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The New York City Teaching Fellows Program: A Case Study in Alternative Certification in Mathematics

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Abstract

The purpose of this study is to understand the mathematical content knowledge new teachers have before and after taking a mathematics methods course in the New York City Teaching Fellows program. Further, the purpose is to understand attitudes toward mathematics Teaching Fellows have over the course of the semester. Findings revealed a significant increase in mathematical content knowledge and positive attitudes toward mathematics. Relationships were found between attitudes and self-efficacy. Finally, Teaching Fellows found that classroom management was the biggest issue in their teaching, and that problem solving and numeracy were the most important topics addressed in the methods course.

Introduction

This study examined two classes of mathematics teachers in the New York City Teaching Fellows (NYCTF) program enrolled in a mathematics methods class in terms of their mathematical content, attitudes toward mathematics, and concepts of teaching self-efficacy. The purpose of this study is to understand what mathematical content knowledge new teachers have both before and after a mathematics methods course, as well as what attitudes these new teachers hold. Further, the purpose is to understand the relationship between teacher attitudes toward mathematics and concepts of self-efficacy. Most studies in alternative certification investigated teacher retention and student achievement as the variables used to determine success. Naturally these are two of the most important variables, but the intention of this study is to investigate other variables related to success such as teacher content knowledge, attitudes toward mathematics, and teacher self-efficacy.

Teacher content knowledge is important since content knowledge is a necessary, but not sufficient, condition for good teaching (Ball, Hill, & Bass, 2005). Attitudes toward mathematics

are important since there is a reciprocal relationship between achievement in mathematics and attitudes toward mathematics (Evans, 2007; Ma & Kishor, 1997). Further, negative teacher attitudes toward mathematics often lead to avoidance of teaching strong mathematical content and affect students' attitudes and behaviors (Amato, 2004; Leonard & Evans, 2007). Poor attitudes toward teaching are directly related to teacher retention issues (Costigan, 2004). Moreover, there has been little published on the effects of field experience on new mathematics teacher content knowledge and attitudes (Evans, 2009; Leonard & Evans, 2008; Philipp et al., 2007). Philipp et al. found that preservice teachers with field experience at the elementary level showed an increase in content proficiency and positive beliefs, while those who did not have field experience did not. This intention of this study is to expand upon the literature by examining the field experience relationship, specifically in-service teaching, with content knowledge and attitudes held by new teachers in an alternative certification program.

The New York City Teaching Fellows (NYCTF) program is an alternative certification program developed in 2000 in conjunction with The New Teacher Project and the New York City Department of Education (NYCTF, 2008; Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2007). The program goal was to recruit professionals from other fields to supply the large teacher shortages in New York City's public schools with quality teachers. At the outset of the program there was a 7000 teacher shortage predicated for fall 2000 with a possible shortage of 25,000 teachers over the next several years (Stein, 2002). Prior to September 2003, New York State allowed for teachers to obtain temporary teaching licenses to help fill the teacher shortage.

Every year Teaching Fellows who will start teaching in September begin graduate coursework in education at one of many New York City universities in mid-June, and they begin student teaching in July. During the summer months Teaching Fellows are given a stipend and

receive subsidized tuition. Their full time teaching assignments begin in September while they continue taking graduate courses in education at their partnering universities. Teaching Fellows who are mathematics deficient at the university in which this study takes place begin their coursework in early June by taking a two-week mathematics content course before the other students arrive, and are thus labeled "Mathematics Immersion." Teaching Fellows who are considered Mathematics Immersion lack the needed 30 credits in mathematics content courses, and subsequently must complete those credits within three years while they earn their master's degree. Before becoming certified, Teaching Fellows first receive a Transitional B license from the New York State Education Department (NYSED) that allows them to teach for three years. Before beginning teaching in September, Teaching Fellows must pass the Liberal Arts and Sciences Test (LAST) and the Content Specialty Test (CST) in mathematics required by New York State. Teaching Fellows generally teach in higher needs schools throughout the city (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006).

The Teaching Fellows program has grown very quickly since its inception in 2000. "Fellows grew from about 1 percent of newly hired teachers in 2000 to 33 percent of all new teachers in 2005" (Boyd, Loeb, Lankford, Rockoff, & Wyckoff, 2007, p. 10). Teaching Fellows currently account for one-fourth of all New York City mathematics teachers and currently there are over 8000 Teaching Fellows teaching in New York City (NYCTF, 2008). The Teaching Fellows program represents the largest alternative certification program in New York (Kane, Rockoff, & Staiger, 2006). In 2008 about 15% of applicants to the Teaching Fellows program were accepted into the program with over 8% of applicants actually entering training in the summer before teaching. The average grade point average in 2008 for new Teaching Fellows was 3.3 (NYCTF, 2008).

A concern with alternative certification is lack of retention, especially in large urban areas such as New York City (Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005). Sipe and D'Angelo (2006) found when surveying Fellows that about 70% of them intended to stay in education. NYCTF reports that 89 percent of Teaching Fellows begin a second year of teaching after the completion of their first year (NYCTF, 2008). Boyd, Grossman, Lankford, Loeb, Michelli, and Wyckoff (2006) reported that about 46% of Teaching Fellows stay in teaching after four years as compared to 55% to 63% of traditionally prepared teachers. Kane, Rockoff, and Staiger (2006) found that Teaching Fellows and traditionally prepared teachers have similar retention rates. Further, Tai, Liu, and Fan (2006) claim that alternative certification teachers, in general, have comparable commitment to the teaching profession as do traditionally trained teachers.

Prior Research in NYCTF

There has been a interest in studying the effects of alternative teacher certification in America's classrooms with a particular interest in teacher quality issues for some time (Darling-Hammond, 1994, 1997; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Decker, Mayer, & Glazerman, 2004; Evans, 2009; Humphrey & Wechsler, 2007; Laczko-Kerr & Berliner, 2002; Raymond, Fletcher, & Luque, 2001; Xu, Hannaway, & Taylor, 2008). Further, there has been specific interest in Teaching Fellows in New York City schools in particular (Boyd, Grossman, Lankford, Loeb, Michelli, & Wyckoff, 2006; Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006; Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2007; Cicchelli & Cho, 2007; Costigan, 2004; Kane, Rockoff, & Staiger, 2006; Stein, 2002). However, most studies investigated teacher retention and student achievement as the variables used to determine teacher quality and success. Naturally these are two of the most important variables, but there is a need to investigate

neglected variables in alternative certification that affect teacher quality such as teacher content knowledge, attitudes toward mathematics, and self-efficacy. Previous research has found that teachers prepared in alternative certification programs, such as the Teaching Fellows program, had, on average, higher content test scores than other teachers (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006; Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2007). However, details about content knowledge have been sparse and there has been a lack of specific focus on secondary mathematics teachers, specifically, in previous research.

Boyd, Grossman, Lankford, Loeb, Michelli, and Wyckoff (2006) studied the various pathways to becoming a teacher in New York City with a particular focus on alternative certification. Like many other researchers, they focused primarily on student achievement and teacher retention as a measure of success. Further, Boyd et al. found that for the first year of teaching teachers prepared through the alternative certification programs had students with slightly smaller achievement gains in mathematics as compared with traditionally prepared teachers. For elementary teachers there were no differences found by the second year between alternatively prepared and traditionally prepared teachers. In middle school, students of Teaching Fellows perform just as well as the students of traditionally prepared teachers. By the third year of teaching, students of Teaching Fellows outperformed students of traditionally prepared teachers. Boyd et al. studied student data in grades 3 to 8 in New York City, which makes this study limited to elementary and middle school years.

Stein (2002) was interested in perceptions held by the Teaching Fellows and surveyed 31 Teaching Fellows at Lehman College in New York. Stein concluded that the Teaching Fellows program is very successful at certifying new teachers. However, 90 percent of the sample said they were considering leaving their high needs schools for better schools in or outside of New

York City, or leaving the teaching profession altogether. Stein addressed another important issue beyond simply teacher retention in the profession of education. That is, there is a difference in teacher retention in the profession and retention in the schools that need these teachers most. Stein found that over one-third of teachers studied considered the prospect of quitting on a daily basis. Similar to results found in other studies (Costigan, 2004; Cruickshank, Jenkins, & Metcalf, 2006; Evans, 2009; Veenman, 1984), teachers were very concerned with student behavioral problems and unsupportive administration.

Like Stein (2002), Costigan (2004) conducted one of the few studies that examined Teaching Fellows' attitudes toward teaching. This is important since teacher attitudes are directly related to teacher retention. Costigan conducted a study in which 38 Teaching Fellows were sampled to gather their written and verbal descriptions of their first year experiences. However, Costigan does not give specific details about these teachers such as their grade levels or content areas. Costigan found that upon entering the program Teaching Fellows generally had "rich beliefs and values about teaching" (p. 133) and appeared very optimistic about making a difference in their students. Teaching Fellows also expressed the common fear of poor student behavior and having uncontrollable classes, as well as poor support from administration. After beginning teaching many Teaching Fellows expressed frustration with the lack of respect they received from their students. Costigan noticed a shift in topic in Teaching Fellows' journals from idealism and optimism to the practical concerns of the everyday classroom. Many Teaching Fellows expressed frustration that the material they learned in their methods courses was not useful for the realities of their own classrooms since the material they were teaching was of a lower level. As the year progressed Teaching Fellows expressed more comfort in the

classroom. By the end of the year the concern appeared to be more about teacher autonomy in the classroom instead of classroom behavioral management issues.

From the literature it is clear that there has been some research conducted, with varying results, on New York City Teaching Fellows' effectiveness as measured by student achievement. However, there have not been any known studies that specifically focused on the combination of mathematics content knowledge and self-efficacy, and very little that substantially addressed attitudes toward mathematics for Teaching Fellows. Further, very few studies focused on mathematics Teaching Fellows particularly. An emphasis on secondary mathematics Teaching Fellows is needed since many studies focused on teachers in elementary and middle schools. Humphrey and Wechsler (2007) called for more research into alternative certification pathways. They say, "Clearly, much more needs to be known about alternative certification participants and programs and about how alternative certification can best prepare highly effective teachers" (p. 512).

Theoretical Framework

Aiken (1970, 1974, 1976) was an early pioneer in researching the relationship between mathematical achievement and attitudes toward mathematics. Like Aiken, Ma and Kishor (1997) found a small but positive significant relationship between achievement and attitudes through meta-analysis. This relationship between achievement and attitudes, along with Ball, Hill, and Bass' (2005) emphasis on the importance of content knowledge for teachers, forms the framework of this study. Additionally, Bandura's (1986) construct of self-efficacy theory frames this study's focus on self-efficacy in Teacher Fellows. Bandura found that teacher self-efficacy can be subdivided into a teacher's belief in his or her ability to teach well, and his or her belief in a student's capacity to learn well from the teacher.

Research Questions

1. What differences exist between Teaching Fellows' mathematical content knowledge before and after a mathematics methods course?
2. What differences exist between Teaching Fellows' attitudes toward mathematics before and after a mathematics methods course?
3. Is there a relationship between Teaching Fellows' attitudes toward mathematics and concepts of self-efficacy?
4. What are Teaching Fellows' attitudes toward teaching and learning mathematics?

Methodology

The methodology of this study is mixed that involves both quantitative and qualitative methods. The sample in this study consisted of 42 new teachers in the Teaching Fellows program with approximately one third are male and two thirds are female. The teachers in this study were selected due to availability and thus represent a convenience sample. The Teaching Fellows in this study were enrolled in a mathematics methods course that involved both pedagogical and content instruction.

Teaching Fellows were given a mathematics content test and two attitudinal questionnaires at the beginning and the end of the semester. The mathematics content test consisted of 25 free response items ranging from algebra to calculus. The mathematics content test taken at the end of the semester was similar in form and content to the one taken at the beginning.

The first attitudinal questionnaire was from Tapia (1996) and had 40 items that measured attitudes toward mathematics including self-confidence, value, enjoyment, and motivation in mathematics. The instrument used a 5-point Likert scale ranging from strongly agree, agree,

neutral, disagree, to strongly disagree. The second attitudinal survey was adapted from the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) developed by Enochs, Smith, and Huinker (2000), and measures concepts of self-efficacy. The MTEBI is a 21-item 5-point Likert scale instrument with choices of strongly agree, agree, uncertain, disagree, and strongly disagree, and is grounded in the theoretical framework of Bandura's self-efficacy theory (1986). Based on the Science Teaching Efficacy Belief Instrument (STEBI-B) developed by Enochs and Riggs (1990), the MTEBI contains two subscales: Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE) with 13 and 8 items, respectively. Possible scores range from 13 to 65 on the PMTE, and 8 to 40 on the MTOE. The PMTE specifically measured a teacher's self-concept of his or her ability to effectively teach mathematics. The MTOE specifically measured a teacher's belief in his or her ability to directly affect student learning outcomes. Enochs, Smith, and Huinker (2000) found the PMTE and MTOE had Cronbach alpha coefficients of 0.88 and 0.77, respectively.

The quantitative data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 15.0. The statistical analyses utilized paired samples and independent samples *t*-tests, and Pearson correlations. Teaching Fellows were also required to keep reflective journals on their teaching and learning over the course of the semester. This provided qualitative data regarding their attitudes toward teaching and learning mathematics. Finally, the final item on the final examination in the mathematics methods class required the Teaching Fellows to state their own position toward teaching mathematics from a traditional back to the basics approach to a reform constructivist approach. They further were required to justify their responses.

Research question one is answered using data collected from the mathematics content test. A paired samples *t*-test was used to determine if any significant increase occurred over the

course of the semester. The results of the data analysis from the attitudinal and self-efficacy instruments were used to answer research question two and three. Paired samples *t*-tests were used to determine any significant attitudinal differences over the course of the semester.

Research question four was answered using qualitative methodology. Teaching Fellows were required to keep journals for both teaching and learning. Teaching journals were used so that teachers could reflect on their own teaching in their classrooms, and learning journals were used so that teachers could reflect on their own learning in the teacher education coursework over the semester. Additionally, Teaching Fellows' responses to the final question of the final examination were used to answer research question four.

Limitations

The major limitation in this study is the role of the teacher-researcher. The instructor in the mathematics methods course was also the researcher in this study. Therefore, consideration must be given for possible bias in student reporting since the students in this study knew that the instructor would be conducting the research for this study. As in all survey research, internal validity issues arise due to student self-report. There is no reason to believe students were not honest in their responses since they were assured that in no way would their responses affect the outcomes in this course. The only issue might pertain to the final item on the final examination since students were graded on the justifications for their positions. Results from this analysis should be interpreted with caution.

Finally, as previously mentioned, the sample in this study consisted of a convenience sample due to availability. This restricts the generalizability of this study. Therefore, it would be beneficial for Teaching Fellows' content knowledge, attitudes toward mathematics, and self-efficacy should be studied with randomly selected larger samples in future research.

Results

To determine internal reliability of the attitudinal instruments, a Cronbach alpha coefficient was found to be 0.93 on the pretest and 0.94 on the posttest for the 40-item attitudinal test. These values are consistent with the literature (Tapia, 1996). For the self-efficacy pretest, Cronbach's alpha was found to be 0.80 for the PMTE and 0.77 for the MTOE, respectively. For the self-efficacy posttest, Cronbach's alpha was found to be 0.82 for the PMTE and 0.83 for the MTOE, respectively. These values are fairly consistent with the values found by Enochs, Smith, and Huinker (2000).

The first research question was answered using the 25-item mathematics content test, and data were analyzed using a paired samples *t*-test. The results of the paired samples *t*-test (two-tailed) revealed a statistically significant difference between pretest scores ($M = 74.79$, $SD = 17.605$) and posttest scores ($M = 84.48$, $SD = 14.225$) for the mathematics content test with $t(41) = -6.002$, $p = 0.000$, $d = 0.86$. This means there was a statistically significant increase in content knowledge as measured by the 25-item mathematics content test over the course of the semester. Additionally, there was a large effect size.

The second research question was answered using the 40-item attitudinal test. Data were analyzed using a paired samples *t*-test. The results of the paired samples *t*-test (two-tailed) revealed a statistically significant difference between pretest scores ($M = 3.25$, $SD = 0.373$) and posttest scores ($M = 3.33$, $SD = 0.410$) for the mathematics content test with $t(41) = -2.041$, $p = 0.048$, $d = 0.20$. This means there was a statistically significant increase in positive attitudes toward mathematics as measured by the 40-item attitudinal test over the course of the semester. However, the effect size was small.

Pearson correlations were used to answer research question three. It was found that there was a statistically significant correlation between pretest mathematics attitude scores ($M = 3.25$, $SD = 0.373$) and pretest PMTE scores ($M = 2.90$, $SD = 0.435$) with $r = 0.690$, $n = 42$, and $p = 0.000$. Additionally, it was found that there was a statistically significant correlation between posttest mathematics attitude scores ($M = 3.33$, $SD = 0.410$) and posttest PMTE scores ($M = 2.94$, $SD = 0.486$) with $r = 0.491$, $n = 42$, and $p = 0.001$. No correlation was found between mathematics attitude scores and MTOE scores.

The fourth research question was answered using Teaching Fellows' teaching and learning journals and their responses to the final item on the final examination. For the frequency of topics addressed by Teaching Fellows in their teaching and learning journals, see Tables 1 and 2. Analysis of the teaching journals revealed that the most commonly addressed topic was classroom management. However, several Teaching Fellows mentioned that classroom management was not as much an issue as they thought it would be. Overall most of the Teaching Fellows believed that classroom management issues were of their highest concern (note that in Table 1 the 28 students who mentioned classroom management as an issue did so because classroom management was difficult for them; the several students who said classroom management was not a problem were not included). Two Teaching Fellows were physically threatened by students, which was of great concern for both of them. One student felt that she was unprepared to deal with the classroom management issues that she encountered. Unsurprisingly, student motivation and attendance issues were the next most frequently mentioned topics. Further, students' lack of basic skills, collaborative learning in the classroom, time management issues, and student lack of conceptual understanding were issues that were frequently mentioned in the teaching journals.

Analysis of the learning journals revealed that the most commonly addressed topics were problem solving and numeracy. The mathematics methods course was taught from a problem solving perspective in line with the National Council of Teachers of Mathematics (NCTM) *Principles and Standards for School Mathematics* (NCTM, 2000). Teaching Fellows were given a "problem of the day" problem solving situation that they were to solve in groups at the beginning of each class. Problem solving as a way of teaching was thoroughly addressed in the course with considerable time devoted to problem solving in the mathematics classroom. It should be noted that one student stated that even though he enjoyed the problem solving aspect of the course, he felt that too much time may have been spent on addressing problem solving. Further, in addition to the mathematics methods textbook (Posamentier, Smith, & Stepelman, 2006), Teaching Fellows read Paulos' *Innumeracy: Mathematical Illiteracy and its Consequences* (1990). In this book Paulos addressed what it means to be numerate (i.e. mathematically literate) in a democratic society. Furthermore, microteaching and motivation techniques were topics that many Teaching Fellows thought enhanced their learning in the course. Every Teaching Fellow was required to present a brief microlesson that contained a motivator to get students interested. Many Teaching Fellows found observing other teachers teach to be a very valuable aspect of this course. Since many teachers felt they had trouble motivating their students, many felt that microteaching and general motivational techniques covered in this course were helpful. Other common areas addressed in the learning journals were technology and manipulatives, differentiation in teaching, standards, questioning techniques, assessment, and real world connections. One student mentioned that at times the course was more theoretical and less practical than she would have liked, something that was also found in the literature (Costigan, 2004).

On the final question of the final examination for the methods course, Teaching Fellow responses regarding their teaching philosophy were ranked as either traditional, moderate, or reform. Teaching Fellows were graded based upon their justification for their positions. Five Teaching Fellows had traditional views, 23 had moderate views, and 14 had reformed views. However, there was some overlap of the teachers' views. Of the five traditional oriented Teaching Fellows, one stated that he could understand other views, but held to the traditional view of teaching. Of the 23 moderate oriented Teaching Fellows, two stated that they could understand the traditional view of teaching. Further, four said they could understand the reform approach. One of those four in particular said that she could better understand the reform approach since taking the methods course. Of the 14 reform oriented Teaching Fellows, five said they could understand the moderate approach. An additional student said she could understand why a teacher would lean toward the traditional approach despite feeling that she is a believer in reform based methods.

Discussion

It was found that Teaching Fellows increased their mathematical content knowledge over the course of a one semester mathematics methods course while teaching in the own classrooms. Additionally, it was found that Teaching Fellows had an increase in positive attitudes toward mathematics over the course of the semester.

A positive correlation was found between Teaching Fellows' attitudes toward mathematics and PMTE scores for both pre and posttests. However, no relationship was found for attitudes toward mathematics and MTOE. This is consistent with the literature (Swars, Daane, & Giesen, 2006) when comparing mathematics anxiety with self-efficacy using the

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI). Mathematics anxiety has been shown to be related to attitudes toward mathematics (Ma, 1999).

Finally, it was found that Teaching Fellows generally found that classroom management was the biggest issue in their teaching, and that problem solving and numeracy were the most important issues addressed in the methods course. It was not surprising that teachers found classroom management as the biggest issue in their teaching journals and this is consistent with the literature for new teachers (Cruickshank, Jenkins, & Metcalf, 2006; Veenman, 1984). However, it was surprising that several teachers found classroom management to be not as much an issue as was previously anticipated. This is in contrast to contrary findings with Teach for America (TFA) alternative certification (Evans, 2009), in which classroom management was exclusively problematic. Finally, it was expected that teachers would find problem solving and numeracy to be two of the most valuable issues addressed in the course since there was a strong emphasis placed on both in the course.

It is hoped that there will continue to be more studies at the secondary level on alternative certification, specifically in the New York City Teaching Fellows (NYCTF) program. Understanding teachers' mathematics content knowledge and their attitudes toward the subject is important for professors of education to guide teacher educator instruction as well as provide much needed support for new teachers. Considering the ever increasing pool of New York City mathematics teachers who enter the profession through the Teaching Fellows program, it is imperative to understand their mathematics content knowledge, attitudes toward mathematics, and their concepts of self-efficacy. Further, considering the rise in alternative certification programs throughout the United States, studying these three areas of concern for new teachers is of great importance. This has a direct impact on the many urban students who receive these new

teachers in their classrooms. Given the field's rhetoric regarding equity and social justice, more studies are necessary on this unique group of teachers who teach urban students.

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Table 1

Analysis of Teaching Journals

Topic	Frequency by Teachers
Classroom Management Issues	28
Student Motivation for Learning and Attendance	14
Standardized State Examinations	12
Lack of Basic Skills	9
Collaborative Learning	8
Time Management Issues	8
Lack of Student Conceptual Understanding	7
Homework issues	5
Unsupportive Administration	5
Constructivism	5
Mathematics Anxiety	2

Table 2

Analysis of Learning Journals

Topic	Frequency by Teachers
Problem Solving	27
Numeracy	25
Microteaching	23
Motivation Techniques	21
Technology and Manipulatives	18
Differentiation in Teaching	14
Standards	13
Questioning Techniques	9
Assessment	9
Real World Connections	8
Literacy in Mathematics	5
Reflective Teaching	5
Social Justice	3
Conceptual Mathematical Understanding	3
Literature Critiques	1