Special Education and General Education Teachers' Knowledge and Perceived Teaching Competence in Mathematics

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Abstract

The purpose of this study was to conduct a survey of special education and general education teachers' mathematical skill and perception of competence. The participants (n=206) were current (n-32) or future (n=174) elementary (K-6) and middle level (4-8) general and special education teachers enrolled in two major state universities in the Southern United States. The participants completed surveys of K-6 mathematics content and reported their perceived level of teaching competence. Findings indicate no differences in mathematics skills by certification area, but significant differences exist by grade level and perceived level of competence in teaching mathematics. The results have implications for teacher preparation.

Introduction

Students with disabilities experience difficulties in mathematics computation as well as mathematics reasoning. This includes difficulties with calculations such as fluency and procedural knowledge (Garrett, 1992; Geary, 2004; Houchins, Shippen, & Flores, 2010; Jordan, Hanich, & Kaplan, 2003; Pellegrino & Goldman, 1987). Students with disabilities in mathematics tend to lack an understanding of mathematical concepts and this interferes with problem solving and reasoning (Mercer & Miller, 1992; Parmar, Cawley, & Frazita, 1996). Poor strategy knowledge and strategy use also contribute to difficulties across mathematics achievement (Flores, Houchins, & Shippen, 2006; Montague & van Garderen, 2003; Yang, Shaftel, Glasnapp, & Poggio, 2005).

Students with mathematics disabilities continue to struggle in the area of mathematics despite identification and intervention through special education (Das, Naglieri & Kirby, 1994; Montegue, 1997). Previous research has shown that students with mathematics disabilities make progress, but do not reach levels of achievement near their same age peers. Fleischner, Garnett, and Shepard (1982) found that sixth grade students with disabilities perform mathematical computations as well as third graders without disabilities. Cawley and Miller (1989) found that students with disabilities made one year of progress for every two years of school. Researchers have found that twelfth grade students with disabilities demonstrate mathematics proficiency levels equivalent to fifth or sixth grade (Cawley, Fitzmaurice, Shaw, & Bates, 1979; Cawley & Miller, 1989; Warner, et al., 1980). Thomas and Jones (2003) argue that the state of mathematics

achievement for students with mathematics disabilities has not changed over the past several decades. These researchers call for significant changes in instructional practices.

Educational Reform: In response to low levels of student achievement, the *No Child Left Behind Act* (NCLB) (2002) holds schools accountable for the adequate achievement of all students, including students with disabilities. The NCLB Act proposes that student achievement will improve significantly and continuously so that all students are proficient in reading and mathematics no later than 2013-2014. To support this expectation, each state has defined "adequate yearly progress" (AYP) to measure its schools' achievement. These AYP standards are primarily based on state assessment results, but include high school graduation rates and school attendance rates. Evaluations of AYP must include the progress of the majority (95%) of students with disabilities included in AYP assessment. The NCLB Act recognizes the needs of students with disabilities and mandates that schools make changes to improve their academic achievement. The inclusion of students with disabilities within a general education reform is a significant step forward for the field of special education. It is also a significant challenge based on current achievement of students with disabilities.

The NCLB Act also calls for all teachers to be highly qualified in each content area that they teach, including teachers of students with disabilities. For example, special educators teaching mathematics are required to be highly qualified in that content area. The notion of highly qualified has been interpreted by each individual state and these definitions vary. Based on a review of state definitions of "highly qualified" for new teachers, requirements include the following: (a) a passing score on a state certification exam in a content area or areas, (b) completing an academic major in a content area or areas, or (c) a combination of certification testing and completion of content area coursework. The call for highly qualified teachers is supported by the *Individuals with Disabilities Education Improvement Act* 2004. Section 612(a)(14) calls for special education teachers to be highly qualified by the NCLB deadline of 2005-2006. The call for increased qualifications of special education teachers is supported by research. Student achievement is higher when teachers are certified (Laczko-Kerr & Berliner, 2002). Students' achievement also increases when their teacher possesses content area knowledge in the subject area taught through either a college major or minor (Kaplan & Owings, 2003). Although these mandates require teacher quality based on coursework and/or assessment, sustained change will involve an intensive investment of resources (Kauffman, 1993) and an organized action plan (Gelman, Pullen, & Kauffman, 2004). In order to begin addressing these challenges, the current state of teacher preparedness should be examined.

Teacher Preparedness: Preparedness for teaching specific content has been examined through surveys of teacher awareness and competence in content standards, amount of field experience, and teacher-preparation programs. Research has shown that the National Council of Teachers of Mathematics (NCTM) standards may not be effectively utilized by special education teachers. Maccini and Gagnon (2002) found that a significant number of special education teachers were not familiar with the goals of the NCTM standards. The researchers also found that special education teachers lacked the resources and materials necessary to effectively utilize NCTM standards in their classrooms.

Maccini and Gagnon's (2002) findings raise great concern considering the goals of NCLB that students with disabilities will make adequate academic progress, achieving at grade level within the next decade. Another concern regarding special education instruction in the area of

mathematics is the method of instruction occurring in classrooms and the mathematical content knowledge and pedagogical knowledge of special education teachers. This leads to questions regarding the preparation of special education teachers by institutions of higher education.

Other concerns in the area of special education teacher preparation exist as well. For example, Bouck (2005) found that a low percentage of beginning secondary level special education teachers had experience working with students at the secondary level. Less than half of the respondents to Bouck's survey reported that they had a field experience at the secondary level. Brownell, Ross, Colon, and McCallum (2005) examined the differences between general education teacher preparation programs and special education teacher preparation programs. These researchers report that there is a lack of research associated with effective special education teacher preparation. They also reported that these programs emphasized knowledge of effective interventions more than content area knowledge.

Purpose: With the current state of mathematics achievement for students with disabilities and recent changes in accountability requirements for student progress, there are great expectations as well as challenges for special education teachers. Researchers have brought concerns to light regarding special education teachers' preparedness to meet these challenges (Bouck, 2005; Brownell, et al., 2005; Jones & Thomas, 2003; Maccini & Gagnon, 2002). Researchers have not examined special education teachers' specific mathematics knowledge and perception of competence in the content area. This is of particular concern regarding the current state of mathematics achievement for students with disabilities and recent changes in accountability requirements for student progress and teacher certification. Teaching mathematics requires an understanding of mathematical concepts and knowledge about how children acquire and apply mathematical skills.

It is not known whether pre-service teachers are competent in mathematical knowledge or receive adequate training in teaching mathematics to students with disabilities. Nor is it known whether there is a difference between the preparation of special education teachers and general education teachers in this area. In order to answer these questions, it is important to first examine teachers' mathematical knowledge. The purpose of this study was to conduct a survey of special education and general education teachers' mathematical knowledge at both the practitioner and pre-service levels and investigate their perception of competence to teach mathematics.

Method

Participants: Pre-service and in-service graduate and undergraduate students (n=206) enrolled in either a general or special education program participated in the study. The participants were current or future teachers at the elementary (K-6) or middle (4-8) levels. These particular participants were chosen because the mathematics knowledge surveyed included content through the sixth grade level. The participants were enrolled in two public universities, one located within the Southwestern region and the other located in the Southeastern region of the United States. Participant demographics include 54% (n = 110) as current or future special educators, 46% (n = 96) as current or future general educators. Current or future grade level of students taught included 60% (n = 124) as elementary, grades Kindergarten through sixth grade and, 40% (n = 82) as middle level, grades four through eight. Gender demographics were 14% (n=30) male, 86% (n=176) female. Demographic information associated with cultural background were 5% (n=10) African American, 23% (n=49) Latina/Latino, 69% (n=142) White, 0% (n=0) Asian, and 3% (n=5) Other. The participants' ages fell into the following categories:

18-20 years (20%, n=42), 21-29 years (59%, n=122), 30-39 years (12%, n=25), 40-49 years (7%, n=13), and 50-59 years (2%, n=4). The years of teaching experience were reported as ordinal numbers ranging from 0-13. The demographic data are summarized in Table 1 and Table 2.

Table 1. Participant Personal Demographic Information

Male	30
Female	176
African American	10
Latino/Latina	49
White	142
Asian	0
Other	5
18-20 years	42
21-29 years	122
30-39 years	25
40-49 years	13
50-59 years	4

Table 2. Participant Professional Demographic Information

General Education	96
Special Education	110
Elementary	124
Middle Level	82
0 years	174
1 year	10
2 years	4
3 years	3
4 years	3

Survey Instruments: Computational knowledge was surveyed using the Math Operations Test-Revised (MOT-R)(Fuchs, Fuchs, Hamlett, & Stecker, 1991). The MOT-R measures mathematical operations skills through the sixth grade level. The MOT-R is correlated (r =.78) with the computation sub-test of the Stanford Achievement Test (Fuchs et al., This instrument was chosen based on the number of items related to each skill. Rather than one item per skill, the participants had multiple opportunities to demonstrate each computational skill.

Mathematical problem solving skills were surveyed using the *Math Concepts and Applications Test* (MCAT) (Fuchs et al., 1994). The MCAT measures mathematical reasoning through the sixth grade level. The items survey knowledge of number concepts, numeration, applied computation, geometry, measurement, charts and graphs, and word problems. The criterion validity of the MCAT with the Concepts of Number subtest of the *Stanford Achievement Test* was .80 and the internal consistency reliability was .92 (Fuchs et al.). This test was chosen based on the variety of skills assessed and the format of the instrument.

The survey packet also included a questionnaire eliciting demographic information and perception of competence. Participants were asked to identify the following: (a) age; (b) cultural

background; (c) number of years of teaching experience; (d) area of current or future certification; and (e) grade level at which they taught or would teach. The participants were also asked to rate their competence in teaching mathematics to current or future students as "competent" or "not competent."

Procedures: The surveys and questionnaire were distributed and completed by graduate and undergraduate students enrolled in general education and special education courses specific to methods within each major. The participants volunteered for the study and completed the background questionnaire at the beginning of a class meeting. The background questionnaire was completed first so that the mathematics tasks within the problem solving and computation survey did not interfere with the participants' answers, particularly their answer to the question about teaching competence. At the next class meeting, participants completed the computation and problem solving surveys using pencil and paper. No time limit was assigned, but surveys were completed in an average of 30 minutes. The order of the computation and problem solving surveys were counterbalanced so that half of the participants completed the computation portion first and the other half completed the problem solving portion first.

Data Analysis and Results

A 3 X 3 Multivariate Analysis of Variance (MANOVA) was conducted. The 3 (grade level, certification area, and perceived competence in teaching mathematics skills) X 3 (percent correct for computation skills, percent correct for problem solving skills, and total percent correct) MANOVA was conducted using the Statistical Package for the Social Sciences (SPSS) version 16.0. The independent variables were (a) *grade leve*l representing elementary and middle level, (b) *certification* representing general and special education, and (c) *competence in teaching mathematics skills* representing "yes" or "no". The dependent variables were the percent correct scores on the computational and problem solving portions of the survey instrument completed by the participants and the total percent correct.

The results of the MANOVA indicated a significant main effect for grade level (elementary vs. middle), Wilks' lambda $\lambda = .96$ $F(3, 191) = 2.68$, $p < .05$, and a highly significant main effect for perceived competence in teaching mathematics skills, Wilks' lambda $\lambda = .88$, $F(3, 191) = 9.05$, $p < .01$. The univariate tests associated with the grade level main effect were significant for middle level teachers showing higher scores in computation skills, $p < .05$, with no significant differences between elementary and middle level teachers for problem solving skills. There was no significant main effect between general education and special education teachers across all dependent variables. The univariate tests associated with the perceived competence in teaching mathematics skills main effect were highly significant indicating that participants noting higher levels of competence in teaching mathematics showed higher scores in problem solving skills, $p < .01$, with no significant differences between those who indicated competence in teaching mathematics and their computation scores.

Discussion

The purpose of this study was to conduct an initial survey of special education and general education teachers' mathematical knowledge at both the practitioner and pre-service levels. In addition teachers reported their perception of competence to teach mathematics. The participants demonstrated their knowledge of mathematics skills ranging from the kindergarten level to the sixth grade level.

Findings related to certification: No other research related to special education teachers' actual competence and perceived competence has been conducted. Researchers have found differences between groups in other areas, such as reading (Bos, Mather, Dickson, & Babur, 2001; McCutchen et al, 2002; McCutchen et al., 2002). The results indicated there were no differences in general education and special education teachers' performance on the problem solving portion of the survey (mean of 83% correct for both groups) and the computation portion of the survey (mean of 83% for general education and 81% for special education). This lack of difference is significant and has implications for teacher preparation. In the wake of the reauthorization of NCLB (2002), it is important to note that despite differences in preparation and highly qualified status, both groups performed at the same level. It is unknown whether the changes made in certification had an impact on this finding or if teachers' mathematics skills were similar prior to these changes. There was no difference in general education and special education teachers' perceived competence in teaching mathematics. This appears to be a logical finding since both groups performed similarly.

Findings related to grade level: The results indicated significant differences by grade level of teaching and perceived level of competence in mathematics skills. Middle teachers performed significantly better than elementary teachers with regard to computation (mean of 80% for elementary and 84% for middle level teachers). There were no differences found between grade levels with respect to problem solving.

Findings related to problem solving: Another interesting finding is related to teachers' perceptions of their competence to teach mathematics. Differences in teachers' reports of competence were related to their problem solving performance. Teachers who reported feeling competent to teach mathematics performed better on the problem solving portion of the survey (87% correct) than those who did not report feeling competent (80% correct).

Teachers' performance across grade level and certification: There were certain areas in problem solving and computation that appeared to be problematic across all participants. In the area of computation, items involving fractions or decimals were missed the most. Over half (50-63%) of the participants had difficulty with the following: (a) adding and subtracting fractions and mixed numbers with like denominators; (b) adding fractions with unlike denominators; (c) multiplying fractions and mixed numbers; (d) multiplying decimals; and (e) dividing decimals. In the area of problem solving, participants had difficulty with items involving measurement, capacity, and multiple step word problems that required more than one operation. Over half (50-63%) of the participants had difficulty with the following: (a) converting centimeters to meters; (b) adding yards, feet, and inches with regrouping; (c) determining the volume of a cube when given the measurements of the height, base length, and base width; and (d) solving a word problem involving the purchase of multiple items and the earning of stamps for purchases up to and over a certain amount. These types of mathematical difficulties are similar to those demonstrated by children in schools (Flores, Houchins, & Shippen, 2006; Montague & van Garderen, 2003; Yang, et al., 2005). It is unknown whether there is a connection to teachers' knowledge or level of comfort with these types of mathematical tasks.

Limitations and Suggestions for Future Research: Results of the current study do have limitations. Although the majority of the participants were pre-service teachers, the participants

who were certified teachers may have received their teaching preparation from other institutions and/or in other regions of the country. The majority the sample came from two geographical regions of the country; therefore, the results may not be representative of the whole country.

This study did not explore the differences between the types of teacher certification programs. All of the teachers included in this study had been or were currently enrolled in a traditional preparation program. Teachers who matriculate through a traditional preparation program may have experiences that differ from those who complete an alternative program. As a result, teachers trained in alternative programs may lack pedagogical skills, thus making them less prepared (Tissington & Grow, 2008).

The variations in certification types, and the subsequent experiences that are inherent to both types of programs, could potentially reveal differences in perceived competence and performance. As the number of alternatively certified teachers increases, particularly in the field of special education, it may be beneficial to note their perceptions regarding mathematics instruction. Researchers should consider this variable in future investigations.

Continued investigation is need in higher level mathematics skills as this study addressed only skills from kindergarten through the sixth grade. For example, secondary general and special education teachers could be surveyed with regard to their knowledge of algebra, geometry, and other areas of mathematics included on high school exit exams. Teacher certification standards have changed significantly for special education teachers at the secondary level. The effect of these changes is unknown.

Conclusion: Ongoing emphasis on teachers' accountability and development of content knowledge is critical for several reasons. First, the confluence of federal legislation has thrust education into the accountability age, mandating clear expectations for the requirements necessary to enter the field of education. Teacher preparation programs have responded to these demands of increased teacher quality, yet it is necessary to continuously monitor pre-service teachers' skills in order to continue meeting these requirements.

Second, research has established the relationship between student achievement and teacher competency. This is of particular importance for students with disabilities. As they are held to higher standards of achievement, it is necessary that the teachers who serve them are competent in both content area material and strategies for conveying that material in a manner that meets individual student needs. Thus, maintaining high levels of teacher competency may contribute to higher rates of student success.

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