10-23-2008

A case study of teachers' mathematics content knowledge and attitudes toward mathematics and teaching

Brian R. Evans
Pace University - New York, bevans@pace.edu

A Case Study of Teachers' Mathematics Content Knowledge and Attitudes toward Mathematics and Teaching

by Brian R. Evans, Ed.D.

Pace University

Abstract

This study intended to measure teacher mathematical content knowledge both before and after the first year of teaching and taking graduate teacher education courses in the Teach for America (TFA) program, as well as measure attitudes toward mathematics and teaching both before and after TFA teachers' first year. There was a significant increase in both mathematical content knowledge and attitudes toward mathematics over the TFA teachers' first year teaching. Additionally, several significant correlations were found between attitudes toward mathematics and content knowledge. Finally, after a year of teaching, TFA teachers had significantly better attitudes toward mathematics and teaching than neutral.

Teach for America's mission is to "build the movement to eliminate educational inequity by enlisting our nation's most promising future leaders in the effort" (TFA, 2008). Their vision "is that one day, all children in this nation will have the opportunity to attain an excellent education" (TFA, 2008). Teach for America (TFA) is a non-profit organization formed in 1990 with the intention of sending college graduates to low-income schools to make a difference for the underserved students. Its founder, Wendy Kopp, was herself a new graduate of Princeton University looking to do something more with her life after graduation (Kopp, 2003). She considered that many recent college graduates at America's top universities would consider teaching low-income students if given the opportunity. The idea was that there should be a teachers' corps that would allow new graduates at top universities with an interest in teaching to quickly begin teaching students in underserved communities. Kopp considered that her idea could be a Peace Corps for the 1990's, and that the teachers would either stay in education or go into other sectors and remain advocates for public education. Thus the framework for what would become TFA was developed. Recent college graduates would commit to teaching for two years while taking coursework in teacher education, and they would serve in low-income schools throughout the United States.

In addition to the recent interest in alternative certification programs like TFA, content knowledge and attitude toward mathematics have become increasingly important issues in mathematics education (Amato, 2004; Ball, Hill, & Bass, 2005). This case study looks at one cohort of mathematics TFA teachers in terms of their mathematical content knowledge in their first year of coursework and teaching, as well at their attitudes toward mathematics and teaching over the course of that year. The purpose of this study

is to understand what change in mathematical content knowledge occurs over the first year for TFA teachers, as well as what change in attitudes toward mathematics and teaching occur over the first year. Teacher content knowledge is important since content knowledge is a necessary, but not sufficient, condition for good teaching (Ball, Hill, and 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 the content as well as affect their students' attitudes and behaviors (Amato, 2004; Leonard & Evans, 2007). Moreover, there has been little published on the effects of field experience on new mathematics teacher content knowledge and attitudes (Philipp et al., 2007; Leonard & Evans, under review). Philipp et al. found that preservice teachers with field experience at the elementary level showed an increase in content knowledge and beliefs as compared to those who did not have field experience. This study intends to expand upon the literature regarding the field experience relationship, specifically in-service teaching, with content knowledge and attitudes in new teachers.

There has been a recent interest in studying the effects of TFA teachers in America's classrooms (Darling-Hammond, 1994, 1997; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Laczko-Kerr & Berliner, 2002; Xu, Hannaway, & Taylor, 2008). Both Darling-Hammond et al. and Laczko-Kerr and Berliner studied the effects of TFA teachers in elementary school classrooms. Xu et al. claim to have produced the first study examining the effects of TFA teachers at the secondary level.

Laczko-Kerr and Berliner (2002) studied the effects on student achievement by TFA teachers in Arizona. They found that the students of TFA teachers did not perform significantly differently from students of other uncertified teachers. However, "the level of performance of students of the TFA teachers was lower than that of the students taught by equally inexperienced but fully certified teachers" (Laczko & Berliner, 2002). The authors also found that the students of certified teachers performed better than the students of uncertified teachers. The authors concluded that the situation in Arizona is not very different from the national situation. However, caution should be taken due to the often mentioned low state spending per student in Arizona. According to the U.S. Census Bureau (2003), only Utah spent less money per student than Arizona at the time of this study.

Darling-Hammond et al. (2005) conducted research comparing certified and uncertified teachers in Houston, Texas in the mid 1990's to early 2000's. Like Laczko-Kerr and Berliner, the authors found that certified teachers consistently produced significantly higher student achievement gains as compared to uncertified teachers. They found this to include TFA teachers as well. That is, certified teachers in general produced significantly higher student achievement gains as compared to uncertified TFA teachers. Certified TFA teachers, after two to three years of a teacher preparation program, performed just as well as general certified teachers in the field. However, Darling-Hammond et al. caution that upon becoming certified many TFA teachers leave teaching. This is in contrast to Teach for America's own report of retention of TFA teachers on their website. TFA claims that about two-thirds of TFA teachers stay in the field of education upon completing their time in the program, and half of those remain in

teaching. That means, of all TFA alumni, about one-third stay in the classroom upon fulfilling their commitment according to TFA.

Darling-Hammond et al., referencing the findings by Raymond, Fletcher, and Luque (2001) and Decker, Mayer, and Glazerman (2004), said they found that the students of TFA teachers have comparable gains in achievement, or better, than other similarly experienced teachers. However, Darling-Hammond et al. say that the comparison group of teachers was disproportionately untrained and uncertified. Darling-Hammond et al. found mixed results for the effectiveness of TFA teachers on student achievement in mathematics and found certified TFA teachers to be more effective than other teachers with standard certification for student achievement on one standardized mathematics test, but marginally less effective than other teachers with standard certification on a different standardized mathematics test. Finally, it should be noted that the authors admit that even though uncertified TFA teachers in the classroom are not as effective as certified teachers, TFA teachers fill a gap and provide stability for several years in underserved schools where students might otherwise receive a long line of substitute teachers.

Xu et al. (2008) claim to have conducted the first study of TFA teachers at the secondary level. Thus, there is a need for more research on secondary level TFA teachers. Xu et al. were particularly interested in mathematics and science, and focused on TFA teachers in North Carolina. Contrary to some other reports on TFA teachers, Xu et al. found TFA teachers to be more effective, as measured by student achievement, than traditional teachers, including more experienced traditional teachers. TFA teachers were able to offset their lack of experience perhaps through better academic preparation or

motivation. Xu et al. cautions that placement of TFA teachers in the most high needs schools and classrooms needs to be considered when comparing TFA to more traditionally prepared teachers in general, and the authors account for this placement in their research methodology. They cite two studies conducted in New York City that report on the effectiveness of TFA teachers (Boyd et al., 2006; Kane, Rockoff, & Staiger, 2006). Both studies claimed that TFA teachers had significantly higher student achievement in mathematics when compared to certified teachers from grades 4 to 8. Boyd et al. found specifically an advantage in TFA teachers in the middle school years. Xu et al. conclude that despite finding TFA teachers to be more effective, perhaps with more pedagogical training TFA teachers could even become more effective teachers.

According to TFA the Teach for America 2007 National Principal Survey found that overall over 90 percent of the 785 principals surveyed reported that they were satisfied with TFA teachers, TFA teachers have made a positive impact in their schools, and they would hire TFA teachers again. Again, more than 90 percent of principals rated TFA teachers as effective as, or more effective than, other beginning teachers. Finally, more than 90 percent of principals rated TFA teachers as effective as the overall teaching faculty with half rating TFA teachers more effective than the overall teaching faculty. Similarly principals rated TFA teacher training at least as good as the training of other beginning teachers. Of particular interest to this current study was that principals said that generally TFA teachers are knowledgeable in their subject matter.

From the literature it is clear that there has been research conducted on TFA teacher effectiveness in regards to student achievement with conflicting results. There have not been any known studies that specifically focus on the mathematics content

knowledge and attitudes toward mathematics and teaching for TFA teachers. This current study attempts to fill that gap. This study will make a contribution to the field by addressing a much needed focus on secondary TFA teachers and focusing on TFA teachers' mathematical content and attitudes, two areas much neglected in the literature.

Research Questions

1. What differences exist between Teach for America (TFA) teachers' mathematical content knowledge in the beginning and at the end of their first year teaching and taking teacher education courses in a graduate program?
2. What differences exist between TFA teachers' attitudes toward mathematics and teaching in the beginning and at the end of their first year teaching and taking teacher education courses in a graduate program?
3. Is there a relationship between TFA teachers' mathematical content knowledge and their attitudes toward mathematics and teaching before and after their first year teaching and taking teacher education courses in a graduate program?
4. How positive are TFA teachers' attitudes toward mathematics and teaching at the end of their first year teaching and taking teacher education courses in a graduate program?

Methodology

The methodology of this case study involves quantitative methods. A case study is appropriate for a detailed study using a small group (Lincoln & Guba, 1985). The sample in study consisted of 22 first year TFA teachers who were in both their first year of teaching mathematics as well as their first year taking teacher education coursework in a graduate program at a large university in the northeastern United States. The teachers

in this study were selected due to availability and thus represent a convenience sample. Approximately half of the teachers were female and half were male. The age range of the TFA teachers was from early to mid 20's. Prior to teaching in September, TFA teachers took summer coursework to help prepare for their first year. They continue their coursework over the following two years while teaching. The format for the integrated coursework is that classes were taken once per month on a Saturday with online work submitted and discussions held online during the week. Thus, TFA teachers met with their instructor eight times during the year for approximately six hours of class time on the Saturdays. This enabled the TFA teachers to manage their time better during the week and allowed them to focus on their teaching and schools. Although, it should be mentioned that teachers who chose to earn a Master's degree, as opposed to just certification, in this process must attend some evening classes during the week in their second year in addition to more summer coursework. This does not apply to teachers who only wish to be certified without a Master's degree. First year mathematics TFA teachers essentially take three courses over the course of the year in the combined Saturday program: Mathematics Methods, Assessment, and Literacy.

TFA teachers were given a mathematical content test and two attitudinal questionnaires at the beginning and the end of their first year. The mathematics content test consisted of 25 items ranging from algebra to calculus. The mathematics content test taken at the end of the year was a similar form test. The first attitudinal questionnaire was adapted from Tapia (1996) and had 39 items that measured attitudes toward mathematics. The second attitudinal questionnaire, which was created specifically for this study by the researcher, consisted of 24 items and measured attitudes toward teaching

mathematics. The first instrument was more oriented toward general mathematics attitudes, whereas the second instrument was more oriented toward teaching mathematics. Both instruments used a 5-point Likert scale ranging from strongly agree, agree, neutral, disagree, and strongly disagree.

The quantitative data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 15.0. The primarily statistical analyses utilize paired samples and independent samples *t*-tests and Pearson correlations.

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 first year teaching. The results of the data analysis from the attitudinal instrument were used to answer research question two. A paired samples *t*-test was used to determine any significant attitudinal differences over the first year. For research question three Pearson Product Moment Correlation coefficients were used to determine if there were any relationships between scores on the mathematics content test and two attitudinal instruments. The Pearson correlations were conducted using cross-analyses of pre and post instruments. Research question four was answered using independent samples *t*-tests.

Results

To determine internal reliability of the attitudes toward mathematics instrument, a Cronbach alpha coefficient was found to be 0.93 on the pretest and 0.92 on the posttest. Caution should be taken in interpreting this value since the number of participants was only 22. These values are consistent with the literature (Tapia, 1996). Further, a Cronbach alpha coefficient was found for the attitude toward teaching instrument to be

0.75 on the pretest and 0.68 on the posttest. These numbers are generally low for reliability, but high enough to be useable. Again, caution should be taken regarding small sample size.

The first research question was answered using a paired samples *t*-test. The results of the paired samples *t*-test (two-tailed) reveal a statistically significant difference between pretest scores ($M = 79.05$, $SD = 14.679$) and posttest scores ($M = 82.91$, $SD = 16.550$) for the mathematics content test with $t(21) = -2.350$, $p = 0.000$, $d = 0.25$. This means there was a statistically significant increase in content knowledge as measured by the mathematics content test over the course of the semester. However, the effect size is relatively small.

The second research question was also answered using paired samples *t*-tests. First, data gathered using the attitudes toward mathematics instrument were analyzed. The results of the paired samples *t*-test (two-tailed) reveal a statistically significant difference between pretest scores ($M = 3.06$, $SD = 0.451$) and posttest scores ($M = 3.34$, $SD = 0.356$) for the attitudes toward mathematics instrument with $t(21) = -6.131$, $p = 0.000$, $d = 0.48$. This means there was a statistically significant increase in attitude toward mathematics over the course of the semester. The effect size is in the medium range.

Second, data gathered using the attitudes toward teaching instrument were analyzed. The results of the paired samples *t*-test (two-tailed) reveal no statistically significant difference between pretest scores ($M = 2.92$, $SD = 0.325$) and posttest scores ($M = 3.00$, $SD = 0.275$) for the attitudes toward teaching instrument with $t(21) = -1.423$, p

= 0.170. This means there was no statistically significant increase in attitude toward teaching over the course of the semester.

The third research question was answered using Pearson correlations. For the attitudes toward mathematics instrument the results of the first Pearson correlation analysis reveal a statistically significant correlation between pretest attitudes scores (M = 3.06, SD = 0.451) and pretest content scores (M = 79.05, SD = 14.679) with r = 0.615, n = 22, and p = 0.002. The results of the second Pearson correlation analysis reveal no statistically significant correlation between posttest attitudes scores (M = 3.34, SD = 0.346) and posttest content scores (M = 82.91, SD = 16.550) with r = 0.413, n = 22, and p = 0.056. Finally, the results of the third Pearson correlation analysis reveal a statistically significant correlation between pretest attitudes scores (M = 3.06, SD = 0.451) and posttest content scores (M = 82.91, SD = 16.550) with r = 0.655, n = 22, and p = 0.001. For the attitudes toward teaching instrument the results of the Pearson correlation analyses reveal no statistically significant correlations for any of the cross analyses between attitudes toward teaching and content knowledge.

The fourth research question was answered using independent samples t-tests. Attitudes toward mathematics scores collected at the end of the year had a mean of 3.34 and standard deviation of 0.356. An independent samples t-test was conducted to determine if the participants had significantly better attitudes toward mathematics at the end of the semester as compared to a neutral value coded as "2" on the survey sheet. The results of the independent samples t-test (two-tailed) reveal a statistically significant difference between attitudes toward mathematics scores (M = 3.34, SD = 0.356) and

neutral scores ($M = 2.00$, $SD = 0.000$) with $t(42) = -17.653$, $p = 0.000$ (equal variance not assumed).

Attitudes toward teaching scores collected at the end of the year had a mean of 2.95 and standard deviation of 0.349. An independent samples *t*-test was conducted to determine if the participants had significantly better attitudes toward teaching at the end of the semester as compared to a neutral value coded as "2" on the survey sheet. The results of the independent samples *t*-test (two-tailed) reveal a statistically significant difference between attitudes toward teaching scores ($M = 3.00$, $SD = 0.275$) and neutral scores ($M = 2.00$, $SD = 0.000$) with $t(42) = -17.105$, $p = 0.000$ (equal variance not assumed). This means that the teachers had statistically significant better attitudes toward mathematics and teaching than a neutral value of "2". It should be noted however that comparing actual attitudinal scores with neutral responses should be interpreted with caution.

Discussion

It was found that first year TFA teachers increased their mathematical content knowledge over the course of the first year teaching and taking graduate education courses, as well as improved their attitudes toward mathematics over the first year. Due to relatively high content knowledge among teachers in this study, there is confirmation of results presented by TFA regarding teacher content knowledge (TFA, 2008). TFA claims that principals said that generally TFA teachers are knowledgeable in their subject matter in the for America 2007 National Principal Survey. Several significant correlations were found between attitudes toward mathematics and content knowledge. Additionally, it was found that TFA teachers after a year of teaching had significantly

better attitudinal scores than neutral for both attitudes toward mathematics and attitudes toward teaching.

The results of this study were not very surprising. It was expected that there would be an increase in content knowledge and attitudes toward mathematics over the course of the first year teaching and taking graduate education classes. It was disappointing that there was no increase in attitudes toward teaching over the course of the first year, nor where there any correlations between cross analyses of attitudes toward teaching and content knowledge. This may perhaps be due to lower reliability found on this instrument. Perhaps refining this instrument for its next implementation may be necessary. Finally, it was expected that correlations would be found between attitudes toward mathematics and content knowledge.

The major limitation of this study is the small sample size due to availability of TFA teachers. Unfortunately there were not many mathematics TFA teachers available for this study in the city in which this study took place. Future studies should increase the sample size when practical or study mathematics TFA secondary school teachers from more than one city.

The author of this study is hopeful that there will continue to be more much needed research at the secondary level for alternative certification specifically in the TFA program. Understanding new TFA teachers' mathematics content knowledge and their attitudes toward the subject and teaching is important for professors of education to guide teacher educator instruction as well as provide much needed support for new teachers. Given the short amount of time many TFA teachers stay in the profession some would argue that this may be a waste of resources. However, for the future of many of the urban

students who have TFA mathematics teachers in their classrooms, improvement in new TFA teacher education is of utmost importance.

References

Amato, S. A. (2004). Improving student teachers' attitudes to mathematics. *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education, 2,* 25-32.

Ball, D. L., Hill, H. C., & Bass, H. (2005). Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *American Educator, 14-17, 20-22, & 43-46.*

Boyd, D. J., Grossman, P., Lankford, H., Loeb, S., Michelli, N. M., & Wyckoff, J. (2006). Complex by design: Investigating pathways into teaching in New York City schools. *Journal of Teacher Education, 57*(2), 155-166.

Darling-Hammond, L. (1994). Who will speak for the children? How "Teach for America" hurts urban schools and students. *Phi Delta Kappan, 76*(1), 21-34.

Darling-Hammond, L. (1997). *The right to learn: A blueprint for creating schools that work.* San Francisco, CA. Jossey-Bass.

Darling-Hammond, L., Holtzman, D. J., Gatlin, S. J., & Heilig, J. V. (2005). Does teacher preparation matter? Evidence about teacher certification, Teach for America, and teacher effectiveness. *Education Policy Analysis Achieves, 13*(42).

Decker, P. T., Mayer, D. P., & Glazerman, S. (2004). *The effects of Teach for America on students: Finding from a national evaluation.* Princeton, NJ: Mathematica Policy Research, Inc.

Evans, B. R. (2007). Student attitudes, conceptions, and achievement in introductory undergraduate college statistics. *The Mathematics Educator, 17*(2), 24-30.

Kane, T. J., Rockoff, J. E., Staiger, D. O. (2006). What does certification tell us about

teacher effectiveness? Evidence from New York City. Working Paper No. 12155, National Bureau of Economic Research April 2006.

Kopp, W. (2003). One day, all children: The unlikely triumph of Teach for America and what I learned along the way (2nd ed.). Cambridge, MA: The Perseus Books Group.

Laczko-Kerr, I. & Berliner, D. C. (2002). The effectiveness of "Teach for America" and other under-certified teachers on student academic achievement: A case of harmful public policy. *Education Policy Analysis Achieves, 10*(37).

Leonard, J & Evans, B. R. (2007). *Reforming mathematics instruction in teacher education programs to enhance preservice teachers' understanding in mathematics.* Paper presented at the annual meeting of the American Educational Research Association (AERA), Chicago, IL.

Leonard, J. & Evans, B. R. (under review). Math links: Building learning communities in urban settings. *Journal of Urban Mathematics Education.*

Lincoln, Y. & Guba, E. (1985). Naturalistic inquiry. Newbury Park, CA: Sage.

Ma, X. & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education, 28*(1), 26-47.

Paulos, J.A. (1990). *Innumeracy: Mathematical illiteracy and its consequences*. New York: Vintage Books.

Philipp, R. A., Ambrose, R., Lamb, L., Sowder, J. T., Shappelle, B. P., Sowder, L., et al. (2007). Effects of early field experiences on the mathematical content knowledge and beliefs of prospective elementary school teachers: An

experimental study. *Journal for Research in Mathematics Education, 38*(5), 438-476.

Raymond, M., Fletcher, S. H., & Luque, J. (2001). *Teach for America: An evaluation of teacher differences and student outcomes in Houston, Texas.* Stanford, CA: The Hoover Institution, Center for Research on Education Outcomes.

Tapia, M. (1996). *The Attitudes toward Mathematics Instrument*. Paper presented at the Annual Meeting of the Mid-South Educational Research Association, Tuscaloosa, AL.

Teach for America (2008). Retrieved April 21, 2008, from http://www.teachforamerica.org/.

U.S. Census Bureau (2003). Public education finances 2001. Retrieved April 23, 2008, from http://www.census.gov/govs/school/01fullreport.pdf.

Xu, Z., Hannaway, J., & Taylor, C. (2008). Making a difference? The effects of Teach for America in high school. Retrieved April 22, 2008, from http://www.urban.org/url.cfm?ID=411642.