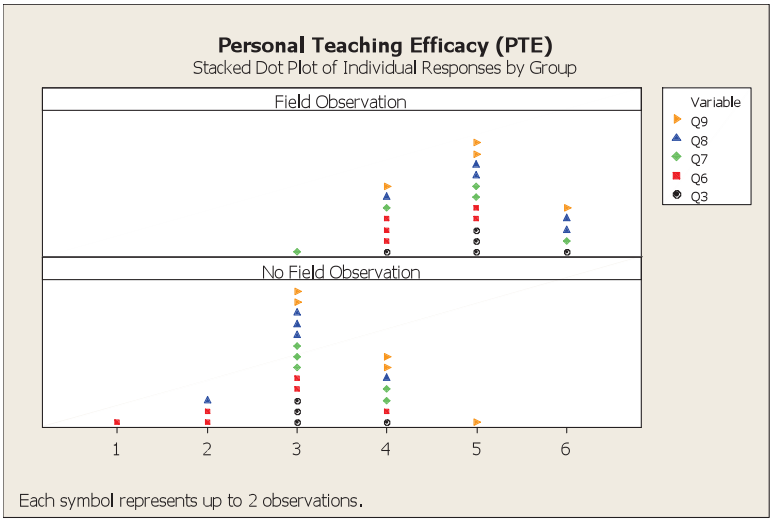


Figure 2. PTE Stacked Dot Plots of Individual Responses



The data was examined further by determining the mean and median for each of the two groups on each individual question and on the GTE and PTE groups of questions. A series of one-tailed *t*-tests were used to compare means. Since the normality requirement of these tests was suspect a series of one-tailed Mann-Whitley tests with correction was performed for ties. This test is used to compare medians and is independent of the underlying distribution. The measurements and *p*-values from these analyses are included in Table 1.

Table 1.

Comparison of Means and Medians of the Groups by Question

Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**GTE**	**PTE**
Mean No Field Experience	3.375	3.125	3.250	2.625	2.000	2.500	3.375	3.125	3.750	3.375	2.900	3.200
Mean With Field Experience	4.375	3.625	5.125	4.000	3.125	4.375	4.750	5.125	5.000	5.000	4.025	4.875
Difference in Means	**1.000**	**0.500**	**1.875**	**1.375**	**1.125**	**1.875**	**1.375**	**2.000**	**1.250**	**1.625**	**1.125**	**1.675**
***t*-test *p* value**	**0.050**	**0.264**	**0.000**	**0.003**	**0.045**	**0.000**	**0.003**	**0.000**	**0.002**	**0.001**	**0.000**	**0.000**
t											**-4.080**	**-9.675**
Median No Field Experience	3.000	3.000	3.000	2.500	2.000	2.500	3.000	3.000	4.000	4.000	3.000	3.000
Median With Field Experience	4.500	3.500	5.000	4.000	3.000	4.000	5.000	5.000	5.750	5.750	4.000	5.000
Difference in Medians	**1.500**	**0.500**	**2.000**	**1.500**	**1.000**	**1.500**	**2.000**	**2.000**	**1.750**	**1.750**	**1.000**	**2.000**
Mann-Whitney Test *p* value	**0.078**	**0.357**	**0.001**	**0.008**	**0.071**	**0.001**	**0.008**	**0.001**	**0.007**	**0.003**	**0.000**	**0.000**

Regardless of the test used the same conclusion was reached. In every case the measured means and medians are higher for the group of preservice teachers who completed the field experience research project. At the a = 0.10 level these differences are statistically significant for the GTE and PTE groups of questions and for each of the individual questions except for question number 2. This data supports the conclusion that the field experience research project had a significant positive effect on both general and personal measures of teacher self-efficacy.

Implications and Discussion

These research outcomes point to possible benefits that might result from intentionally designing programs that engage preservice teacher candidates in ways that increase their personal teaching efficacy and general teaching efficacy. The field of mathematics education has need of training and retaining effective mathematics teachers. The data suggests that, when possible, preparers of preservice teacher programs should incorporate research projects in which preservice teachers engage in and with teachers in highly effective schools that are overcoming considerable challenges. In addition to its potential to raise the preservice teachers' efficacy, it allows for numerous other learning opportunities and attitudinal inspiration.

While there was a significant difference between the efficacies of the preservice candidates who did the in-field research over those who did not do the in-field research, this experience is only one of many vicarious experiences preservice teachers have throughout their course work. Due to the relatively small sample size the mathematics education community could benefit from similar research done by others in various locals.

The preservice teachers who did their research "in the field" tended to have more positive comments about their learning from the assignment. This group of preservice teachers also gave vastly more descriptive reflections about their learning and spoke with more confidence during university research presentations. One of the differences between the two types of research projects involves the idea of "collective efficacy." The group of students who went together to investigate how the teachers at a public school overcame difficulties to teach mathematics to their students bonded in ways that those who worked alone on the text-based project did not. Throughout the field experience trip the preservice teachers had multiple opportunities to discuss findings and share exciting observations.

Another difference in the research projects that might account for the variability of teacher efficacy between the two groups is their physiological and emotional states (Bandura 1997). During the in-field research trip preservice teachers were constantly thrust into various states of emotion as they helped teachers and students, were told success stories by principals, teachers, and students, and became more knowledgeable about societal inequities. At times some of the preservice teachers were exhilarated about something they saw and at other times crying about a story involving a student who overcame great odds. Further research is needed on the role these experiences play, if any, on a preservice teacher's efficacy.

Working to find educational contexts that work to nurture preservice mathematics teachers' sense of efficacy can help teacher education programs form and assess various

experiences that result in better prepared and more confident teachers who are more willing to stay in the field when they encounter difficult situations.

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Appendix A

Teacher Efficacy Scale Short Form (Hoy & Woolfolk, 1990)

1. *The amount 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 try, I can get through to most difficult students.*
4. *A teacher is very limited in what he/she can achieve because a student's home environment is a large influence on his/her achievement.*
5. *If parents would do more for their children, I could do more.*
6. *If a student did not remember 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.*
8. *If one of my students couldn't do a class assignment, I would be able to accurately assess whether the assignment was at the correct level of difficulty.*
9. *If I really try hard, I can get through to even the most difficult or unmotivated students.*
10. *When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his or her home environment.*