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Secondary Mathematics Teacher Differences: Teacher Quality and Preparation in a New York City Alternative Certification Program

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Providing students in urban settings with quality teachers is important for student achievement. This study examined the differences in content knowledge, attitudes toward mathematics, and teacher efficacy among several different types of alternatively certified teachers in a sample from the New York City Teaching Fellows program in order to determine teacher quality. Findings revealed that high school teachers had significantly higher content knowledge than middle school teachers; teachers with strong mathematics backgrounds had significantly higher content knowledge than teachers who did not have strong mathematics backgrounds; and mathematics and science majors had significantly higher content knowledge than other majors. Further, it was found that mathematics content knowledge was not related to attitudes toward mathematics and teacher efficacy; thus, teachers had the same high positive attitudes toward mathematics and same high teacher efficacy, regardless of content ability.

In fall 2000, New York City faced a predicted shortage of 7,000 teachers and the possibility of a shortage of up to 25,000 teachers over the following several years (Stein, 2002). In response to these shortages the New Teacher Project and the New York City Department of Education formed the New York City Teaching Fellows (NYCTF) program (Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2007; NYCTF, 2008). The program, commonly referred to as Teaching Fellows, was developed to recruit professionals from other fields to fill the large teacher shortages in New York City's public schools with quality teachers.

The Teaching Fellows program allows career-changers, who have not studied education as undergraduate students, to quickly receive provisional teacher certification while taking graduate courses in education and teaching in their own classrooms. Teaching Fellows begin graduate coursework at one of several New York universities and begin student teaching in the summer before they start independently teaching in September. Those who lack the 30 required mathematics course credits are labeled Mathematics Immersion, and must complete the credits within three years, while those with the minimum 30 required credits are labeled Mathematics Teaching Fellows. Prior to teaching in September, Teaching Fellows must pass the Liberal Arts and Sciences Test (LAST) and the mathematics Content Specialty Test (CST) required by the New York State Education Department (NYSED) for teaching certification. Teaching Fellows receive subsidized tuition, earn a one-year summer stipend in their first summer, and are eligible to receive full teacher salaries when they begin teaching. Over the next several years Teaching Fellows continue taking graduate coursework while teaching in their classrooms with a Transitional B license from the NYSED that allows them to teach for a maximum of three years before earning Initial Certification.

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The Teaching Fellows program has grown very quickly since its inception in 2000. According to Boyd et al. (2007), Teaching Fellows "grew from about 1% of newly hired teachers in 2000 to 33% of all new teachers in 2005" (p. 10). Currently, Teaching Fellows account for 26% of all New York City mathematics teachers and a total of about 8,800 teachers in the state of New York (NYCTF, 2010). Of all alternative certification programs in New York, the Teaching Fellows program is the largest (Kane, Rockoff, & Staiger, 2006).

There has been concern that teachers prepared in alternative certification programs are lower in quality than those prepared in traditional teacher preparation programs (Darling-Hammond, 1994, 1997; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Laczko-Kerr & Berliner, 2002); thus measures of teacher quality are of particular concern to the Teaching

Fellows Program, New York State policymakers, and other states implementing and evaluating alternative certification programs.

Teacher Quality

Teacher quality is one of the most important variables for student success (Angle & Moseley, 2009; Eide, Goldhaber, & Brewer, 2004). In this study three variables that indicate teacher quality were analyzed: content knowledge, attitudes toward mathematics, and teacher efficacy.

The National Council of Teachers of Mathematics (NCTM, 2000) defined highly qualified mathematics teachers as teachers who, in addition to possessing at least a bachelor's degree and full state certification, "have an extensive knowledge of mathematics, including the specialized content knowledge specific to the work of teaching, as well as a knowledge of the mathematics curriculum and how students learn" (p. 1). NCTM recommends that high school mathematics teachers have the equivalent of a major in mathematics, commonly understood in New York to be at least 30 credits of calculus and higher. For middle school teachers NCTM recommends that mathematics teachers have at least the equivalent of a minor in mathematics. The NYSED requires both high school and middle school mathematics teachers to have at least 30 credits in mathematics.

Researchers have supported the notion that strong mathematical content knowledge is essential for quality teaching (Ball, Hill, & Bass, 2005; Ma, 1999; NCTM, 2000). Teachers prepared in alternative certification programs, such as the Teaching Fellows program, have on average higher content test scores than other teachers (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006; Boyd et al., 2007). While these findings are encouraging, there has been a lack of concentrated focus on the content knowledge of secondary mathematics teachers specifically. Building on this position, this study examined the content knowledge of the Teaching Fellows with teacher content knowledge defined for this study to be the combination of knowledge, skills, and understanding of mathematical concepts held by teachers.

Despite strong academic credentials (Kane et al., 2006), few differences are found between the mathematics achievement levels of students of Teaching Fellows and traditionally prepared teachers in grades 3 to 8 (Boyd, Grossman, Lankford, Loeb, Michelli, & Wyckoff , 2006; Kane et al., 2006), but, after several years of teaching experience, the students of Teaching Fellows outperform the students of traditionally prepared teachers in academic achievement (Boyd, Grossman, Lankford, Loeb, Michelli, & Wyckoff , 2006). However, very few studies have focused on Teaching Fellows who teach mathematics in particular, and an emphasis on secondary mathematics Teaching Fellows is needed because much of the existing research has focused on teachers in elementary schools only.

Teacher quality typically addresses content and pedagogical knowledge, but examining teacher attitudes is also important. Previous studies have shown that attitudes in mathematics have a positive relationship with achievement in mathematics for students (Aiken, 1970, 1974, 1976; Ma & Kishor, 1997), which may translate to teachers as well. Attitudes toward mathematics are defined for this study as the sum of positive and negative feelings toward mathematics in terms of self-confidence, value, enjoyment, and motivation held by teachers. Amato (2004) found that negative teacher attitudes can affect student attitudes. Trice and Ogden (1986) found that teachers who had negative attitudes toward mathematics often avoided planning mathematics lessons. Charalambous, Panaoura, and Philippou (2009) called for teacher educators to actively work to improve teachers' attitudes.

Like teacher attitudes, teacher efficacy is a strong indicator of quality teaching (Bandura, 1986; Ernest, 1989). Teachers with high efficacy, defined as a teacher's belief in his or her ability to teach well and belief in the ability to affect student learning outcomes (Bandura, 1986), are more student-centered, innovative, and exhibit more effort in their teaching (Angle & Moseley, 2009). Additionally, teachers with high efficacy are more likely to teach from an inquiry and student-centered perspective (Czerniak & Schriver, 1994), devote more time to instruction (Gibson & Dembo, 1984; Soodak & Podell, 1997), and are more likely to foster student success and motivation (Angle & Moseley, 2009; Ashton & Webb, 1986; Haney, Lumpe, Czerniak, & Egan, 2002). Mathematics anxiety is one hurdle in building efficacy in teachers: Teachers with higher mathematics anxiety were found to believe themselves to be less effective (Swars, Daane, & Giesen, 2006).

Research in Alternative Certification

Concern about alternative teacher certification programs has led to an interest in studying the effects of these programs in U.S. classrooms, particularly in terms of teacher quality issues (Darling-Hammond, 1994, 1997; Darling-Hammond et al., 2005; Evans, 2009, in press; Humphrey & Wechsler, 2007; Laczko-Kerr & Berliner, 2002; Raymond, Fletcher, & Luque, 2001; Xu, Hannaway, & Taylor, 2008). Many recent studies examining the Teaching Fellows in New York schools focus on teacher retention and student achievement as variables to determine success. Though these variables are important (Boyd, Grossman, Lankford, Loeb, Michelli, & Wyckoff, 2006; Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006; Boyd et al., 2007; Kane, et al., 2006; Stein, 2002), there is also a need to investigate other variables related to success, such as teacher content knowledge, attitudes toward mathematics, and teacher efficacy because these variables can affect student learning outcomes (Angle & Moseley, 2009; Ball et al., 2005; Bandura, 1986; Ernest, 1989). Few studies have examined the relationship between mathematical content knowledge and teacher efficacy. Those that exist have examined preservice teacher content knowledge and efficacy for traditionally prepared teachers (i.e. Swars et al., 2006; Swars, Hart, Smith, Smith, & Tolar, 2007).

Researchers have called for a strong academic coursework component for alternative certification teachers (Suell & Piotrowski, 2007), yet little is known about the knowledge and skills that these teachers already possess on entering the program. In order to most effectively use limited teacher training resources, policymakers need more research in this area. Humphrey and Wechsler (2007) noted, “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

The theoretical framework of this study is based upon the positive relationship between mathematical achievement and attitudes found in students (Aiken, 1970, 1974, 1976; Ma & Kishor, 1997), the need for strong teacher content knowledge (Ball et al., 2005), and teaching efficacy theory (Bandura, 1986). Bandura found that teacher 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. Teachers who feel that they cannot effectively teach mathematics and affect student learning are more likely to avoid teaching from an inquiry and student-centered approach (Angle & Moseley, 2009; Swars et al., 2006).

Purpose of the Study and Research Questions

This study is a continuation of a previous study (Evans, in press) that examined changes in content knowledge, attitudes toward mathematics, and the teacher efficacy over time of new teachers in the Teaching Fellows program. The previous study found that Teaching Fellows increased their mathematical content knowledge and attitudes over the course of the semester-long mathematics methods course while teaching in their own classroom. They also held positive attitudes toward mathematics and had high teacher efficacy both in terms of their ability to teach well and their ability to positively affect student outcomes. The focus of the present study is finding differences in the various categories of Teaching Fellows across these three variables.

Teacher quality is an important concern in teacher preparation (Eide et al., 2004), and particularly for mathematics teachers of high-need urban students (Ball et al., 2005). The purpose of this study was to determine differences in these variables among different categories of alternative certification teachers in New York City. Determining these differences is important for two reasons. First, it is important for teacher recruitment. If policy makers, administrators, and teacher educators know which teacher characteristics lead to the highest levels of content knowledge, attitudes, and efficacy, recruitment can be better focused. Second, it is important for teacher preparation. Knowing which teachers need the most support, and in which areas, can lead to increased teacher quality through better preparation and focused professional development. This study addresses the following research questions:

1. Are there differences in mathematical content knowledge, attitudes toward mathematics, and teacher efficacy between middle and high school Teaching Fellows?
2. Are there differences in mathematical content knowledge, attitudes toward mathematics, and teacher efficacy between Mathematics and Mathematics Immersion Teaching Fellows?
3. Are there differences in mathematical content knowledge, attitudes toward mathematics, and teacher efficacy between undergraduate college majors among the Teaching Fellows?
4. Is mathematical content knowledge related to attitudes toward mathematics and teacher efficacy?

The first three research questions addressed the differences that existed among types of teachers in content knowledge, attitudes toward mathematics, and teacher efficacy. These questions are important because it is imperative that policy makers, administrators, and teacher educators determine teacher quality for those who will be teaching mostly high-need urban students. In this study "high-need" refers to urban schools in which students are of lower socio-economic status, have low teacher retention, and lack adequate resources. The fourth research question involved synthesizing the results of the first three questions to generate further implications.

Methodology

This study employed a quantitative methodology. The sample consisted of 42 new teachers in the Teaching Fellows program (N = 30 Mathematics Immersion and N = 12 Mathematics Teaching Fellows) with approximately one third of the participants male and two thirds of the participants female. The teachers in this study were selected due to availability and thus represented a convenience sample with limited generalizability. The Teaching Fellows in this study were enrolled in two sections of a mathematics methods course, which involved both pedagogical and content instruction in the first semester of their program. These sections, taught by the author, focused on constructivist methods with an emphasis on problem solving and real-world connections in line with NCTM *Standards* (2000).

Teaching Fellows completed a mathematics content test and two questionnaires at the beginning and end of the semester. The mathematics content test consisted of 25 free-response items ranging from algebra to calculus and was designed to measure general content knowledge. The mathematics content test taken at the end of the semester was similar in form and content to the one taken at the beginning. Prior to their coursework and teaching, the Teaching Fellows take the Content Specialty Test (CST). CST scores were recorded as another measure of mathematical content knowledge. The scores range from 100 to 300, with a minimum state-mandated passing score of 220. The CST consists of multiple-choice items and a written assignment and has six sub-areas: Mathematical Reasoning and Communication; Algebra; Trigonometry and Calculus; Measurement and Geometry; Data Analysis, Probability, Statistics and Discrete Mathematics; and Algebra Constructed Response. Data from the CST were analyzed to validate findings suggested by the mathematics content test.

Attitudes toward mathematics were measured by a questionnaire designed by Tapia (1996) that has 40 items measuring characteristics such as self-confidence, value, enjoyment, and motivation in mathematics. The instrument uses a 5-point Likert scale of *strongly agree*, *agree*, *neutral*, *disagree*, to *strongly disagree*. Teacher efficacy was measured by a questionnaire adapted from the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) developed by Enochs, Smith, and Huinker (2000). The MTEBI is a 21-item 5-point Likert scale instrument with the same choices as the attitudinal questionnaire. It is grounded in the theoretical framework of Bandura's 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. Higher scores indicated better teacher efficacy. The PMTE specifically measures a teacher's concept of his or her ability to effectively teach mathematics. The MTOE specifically measures a teacher's belief in his or her ability to directly affect student-learning outcomes. Enochs et al. (2000) found the PMTE and MTOE had Cronbach α coefficients of 0.88 and 0.77, respectively.

Research questions one and two were answered using independent samples t-tests on data collected from the 25-item mathematics content test, CST, 40-item attitudinal test, and 21-item MTEBI with two subscales. Research question three was answered using one-way ANOVA on data also collected from the same instruments. In this study there was a mix of middle school and high school teachers in the Mathematics and Mathematics Immersion programs. For the third research question Teaching Fellows were divided into three categories based upon their undergraduate college majors: liberal arts, business, and mathematics and science majors. Liberal arts majors consisted of majors such as English, history, Italian, philosophy, political science, psychology, sociology, Spanish, and women studies. Business majors consisted of majors such as accounting, business administration and management, commerce, economics, and finance. Mathematics and science majors consisted of majors such as mathematics, engineering, and the sciences (biology and chemistry). Research question four was answered through Pearson correlations with the same instruments used in the other research questions.

The data were analyzed using the Statistical Package for the Social Sciences (SPSS), and all significance levels were at the 0.05 level. Teachers were separated by teaching level (middle and high school), mathematics credits earned (Mathematics and Mathematics Immersion), and undergraduate major (liberal arts, business, and mathematics and science majors) in order to determine differences between the different types of mathematics teachers sampled to determine teacher quality.

Results

To determine internal reliability of the attitudinal instruments, it was found that the Cronbach α coefficient was 0.93 on the pretest and 0.94 on the posttest for the 40-item attitudinal test. For the efficacy pretest, α = 0.80 for the PMTE α = 0.77 for the MTOE. For the efficacy posttest, α = 0.82 for the PMTE and α = 0.83 for the MTOE, respectively. These values are fairly consistent with the literature (Enochs et al., 2000; Tapia, 1996).

The first research question was answered using independent samples *t*-tests comparing middle and high school teacher data using responses on the mathematics content test, CST, attitudinal test, and MTEBI with two subscales: PMTE and MTOE. There was a statistically significant difference between middle school teacher scores and high school teacher scores for the mathematics content pretest, posttest, and CST (see Table 1). Thus, high school teachers had higher content test scores than middle school teachers, and the effect sizes were large. There were no statistically significant differences found between middle and high school teachers on both pre- and posttests measuring attitudes toward mathematics and teacher efficacy beliefs.

Table 1
Independent Samples t-Test Results on Mathematics Content Tests by Level

Assessment	Mean	SD	*t*-value	*d*-value
Mathematics Content Pre-Test				
Middle School (*N* = 26)	68.42	15.600	-3.334**	1.056
High School (*N* = 16)	85.13	16.041		
Mathematics Content Post-Test				
Middle School (*N* = 26)	79.46	15.402	-3.230**	1.112
High School (*N* = 16)	92.63	6.582		
Mathematics CST				
Middle School (*N* = 26)	255.31	20.372	-2.283*	0.741
High School (*N* = 16)	269.25	17.133		

$N = 42$, $df = 40$, two-tailed
* $p < 0.05$
** $p < 0.01$

The second research question was answered using independent samples *t*-tests comparing Mathematics Immersion and Mathematics Teaching Fellows data using the mathematics content test, CST, attitudinal test, and MTEBI with two subscales: PMTE and MTOE. There was a statistically significant difference between Mathematics Immersion Teaching Fellows' scores and Mathematics Teaching Fellows' scores for the mathematics content pretest, posttest, and CST (see Table 2). Thus, Mathematics Teaching Fellows had higher content test scores than Mathematics Immersion Teaching Fellows, and the effect sizes were large. There were no statistically significant differences found between Mathematics and Mathematics Immersion Teaching Fellows on both pre- and posttests measuring attitudes toward mathematics and teacher efficacy beliefs.

Table 2
Independent Samples t-Test Results on Mathematics Content Tests by Background

Assessment	Mean	SD	*t*-value	*d*-value
Mathematics Content Pre-Test				
Mathematics Teaching Fellows (*N* = 12)	89.50	7.868	-4.005**	1.555
Mathematics Immersion (*N* = 30)	68.90	17.008		
Mathematics Content Post-Test				
Mathematics Teaching Fellows (*N* = 12)	94.33	7.390	-3.130**	1.202
Mathematics Immersion (*N* = 30)	80.53	14.460		
Mathematics CST				
Mathematics Teaching Fellows (*N* = 12)	276.33	16.104	-3.636**	1.277
Mathematics Immersion (*N* = 30)	254.33	18.291		

$N = 42$, $df = 40$, two-tailed
** $p < 0.01$

The third research question was answered using one-way ANOVA comparing different undergraduate college majors using the mathematics content test, CST, attitudinal test, and MTEBI with two subscales: PMTE and MTOE. Teaching Fellows were grouped according to their undergraduate college major. Three categories were used to group teachers: liberal arts (*N* = 16), business (*N* = 11), and mathematics and science (*N* = 15) majors. The results of the one-way ANOVA revealed statistically significant differences between undergraduate major area for the mathematics content pretest, posttest, and CST, with large effect sizes in each case (see Tables 3, 4, 5, and 6). A post hoc test (Tukey HSD) revealed that mathematics and science majors had significantly higher content knowledge than business majors with $p < 0.01$ (pretest, posttest, and CST) and liberal arts majors with $p < 0.01$ (pretest) and $p < 0.05$ (posttest and CST). There were no other statistically significant differences. In summary, in this study mathematics and science majors had higher content knowledge scores than non-mathematics and non-science majors. No statistically significant differences were found between the undergraduate college majors on both pre- and posttests in attitudes toward mathematics and teacher efficacy.

Table 3
Means and Standard Deviations on Content Knowledge for Major

Pre-, Post-, and CST Tests	Mean	Standard Deviation
Content Knowledge Pre Test; Total ($N = 42$)	74.79	17.605
Liberal Arts ($N = 16$)	70.13	16.382
Business ($N = 11$)	64.45	15.820
Math/Science ($N = 15$)	87.33	12.804
Content Knowledge Post Test; Total ($N = 42$)	84.48	14.225
Liberal Arts ($N = 16$)	81.19	15.132
Business ($N = 11$)	76.82	14.034
Math/Science ($N = 15$)	93.60	7.679
CST Content Knowledge; Total ($N = 42$)	260.62	20.184
Liberal Arts ($N = 16$)	255.81	18.784
Business ($N = 11$)	249.64	18.943
Math/Science ($N = 15$)	273.80	15.857

Table 4
ANOVA Results on Mathematics Content Pretest for Major

Variation	Sum of Squares	*df*	Mean Square	*F*	η^2
Between Groups	3883.261	2	1941.630	8.582**	0.31
Within Groups	8823.811	39	226.252		
Total	12707.071	41			

** $p < 0.01$

Table 5
ANOVA Results on Mathematics Content Posttest for Major

Variation	Sum of Squares	*df*	Mean Square	*F*	η^2
Between Groups	2066.802	2	1033.401	6.469**	0.25
Within Groups	6229.674	39	159.735		
Total	8296.476	41			

** $p < 0.01$

Table 6
ANOVA Results on Mathematics Content Specialty Test (CST) for Major

Variation	Sum of Squares	*df*	Mean Square	*F*	η^2
Between Groups	4302.522	2	2151.261	6.765**	0.26
Within Groups	12401.383	39	317.984		
Total	16703.905	41			

** $p < 0.01$

Research question four was analyzed using Pearson correlations to determine if there were any relationships between content knowledge and attitudes toward mathematics or efficacy. No significant relationships were found. This suggests that Teaching Fellows' attitudes toward mathematics and efficacy are unrelated to how much content knowledge they possess.

Discussion and Implications

The results of the analyses on the data collected from this particular group of Teaching Fellows revealed that high school teachers had higher mathematics content knowledge than middle school teachers, Mathematics Teaching Fellows had higher mathematics content knowledge than Mathematics Immersion Teaching Fellows, and mathematics and science majors had higher mathematics content knowledge than non-mathematics and non-science majors. The sample size in this study was small, but effect sizes were found to be quite large. Moreover, no differences in attitudes toward mathematics and teacher efficacy were found between middle and high school teachers; between Mathematics and Mathematics Immersion Teaching Fellows; or among liberal arts, business, and mathematics and science majors. Surprisingly, no relationships were found between mathematical content knowledge and attitudes toward mathematics and teacher efficacy. The statistically significant differences in content knowledge found in this study led to further analysis to determine if there were differences in gain scores for content knowledge on the mathematics content test over the course of the semester for any group; however, no significant differences were found in gain scores between middle and high school teachers, between Mathematics Teaching Fellows and Mathematics Immersion Teaching Fellows, or among the different undergraduate college majors.

In the first study (Evans, in press) the sampled teachers had positive attitudes toward mathematics and high teacher efficacy. The present study revealed that there were no differences between the different categories (teaching level, immersion status, and major) of Teaching Fellows in attitudes toward mathematics and efficacy, and that content knowledge was unrelated to attitudes toward mathematics and efficacy. Combining the results of the first study (Evans, in press) with the results found in this present study, an interesting finding emerged. Teachers in this study had the same high level of positive attitudes toward mathematics and the same high level of teacher efficacy regardless of content ability. Thus, some of the teachers in this study believed they were just as effective at teaching mathematics, despite not having the high level of content knowledge that some of their colleagues possessed. This finding is significant because high content knowledge is a necessary condition for quality teaching (Ball et al., 2005). This finding also contradicts other research conducted that found a positive relationship between content knowledge and attitudes (Aiken, 1970, 1974, 1976; Ma & Kishor, 1997). It is possible that the unique sample of alternative certification teachers may have contributed to this difference, and this possibility should be further investigated. It should also be noted that the instructor in the mathematics methods course was also the researcher. Thus, consideration must be given for possible bias in participant reporting since the participants in this study knew that the instructor would be conducting the research. Participants were assured that their responses would not be used as an assessment measure in the methods course.

Although New York State requires a minimum of 30 mathematics credits for both middle and high school teachers, high school teachers had higher content knowledge than middle school teachers. This may be due to their experience working with higher level mathematics in their teaching. However, this does not explain the reason that sampled high school teachers scored better on the CST and content pretest instruments: this study began at the beginning of their teaching careers, and the teachers did not yet have significant classroom experience. It is possible that teachers with stronger content knowledge may be drawn more to high school teaching, rather than middle school teaching, and the more rigorous content that comes with teaching high school mathematics. Because the participants in this study represent a convenience sample due to availability, which restricts the generalizability of this study, further research should extend to larger sample sizes.

Many alternative certification teachers, such as the Teaching Fellows, teach in high-need urban schools in New York City (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006) and throughout the United States. Therefore, it is imperative that policy makers, administrators, and teacher educators continually evaluate teacher quality in alternative certification programs. NCTM (2005) stated, "Every student has the right to be taught mathematics by a highly qualified teacher—a teacher who knows mathematics well and who can guide students' understanding and learning" (p. 1). New York State holds the same high standards for both high school and middle school teachers. Thus, educational stakeholders should investigate and implement strategies to better middle school teachers' content knowledge. Based on the results of this study it is recommended that middle school teachers be given strong professional development in mathematics content knowledge by both the schools in which they teach and the schools of education in which they are enrolled. Future studies should examine this issue with larger samples of Teaching Fellows and teachers from other alternative certification programs to increase generalizability. It is imperative that future research address whether or not there are differences in actual teaching ability among the Mathematics and Mathematics Immersion Teaching Fellows and different college majors held by the teachers. One way to determine this would be to measure students' mathematics performance to identify differences in student achievement among the variables examined in this study.

As earlier stated, Teaching Fellows currently account for one-fourth of all New York mathematics teachers (NYCTF, 2008), and increasingly alternative certification programs account for more teachers coming to the profession throughout the United States (Humphrey & Wechsler, 2007). For the sake of students who have teachers in alternative certification programs, the certification of high quality teachers must continually be a priority for policy makers, administrators, and teacher educators. Considering the call for high quality teachers, high stakes examinations, and accountability, now more than ever we need to ensure that the teachers we certify are fully prepared in both content knowledge and dispositions to best teach our high-need students.

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