



Pre-Service Teachers' Perception and Beliefs of Readiness to Teach Mathematics

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Abstract

This study explored pre-service teachers' perceptions regarding their readiness to teach mathematical concepts and their preparation to integrate mathematical topics in instruction. Participants consisted of pre-service teachers who agreed to participate in a state-wide survey. For the purpose of this study, data was disaggregated into two groups: pre-service teachers who attended a private teacher education program and pre-service teachers who attended a public teacher education program. Results of this study indicate that pre-service teachers from both private and public colleges felt adequately prepared to teach mathematics and were indifferent in their perception of their ability to integrate mathematical concepts.

Keywords: teacher preparation; mathematical readiness; teacher perception; integration of topics; private teacher preparation; public teacher preparation; Higher Education Teacher Preparation; Mathematical integration; mathematic education; and mathematical education preparation.

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In an effort to raise the academic achievement of all children, The *No Child Left Behind* Act of 2001 (NCLB, 2001) mandates that all teachers be highly qualified in the content area they teach and that all student subgroups meet the academic standards set forth by individual states. At the heart of this mandate is the requirement that teacher preparation institutions graduate teachers who have the subject content knowledge to instruct *all* children in grades K-12. This type of mandate reflects the increased concern in recent years of the failure to adequately staff schools in grades K-12 with qualified teachers. A review of the literature also indicates that there is a heightened concern for both the quantity and quality of teachers to fill mathematics teaching positions (Ingersoll & Perda, 2009; Boe, 2006; U.S. Department of Education, 2002; National Commission on Mathematics and Science Teaching, 2000). Institutions of higher education (IHEs) that provide teacher training programs are faced with the challenge to ensure that graduates are prepared to teach mathematics to students in grades K-12. Two bodies of research warrant consideration from Institutions of higher education that provide Teacher Training Programs: (1) teachers' mathematical background and (2) pedagogical knowledge.

Mathematical Background

The literature indicates that teachers' background subject knowledge directly influences student achievement (Barth, 2002; Ingersoll, 2003; Darling-Hammond & Bransford, 2005; Heritage & Vendlinski, 2006; Hill, Rowan & Ball, 2005; National Mathematics Advisory Panel, 2008). This view is supported by studies which spans over several decades documenting that many teachers enter the classroom without a comprehensive understanding of mathematics (Hill, Rowen, & Ball, 1995; Ball & Bass, 2000; Ball, 1990; Usiskin, 2001). Such findings claim that the lack of teachers' mathematical understanding significantly impact students' opportunities for

learning, as teacher content knowledge is a vital component for academic success (Darling Hammond, 2000). In order to explain mathematical concepts and provide connections and rationales behind mathematical operations, teachers need a profound understanding of the subject (Ma, 1999). Rosas & Campbell's (2010) study found that pre-service teachers had a limited understanding of mathematics. Their study, which focused on mathematical achievement of pre-service teachers at a small private IHE in southwestern Ohio, revealed that these graduate students completed an average of three undergraduate mathematics courses ($M = 3.5$; $SD = 2.09$), with the majority (77%) of the coursework at the basic level. This finding of a basic level of mathematics coursework supports Floden & Meiketti's (2005) literature review, which found that teachers only had a cursory understanding of mathematics and lacked the ability to elucidate important concepts. "If the ability to explain basic concepts is important for teaching, then the subject matter courses teachers now typically take leave a large fraction of teachers without important subject matter knowledge" (p. 283).

Rosas & Campbell's (2010) study found that pre-service teachers in the graduate program had an inadequate, basic mathematics background to prepare K-12 students for Ohio's required standardized tests. When pre-service teacher participants were given the Ohio Achievement Math Practice Test at the 8th grade level, the majority of the pre-service teacher participants (69%, $n=26$) correctly answered 50% or less of the math questions, which covered concepts of measurement, data and probability, patterns/algebra, and number sense. The belief that student achievement is directly linked to teachers' subject knowledge and their understanding of how individuals learn is based on intuition and logic. A reasonable assumption would be that teachers must know the subject content they teach. However, according to Floden & Menikeetti (2005), there is little empirical research to support such a claim. Floden & Menikeetti (2005) reviewed

the literature and found few empirical studies that conclusively affirmed the common belief that teachers' background knowledge directly impacts student achievement. Of the forty empirical studies reviewed by Floden & Meniketti (2005), the majority used classroom assessments to measure student achievement, severely limiting the generalizability of the findings. The few empirical studies that linked teachers' mathematical content knowledge to student achievement were vague.

There was a lack of specific information which linked mathematical coursework and content completed by the teachers during their teacher preparation programs to students' mathematical achievement. This inability to specifically identify the mathematics content courses can be attributed to two main issues: (1) the variability of college courses within and across IHEs and (2) the fact that student data on mathematic achievement was not established until the 1990s. The shortage of empirical studies to define the relationship between content knowledge from IHEs' teacher preparation courses and K-12 student achievement compounds the issue further.

Pedagogical Knowledge

In addition to the research on mathematical background knowledge, Institutes of Higher Education that provide teacher training programs also must be cognizant of teacher candidates' pedagogical background and its effect on teaching performance. It is important to note that while content knowledge represents a general aptitude, pedagogical content knowledge refers to an understanding of how to teach the subject (Shulman, 1986). Several researchers (Usiskin, 2001; Conference Board of Mathematical Sciences, 2001; Shulman, 1986; Darling Hammond, 2000) stress that pre-service teacher education programs need to focus on distinctive courses that expand upon future teachers' conceptual and pedagogical knowledge in mathematics. Teacher

training programs typically require pre-service teachers to complete methods of teaching coursework and field experiences. In an effort to determine the effectiveness of methodology coursework and field experience, Clift & Brady (2005) reviewed the research from 1995 through 2001 and found that most studies focused on pre-service teachers' beliefs and perceptions of teaching.

In general, the reviewed research indicated that teacher candidates who participated in mathematics methodology courses and field experiences reported confidence in their ability "to write lesson plans, ... to focus on learning as exploratory rather than rote, ... the importance of the teacher's role, and ... method and understandings of problem-solving process and skills (p.318)". However, Clift & Brady (2005) found studies which indicated that while methodology courses focused on instruction that included National Council of Teachers of Mathematics (NCTM) standards, in practice there was little evidence that pre-service teachers included the standards in instruction during field experiences. Even more confounding, Clift & Brady found that cooperating teachers' understanding of standard-based instruction improved through their experiences with pre-service teachers, their. The research further indicated a consistent theme of a paradigm shift from the teacher as the "authority and provider of knowledge to teacher as facilitator" (p.319). Such contrasting findings obviously indicate that more in-depth research, which directly connects teacher preparation to student achievement, is needed in the field of mathematics instruction. The first step to this type of research requires an investigation into the pre-service teachers' perception about their readiness to teach mathematics.

In summary, the literature revealed that the research on teachers' mathematics content knowledge and teaching methodology was limited and therefore inconclusive. The purpose of this study was to provide more specific information about pre-service teachers' perceptions of

their readiness to teach mathematics, their mathematical knowledge base, and their ability to integrate mathematics in the curriculum. This study will add to the body of knowledge on mathematics teacher training. The research questions that guided this study were as follows:

1. What are pre-service teachers' perceptions of their readiness to teach mathematical concepts?
2. What are pre-service teachers' beliefs on the integration of mathematical topics in instruction?

Methodology

This study explored Ohio's pre-service teachers' perceptions regarding their readiness to teach mathematical concepts and their preparation to integrate mathematical topics in instruction. Data was disaggregated from an Ohio 2006-2007 statewide survey and analyzed using descriptive statistics.

Participants

Participants for this study consisted of pre-service teachers who agreed to participate in the Teacher Quality Partnership (TQP, 2007). In 2003, 50 institutes of higher education formed a partnership known as the Teacher Quality Partnership (TQP) to identify effective teacher preparation practices and their impact on students. The participating IHEs consisted of thirty-eight private colleges and/or universities and twelve public universities which offered teacher preparation programs. During the final semester of coursework, pre-service teachers at each participating institute were asked to volunteer in the TQP study by completing an eleven-page survey regarding their beliefs about the quality of their teacher preparation program and their concerns regarding teaching. Data from each institution was compiled and a data base was formed. For the purpose of this study, the data was divided into two groups: 1) pre-service

teachers who attended a private IHE and 2) pre-service teachers who attended a public IHE. Demographic questions on the survey revealed that the majority of the participants from both private and public IHEs were white and non-Hispanic females. Table 1 presents the demographics of the pre-service participants.

Table 1

Demographic Data of Pre-service Participants by Percentage

Institutes of Higher Education	Participant n	Percentage of		Percentage of	
		Male	Female	White	Other
Private	2559	20.75	75.89	91.48	4.37
Public	2747	21.59	76.52	91.01	6.71

TQP, 2008 (2006-2007 Data Set)

Instrumentation

The pre-service survey was developed by a team of Ohio faculty representatives from IHEs participating in TQP. The survey measure has been used each semester since 2004 with pre-service teachers and since 2005 for in-service teachers in Ohio. The pre-service survey consisted of 167 questions/statements regarding teachers’ perceptions of their preparation programs, professional knowledge and skills, teacher efficacy, and concerns about teaching. Using a 5-point Likert type scale, participants were asked to rate each question or statement. Researchers who coordinated the development of the survey asserted that the survey was a reliable measure of teachers’ perceptions, as responses from approximately 7,000 teachers yielded similar mean scores (Loadmen, 2007).

For the purpose of this study, data generated from the survey pertaining to mathematics were disaggregated for the academic year of 2006-2007. The data was then categorized into two groups. The first group consisted of pre-service participants from Ohio's private IHEs and the second group was pre-service teachers from Ohio's public IHEs. Descriptive statistics was used to examine pre-service teachers' perceptions about their background mathematical knowledge and their beliefs on the integration of mathematical topics in instruction. *t*-Tests were completed to determine if there was a significant difference between the responses of pre-service teachers trained at public versus private IHEs.

Results

Disaggregated data from the survey was analyzed to determine pre-service teachers' perceptions of their readiness to teach mathematics. Using a 5- point Likert- type scale, pre-service teachers were asked to rate ten statements regarding how well their program prepared them to teach mathematics (on a scale from 1- *not at all*; 2- *poorly*; 3- *adequately*; 4- *well*; to 5- *very well*). The pre-service teachers from private Ohio IHEs rated all ten questions related to their preparation to teach mathematics as *adequate* ($M=3.31$, $S.D. = 0.15$). The pre-service teachers from public Ohio IHEs also rated all ten questions/statements regarding their preparation to teach mathematics as *adequate* ($M=3.29$, $S.D. = 0.14$). Table 2 provides the pre-service teachers' response to the ten questions regarding their preparation to teach mathematics.

Table 2

Ohio Pre-service Teachers' Perception on Readiness to Teach Mathematics

Survey Response to: <i>How Well Teacher Preparation Prepared them to...</i>	<u>Public Institutes</u>		<u>Private Institutes</u>	
	n	Mean (SD)	n	Mean (SD)
Use mathematical problem solving processes in teaching.	2702	3.35 (1.27)	2506	3.32 (1.27)
Teach mathematical representations (e.g. graphs, tables).	2700	3.50 (1.23)	2505	3.47 (1.26)
Use mathematics communication processes in teaching.	2696	3.27 (1.28)	2502	3.24 (1.29)
Integrate mathematics with other subject areas.	2703	3.38 (1.28)	2507	3.43 (1.28)
Teach mathematical concepts to student groups that are mixed in ability.	2698	3.15 (1.32)	2503	3.16 (1.32)
Teach connections among mathematical ideas.	2701	3.05 (1.34)	2497	3.05 (1.33)
Use discovery approaches in mathematics.	2698	3.19 (1.37)	2498	3.28 (1.36)
Use manipulatives (e.g. blocks) in mathematics.	699	3.50 (1.44)	2497	3.55 (1.44)
Take into account students' prior conceptions about mathematics when planning curriculum & instruction.	2696	3.34 (1.34)	2493	3.40 (1.35)
Use textbook as a resource in mathematics rather than as the primary instructional tool.	2694	3.20 (1.38)	2493	3.26 (1.37)

TQP, 2007 (Data Set for 2006-2007)

5-Point Likert Scale Type: 1=Not at all; 2=Poorly; 3=Adequately; 4=Well; 5=Very Well

A t-Test was completed to determine if a significant difference existed between the responses per question of pre-service teachers trained at an Ohio private versus public IHE. The survey statements regarded pre-service teachers' perceptions of their readiness to teach mathematics. Results of the *t*-Test ($\alpha=.05$) indicated that there was no significant difference in ratings between pre-service teachers' from private and public IHEs. Results of the *t*-Test are presented in Table 3.

Table 3

t-Test Results of Ohio Pre-service Teachers' Perception on Readiness to Teach Mathematics

Survey Response to: <i>How Well Teacher Preparation Prepared them to...</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>MF</i>	<i>SED</i>	<u>95% CI</u>	
						<i>LL</i>	<i>UL</i>
Use mathematical problem solving processes in teaching.	0.8517	5205	0.3944	0.03	0.035	-0.0392	0.0992
Teach mathematical representations (e.g. graphs, tables).	0.8689	5203	0.3849	0.03	0.035	-0.0378	0.0978
Use mathematics communication processes in teaching.	0.8411	5196	0.4003	0.03	0.036	-0.0401	0.1001
Integrate mathematics with other subject areas.	1.4088	5208	0.1590	0.05	0.035	-0.0500	0.0197
Teach mathematical concepts to student groups that are mixed in ability.	0.2730	5199	0.7849	-0.01	0.037	-0.0820	0.0620
Teach connections among mathematical ideas.	0.0000	5196	1.0000	0.00	0.037	-0.0728	0.0728
Use discovery approaches in mathematics.	2.3743	5194	0.0176	-0.09	0.038	-0.1645	-0.0155
Use manipulative (e.g. blocks) in mathematics.	1.2505	5194	0.2112	0.050	0.040	0.1286	0.0286

Take into account students' prior conceptions about mathematics when planning curriculum & instruction.	1.6057	5187	0.1084	0.060	0.037	-0.1334	0.0134
Use textbook as a resource in mathematics rather than as the primary instructional tool.	1.5700	5185	0.1165	-0.060	0.038	-0.1351	0.0151

Note: CI= confidence interval; LL = lower limit; UL = upper limit; $\alpha=.05$; Equal variances not assumed; 5-Point Likert Scale: 1=Not at all, 2=Poorly, 3 =Adequately, 4=Well, 5=Very Well

The second question which guided this study pertained to pre-service teachers' beliefs on the integration of mathematics. Disaggregated data from the survey was analyzed to determine pre-service teachers' beliefs on the integration of mathematical topics in instruction. Overall, participants from both the private and public institutions rated the belief statements at $M=3.40$ ($S.D. =0.3078$), which indicates a similar level of indifference (“neither agree or disagree”). Using a 5- point Likert-type scale, pre-service teachers were asked to rate their level of agreement or disagreement for eight statements. The statement that had the lowest rating from the pre-service teachers was the statement, “In my mathematics lessons, I aim for in-depth study of selected topics, even if it means sacrificing comprehensive coverage”.

The pre-service teachers from public IHEs rated this statement as “neither disagree or agree” ($M=3.0$; $S.D. = 3.0$). The pre-service teachers from private IHEs rated the statement as “neither disagree or agree” ($M= 2.97$; $S.D. = 1.14$). The statement which pre-service teachers rated the highest was, “My job as a teacher is to encourage students to think and question mathematically”. The pre-service teachers from public IHEs rated this statement as “neither disagree or agree” ($M=3.86$; $S.D =1.14$). The pre-service teachers from private IHEs rated the

statement as “neither disagree or agree” ($M= 3.85$; $S.D. = 1.16$). Overall, the pre-service teachers from private IHEs rated all eight questions as “neither disagree or agree” ($M=3.4$; $S.D. = 0.31$). The pre-service teachers from public IHEs also rated all eight questions as “neither disagree or agree” ($M=3.3$; $S.D. 0.32$). Table 4 presents the findings on pre-service teachers’ belief on the integration mathematics topics in instruction.

Table 4

Ohio Pre-service Teachers’ Belief on the Integration of Mathematics Topic in Instruction

<u>Survey Statements</u>	<u>Public Institutes</u>		<u>Private Institutes</u>	
	N	Mean (SD)	N	Mean (SD)
My primary goal is to help students learn mathematical terminology.	2670	3.13 (1.18)	2476	3.14 (1.21)
My primary goal is to help students achieve a deep conceptual understanding of mathematics.	2670	3.70 (1.28)	2472	3.67 (1.27)
In my mathematics lessons, I aim for in-depth study of selected topics, even if it means sacrificing comprehensive coverage.	2659	3.00 (1.13)	2470	2.97 (1.14)
My primary goal is to help students master computational skills.	2664	3.43 (1.10)	2468	3.47 (1.12)
I generally teach basic facts and computation skills before discussing underlying principles of mathematics.	2660	3.27 (1.18)	2471	3.30 (1.18)
In my mathematics lessons I aim for comprehension coverage, even if it means sacrificing in-depth study.	2663	3.08 (1.09)	2470	3.12 (1.13)
My job as a teacher is to encourage students to think and question mathematically.	2666	3.86 (1.14)	2475	3.85 (1.16)
My job as a teacher is to transmit the knowledge and content of mathematics.	2664	3.66 (1.18)	2470	3.68 (1.20)

TQP 2007 (Data Set 2006-2007)

5-Point Likert Scale: 1=Strongly Disagree; 2=Somewhat Disagree; 3=Neither Disagree or Agree; 4=Somewhat Agree; 5=Strongly Agree

t-Tests were completed to determine if there was a significant difference between pre-service teachers' mean ratings of statements regarding beliefs on the integration of mathematics topic in instruction. Results of the *t*-Test ($\alpha=.05$) indicated that there was no difference in the beliefs between pre-service teachers' from private and public IHEs. Results of the *t*-Tests ($\alpha=.05$) are presented in Table 5.

Table 5

t-test Results of Ohio Pre-service Teachers' Belief on the Integration of Mathematical Topic in Instruction

Survey Questions	<i>t</i>	<i>df</i>	<i>p</i>	<i>MD</i>	<i>SED</i>	95% CI	
						<i>LL</i>	<i>UL</i>
My primary goal is to help students learn mathematical terminology.	0.3001	5144	0.7641	-0.0100	0.033	-0.0755	0.0555
My primary goal is to help students achieve a deep conceptual understanding of mathematics.	0.8420	5129	0.3998	0.0300	0.036	-0.0323	0.0923
In my mathematics lessons, I aim for in-depth study of selected topics, even if it means sacrificing comprehensive coverage.	1.2904	5131	0.1970	-0.0400	0.031	-0.1009	0.0209
My primary goal is to help students master computational skills.	1.2904	5131	0.1970	-0.0400	0.031	-0.1009	0.0209
I generally teach basic facts	0.9099	5129	0.3629	-0.0300	-0.033	-0.0948	0.0348

and computation skills before discussing underlying principles of mathematics.

In my mathematics lessons I aim for comprehension coverage, even if it means sacrificing in-depth study.	1.2907	5131	0.1969	-0.0400	0.031	-0.1009	0.0209
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My job as a teacher is to encourage students to think and question mathematically.	0.3116	5139	0.7553	0.01000	0.032	-0.0530	0.0730
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My job as a teacher is to transmit the knowledge and content of mathematics.	0.6019	5132	0.5473	-0.02000	0.033	-0.0853	0.0453
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Note: CI= confidence interval; LL = lower limit; UL = upper limit; $\alpha=.05$; Equal variances not assumed; 5-Point Likert Scale: 1=Strongly Disagree; 2=Somewhat Disagree; 3=Neither Disagree or Agree; 4=Somewhat Agree; 5=Strongly Agree

Conclusion

This study explored Ohio pre-service teachers’ perceptions regarding their readiness to teach mathematical concepts and their preparation to integrate mathematical topics in instruction. Historically, there is a body of research that indicates that teachers’ background subject knowledge influences their teaching (Barth, 2002; Ingersoll, 2003; Darling-Hammond & Bransford, 2005; Heritage & Vendlinski, 2006; Hill, Rowan & Ball, 2005; National Mathematics Advisory Panel, 2008). However, results of this study indicate that pre-service teachers rate their perception of readiness to teach mathematics only in the *adequate* range (Likert response of 3= *adequate*). The overall mean response for all ten survey questions from Ohio’s public and private pre-service teachers was 3.30 (SD=0.146); the overall mean from the public pre-service teachers was 3.29 (SD=0.14), while the mean for private pre-service teachers was 3.31 (SD=0.15). An overall mean pre-service teacher perception of *adequate* readiness to teach mathematical

concepts, instead of a rating of *well* or *very well* on the Likert scale, is noteworthy for several reasons. While there is a limited number of empirical studies that connects student achievement with teachers' background knowledge, there is a body of research that indicates that student achievement is directly connected to teachers' background knowledge (Darling-Hammond & Bransford, 2005; Heritage & Vendlinski, 2006; National Mathematics Advisory Panel, 2008). Therefore, a rating of "*adequate*" in terms of readiness to teach mathematics concepts is concerning. Teachers' confidence levels to teach mathematical concepts should be at least at the *well* or *very well prepared*. Further research is needed to determine if there is a connection between student achievement and pre-service teachers' perceptions of being prepared to teach mathematics. Results of this study support the research that spans over several decades documenting that many teachers enter the classroom without a comprehensive understanding of mathematics (Ball & Bass, 2000; Ball, 1990). In particular, Flodin and Meiketti (2005) found that teachers only have a cursory understanding of mathematics, which could explain the perceptions of the pre-service teachers in this study. Ma (1990) found that a profound understanding of mathematics is necessary to fully explain mathematical concepts and to provide meaningful connections behind mathematics in the classroom. Therefore, the self-reported *adequate* level of readiness to teach mathematics by Ohio pre-service teachers may be an indication that additional mathematics coursework is needed in teacher preparation programs. There are few empirical studies that specifically identify the mathematical content courses that pre-service teachers would require to have a comprehensive understanding of mathematics (Floden & Meniketti, 2005). This gap in educational research should be addressed in future studies.

The second area of focus in this study was to determine pre-service teachers' beliefs on the integration of mathematical topics in instruction. Both private and public pre-service teachers indicated that they felt indifferent (*"neither agree or disagree"*) on their beliefs of the integration of mathematics. Overall, participants from both the private and public institutions rated the belief statements at $M=3.40$ ($S.D. =0.3078$). This level of indifference may be more indicative of pre-service teachers' lack of comprehensive understanding of mathematics and the critical need to integrate and apply mathematics throughout the curriculum with all K-12 subject areas. The statement that was rated the lowest by both private and public pre-service teachers which further sheds light on the participants' beliefs was, *"In my mathematics lessons, I aim for in-depth study of selected topics, even if it means sacrificing comprehensive coverage"*. These findings support the body of research that stresses the importance on teacher preparation programs to focus on the expansion of pedagogical knowledge in mathematics (Usiskin, 2001; Conference Board of Mathematical Sciences, 2001; Shulman, 1986; Darling Hammond, 2000).

In conclusion, the findings from this study indicate that future empirical research is needed in order to determine if pre-service teachers' perceptions about their readiness to teach mathematics and their ability to integrate mathematical topics in instruction directly impacts student achievement. In addition, a follow-up investigation is needed to determine if the classroom teaching experiences of in-service teachers eventually change their perception of their preparation and readiness to teach mathematics.

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