PRESCHOOL TEACHERS' KNOWLEDGE OF CHILDREN'S MATHEMATICAL DEVELOPMENT AND BELIEFS ABOUT TEACHING MATHEMATICS

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Early childhood education emphasizes the need of providing high quality early childhood mathematics programs for preschool children. However, there is little research that examines the importance of preschool children's mathematical knowledge development and teachers' beliefs about how to teach mathematics to young children.

The purposes of this study were to investigate pre-service and in-service preschool teachers' knowledge of children's mathematical development and their beliefs about teaching mathematics in the preschool classroom and also to determine how experience differentiates the two groups. This research employed a non-experimental research design with convenient sampling. Ninety-eight pre-service teachers and seventy-seven in-service preschool teachers participated in the research. The Knowledge of Mathematical Development Survey (KMD) and the Beliefs Survey were used to investigate possible differences between pre-service and in-service preschool teachers' knowledge of children's mathematical development and between their beliefs about teaching mathematics.

The findings of this study indicate a statistically significant difference between pre-service teachers and in-service preschool teachers in relation to their knowledge of mathematical development. This finding shows that pre-service teachers' knowledge of children's mathematical development is somewhat limited; most pre-service teachers have difficulty identifying the process of preschool children's development of mathematics skills.

A second finding reveals a statistically significant difference between pre-service teachers and in-service preschool teachers in relation to their beliefs about (a) age-appropriateness of mathematics instruction in the early childhood classroom, (b) social and emotional versus mathematical development as a primary goal of the preschool curriculum, and (c) teacher comfort with mathematics instruction. No statistically significant difference was found between pre-service teachers' and in-service preschool teachers' beliefs regarding the locus of generation of mathematical knowledge. Both groups believe it is the teacher's responsibility to intentionally teach mathematics to young children. This result suggests that both pre-service and in-service preschool teachers believe that teachers should play a central role in the teaching of mathematics to preschool children. However, both groups would need appropriate education and training to learn how to teach mathematics to young children.

Pre-service and in-service preschool teachers' varying levels of experiences and different levels of education may help explain why there is a significant difference between their knowledge of mathematical development and beliefs about teaching mathematics.

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PRESCHOOL TEACHERS' KNOWLEDGE OF CHILDREN'S MATHEMATICAL DEVELOPMENT AND BELIEFS ABOUT TEACHING MATHEMATICS

Introduction

With the growing importance of mathematics in American society, early childhood programs are increasingly urged to implement mathematics instruction in their classrooms. This state of affairs emphasizes the importance of children learning early the mathematics skills which can provide a solid foundation for later learning (Baroody, Lai, & Mix, 2006; Brenneman, Boyd, & Frede, 2009; Clements, Sarama, & DiBiase, 2004; Clements & Sarama, 2007; Copley, 2010; Ginsburg, Lee, & Boyd, 2008; National Association for the Education of Young Children & National Council of Teachers of Mathematics (NAEYC & NCTM), 2002; National Council of Teachers of Mathematics, 2000; National Research Council (NRC), 2009). Federal and state policy makers in early childhood education have issued statements concerning the urgency of including mathematics in childhood education and requiring provisions for mathematics in the early childhood classroom (NAEYC & NCTM, 2002; NRC, 2009). An abundance of recent research has indicated that, even prior to entering kindergarten, children must have the ability to learn and understand a variety of mathematical concepts (Baroody, 2004; Baroody et al., 2006; Brenneman, et al, 2009; Charlesworth, 2005; Clements, 2001; Clements & Sarama, 2007; Clements & Sarama, 2009; Copley, 2010; Ginsburg et al., 2008; NAEYC & NCTM, 2002; NRC, 2009).

The National Council of Teachers of Mathematics (NCTM, 2000) emphasizes the need to provide high quality early childhood mathematics programs in preschools. The NAEYC and the NCTM (2002) published a position statement on the challenges of promoting early childhood

mathematics and their recommendations for promoting early childhood mathematics. The position statement recommends that professional development programs be implemented to support teachers in improving their knowledge about effective early childhood mathematical development. According to the NCTM (2000), the quality of mathematical education in early childhood plays an important role in the children's understanding of possibly difficult mathematical concepts. Sarama, DiBiase, Clements, and Spitler (2004) suggested that early childhood teacher training focus both on teaching mathematics content and on helping teachers clarify their beliefs about teaching mathematics.

In addition to these concerns about preschool teachers' knowledge of mathematics and their beliefs, there is little research that examines the importance of preschool children's mathematical knowledge development and teachers' beliefs about how to teach mathematics to young children (Baroody et al., 2006; Clements et al., 2004; Clements & Sarama, 2007; Cox, 2011; Ginsburg et al., 2008; Platas, 2008; Rosenfeld, 2010).

Consequently, there is a need to enhance preschool teachers' confidence and competence in teaching mathematics. Assessing this need is considered an important consideration in the improvement of mathematics instruction in preschool (Clements & Sarama, 2008; Clement, Sarama, & Liu, 2008; Ginsburg et al., 2008; NAEYC & NCTM, 2002; Platas, 2008).

Overview of Current Preschool Mathematics Teaching

It is of the utmost importance that early childhood teachers create environments that provide young children with opportunities for learning and exploration in their various math activities (Brenneman et al., 2009; Clements, 2001; Copley, 2000; Copley, 2010; Copple & Bredekamp, 2009; Ginsburg et al., 2008; NAEYC & NCTM, 2002; Texas Education Agency & the

University of Texas (TEA & UT System), 2008). Early childhood teachers should not only be proficient in teaching mathematics, but also should be able to implement various mathematical experiences for their children (Clements et al., 2004; Clements & Sarama, 2007; Copley, 2004; Copple, 2004; Copple & Bredekamp, 2009; Ginsburg & Amit, 2008; Ginsburg & Golbeck, 2004; NAEYC & NCTM, 2002).

Recent research findings have revealed three substantial challenges that early childhood educators face in regard to support for children's mathematical development: inadequate classroom support and teacher training; teachers' beliefs about support for mathematics in early childhood development; and inadequate facilities for monitoring development in mathematics among young children (Clements et al., 2004; Ginsburg et al., 2008; NAEYC, 2011b; NAEYC & NCTM, 2002; NRC, 2009; Platas, 2008).

Current preschool mathematics teaching should provide high quality teaching to support the learning of mathematics in early childhood education (Brenneman et al., 2009; Clements, 2001; Clements et al., 2004; Clements & Sarama, 2007; Clements & Sarama, 2009; Copley, 2010; NAEYC & NCTM, 2002; NCTM, 2000; NRC, 2009).

One of the current practices lacking in early childhood education is teacher professional training to support preschool children's mathematics development (Copley, 2004; Ginsburg et al., 2008; Sarama et al., 2004). Policy makers and evaluators have realized that preschool teachers do not have adequate knowledge of mathematics necessary to impart the mathematics skills preschool children need (Combro, Jablon, & Stetson, 2011; NRC, 2009). Moreover, teachers' perceptions of young children's apparent incapability for learning mathematics have made the situation worse; they often underestimate their children's ability

to learn and practice mathematics (NRC, 2009). In spite of their teachers' beliefs, young children can be motivated to use mathematical skills in their daily interactions with one another (Brenneman et al., 2009; Copley, 2010). As young children play, their teachers should identify opportunities to introduce new math skills and concepts, and should be instrumental in integrating mathematical learning experiences throughout the day (Copple & Bredekamp, 2009; NAEYC & NCTM, 2002; TEA & UT System, 2008). Consequently, teachers should identify their children's interests and support the mathematics that children are exposed to in everyday encounters (Copple & Bredekamp, 2009).

In order to promote children's mathematical knowledge development, early childhood educators should understand young children's cognitive, physical, social, emotional, and language development (NAEYC & NCTM, 2002, p. 3). Copley (2010) emphasizes the need for early childhood educators to provide high quality mathematical experiences for preschool children in order to develop a solid, positive foundation in mathematics. In addition, the mathematics curriculum should be planned according to the development of young children's understanding of relationships and sequences in mathematics during the course of their school activities (NAEYC & NCTM, 2002). The classroom should be used as an appropriate instrument to promote preschool children's exploration with various math concepts (Brenneman et al., 2009; Clements & Sarama, 2008; Clements, et al., 2008; Ginsburg et al., 2008; NAEYC & NCTM, 2002).

The Importance of High Quality Mathematical Teaching in Preschool

The realization that very young children today are capable of early mathematical learning has prompted educators to push for reforms in the preschool curriculum. This situation

has encouraged professional organizations such as NAEYC and NCTM to provide guidelines that preschool teachers should consult and follow in their teaching of mathematical concepts and skills. The NAEYC and the NCTM (2002) have developed specific recommendations related to high quality mathematics instruction in the early childhood classroom. In addition to these organizations, many national and state organizations have provided teachers with guidelines to help improve mathematics instruction for young children; a total of 46 states have comprehensive learning standards for preschool children (Barnett, Epstein, Friedman, Boyd, & Hustedt, 2009). As the NCTM and NAEYC (2002) state, the learning and development of mathematical skills and knowledge is important in building the foundation of mathematical development of preschool children. Preschool teachers in early childhood education should possess adequate knowledge and skills in mathematics, appropriate beliefs about the abilities of young children, and knowledge of developmentally appropriate methods of mathematics instruction if quality teaching is to be expected (Baroody, 2004; Clements, 2004; Copley, 2010; Copple & Bredekamp, 2009; Ginsburg et al., 2008; Sarama et al., 2004). However, some early childhood programs do not focus on high quality mathematics instruction, despite research supporting the theory that early mathematics experiences promote readiness skills and can influence mathematical outcomes later in education (Brenneman et al; 2009; Clements et al., 2004; Ginsburg et al., 2008; NRC, 2009; Platas, 2008).

Many early childhood educators are aware of the importance of mathematical knowledge development in preschool. Unfortunately, there are few studies in early childhood education focused on the importance of preschool children's mathematics knowledge development (Baroody et al, 2006; Brenneman et al; 2009; Clements et al., 2004; Clements &

Sarama, 2007; Clements & Sarama, 2009; Copley, 2010; Cox, 2011; Ginsburg & Amit, 2008; Ginsburg & Golbeck, 2004; Ginsburg et al., 2008; NRC, 2009; Platas, 2008; Seo & Ginsburg, 2004).

Significance of the Study

This study was inspired by ideas from the work of Platas (2008) entitled *Measuring Teachers' Knowledge of Early Mathematical Development and their Beliefs about Mathematics Teaching and Learning in the Preschool Classroom*. Platas measured preschool teachers' knowledge of early mathematical development through the use of reliable and validated survey instruments and statistical analysis (2008). Platas' study found a significant variation in the knowledge and beliefs of early childhood preschool teachers on age-appropriateness of mathematics instruction, classroom locus of generational mathematical knowledge, math versus socio-emotional development, and their comfort level in providing the instruction (Platas, 2008). In addition, the instruments used in this research have been found to be helpful for the preparation and the professional development of current pre-service teachers and in-service preschool teachers (Platas, 2008; Rosenfeld, 2010).

Platas' work has raised many issues regarding the developmental knowledge of preschoolers; issues that include the age-appropriateness of mathematics curriculum used by teachers in preschools, the extent of learning of the mathematical concepts taught, the purpose of teaching mathematics concepts in preschool, and the comfort level of teachers when they introduce such mathematics concepts to preschool children (Platas, 2008). This study is a response to Platas' (2008) recommendations that further study is still needed in early

mathematics instruction, especially in the area of teachers' knowledge of children's mathematical development and their beliefs about teaching mathematics in preschool.

Platas (2008) developed two instruments, the Knowledge of Mathematical Development Survey (KMD) and the Beliefs Survey, to create a meaningful understanding of how pre-service and in-service preschool teachers in early childhood education should handle and evaluate their teaching abilities and methods. However, it remains uncertain whether pre-service and in-service preschool teachers have similar levels of knowledge of mathematical development and beliefs about teaching mathematics (Platas, 2008; Rosenfeld, 2010). Although Platas (2008) was able to compare early childhood teachers based on their knowledge of early mathematical development and beliefs about mathematics teaching and learning, there has been little to no research conducted on pre-service and in-service preschool teachers in regards to the similarity of their knowledge. In my opinion this gap needs to be filled, because current and future teachers' knowledge and beliefs is/will be highly impactful in young children's mathematical knowledge development. The more professional training pre-service and in-service preschool teachers receive, the more competent they will be in the classroom.

This study goes beyond exploring teachers' beliefs on both knowledge development and mathematics teaching by comparing their knowledge of children's early mathematical development, and their beliefs about teaching mathematics to young children. The significance of the study will be extracted from the quality of knowledge and beliefs held by both pre-service and in-service preschool teachers regarding children's mathematical development, as this subject has great implications in the quality of education these teachers will deliver to preschool children. Furthermore, this study can help improve training of early childhood

educators, which can be beneficial in ensuring the high quality of education children rightfully deserve. In compliance with the standards of NCTM for high quality mathematics programs, the evaluation of teachers' competencies should be conducted to ensure the quality of teaching in mathematics programs. This study's significance lies in ensuring that teachers are adequately skilled and emotionally ready to teach mathematical concepts at the preschool level (Cox, 2011; Platas, 2008). In addition, this study is a contribution to the growing body of research in early childhood mathematics education. Participants in this study may provide fresh ideas from the perspective of both pre-service and in-service preschool teachers; ideas that may be instrumental in improving mathematics instruction for preschool children. Presumption is made that the element of experience will play a significant role in either strengthening or modifying teachers' knowledge and beliefs about teaching mathematics in early childhood education (Cox, 2011; Platas; 2008; Rosenfeld, 2010).

Methods

The purposes of this study were to investigate pre-service and in-service preschool teachers' knowledge of children's mathematical development and their beliefs about teaching mathematics in the preschool classroom, and to determine how experience differentiates the two groups. This research employed a non-experimental research design with convenient sampling. The Knowledge of Mathematical Development Survey (KMD) and the Beliefs Survey were used to investigate differences between pre-service and in-service preschool teacher's knowledge of children's mathematical development, and their beliefs about teaching mathematics. This study used descriptive statistics to describe the basic features of the data and to provide concise summaries about the descriptive statistics used to analyze the Research

questions 1, 2, 4, and 5. Descriptive statistics are also used to describe characteristics of a particular sample of individuals, and are considered a fundamental part of quantitative research (George & Mallory, 2010; Pallant, 2007).

In this study, various descriptive analyses were conducted to identify the frequencies, percentages, mean scores, and standard deviations for continuous interval variables in the sample. The categorical demographic variables are depicted in frequency distributions. I utilized analyses of variance to examine mean differences between the pre-service and in-service preschool teachers based on education attainment, mathematics courses, professional development training, and teaching experiences (George & Mallory, 2010; Pallant, 2007). I used ANOVA (analyses of variance) in order to study the relationship on KMD and Belief Survey between pre-service and in-service preschool teachers.

Participants

This research focused on pre-service and in-service preschool teachers from a public university in north Texas and from public school districts in south Texas. Participants were recruited from a public university. Ninety-eight pre-service teachers who are in pursuit of their teaching degree participated. Seventy-seven in-service public preschool teachers were recruited from 13 school districts and Head Start programs for a total of 16 preschools. All in-service preschool teachers were certified teachers. A total of 77 in-service preschool teacher accessed web-based surveys after they were introduced to the study. Recruitment of pre-service teachers came from those enrolled in early childhood courses, those seeking EC-6 certification, and those enrolled in development/family studies courses at the university during the spring semester of 2013; two of those courses being Environmental Processes and

Assessment and Introduction to early childhood education. The pre-service teachers were recruited from volunteers who met the eligibility requirements, agreed to participate in the study, and completed the surveys.

Procedures

The research study was conducted in accordance with the requirements of the university Institutional Review Board. Prior to commencement of the research, the study was reviewed and approved by Institutional Review Board (IRB) for the Protection of Human Subjects. In order to recruit pre-service teachers, a letter was sent to the chair of the early childhood education program to request his permission and participation. The letter included the materials need for the study, the purpose and importance of the study, and mentioned that participation was voluntary and confidential. Each participant signed the consent form before participating protecting confidentiality. In order to conduct the survey with pre-service teachers, a packet containing three questionnaires were created: the demographic questionnaire, the Knowledge of Mathematical Development Survey (KMD), and the Beliefs Survey. After receiving approval from the program chair, classes were scheduled for administration of the surveys. There were 112 students in the four sections of the Environmental Processes and Assessment and Introduction to early childhood education courses at the university during the spring semester of 2013. The final numbers of study participants were 98 with an 88% return rate on the surveys. In each of the participating classes, I explained the purpose and instruments before students began the survey. The pre-service teachers received and were asked to sign an informed consent form before they started the survey. The survey took approximately 20 minute to complete. The pre-service teachers took paper-and pencil surveys at the same time

before the class began. Pre-service teachers who completed the surveys were given 10 extra points from their instructor, as well as a fancy pen from the researcher.

Due to the fact that the instructors found it to be the most convenient way to participate, and to collect data from in-service preschool teachers as efficiently as possible, I set up a web-based survey. The web-based survey was designed using Survey PsychData; an easy, professional, and secure web-based survey. The web-based survey included three parts: a demographic questionnaire, the KMD, and the Beliefs Survey. In order to recruit in-service preschool teachers, approval letters were sent to the school districts to request their permission and participation. The letter included the survey links to the data collection website, psychdata.com. Upon receiving the approval letter, each principal distributed the survey link to their certified preschool teachers. Although approval for a waiver of signed consent was granted despite of the web-based survey research design, an informed consent notice pertaining to the purpose and importance of the study, instructions, the researcher's contact information, and IRB contact information were displayed on the welcome screen. The instructions asked the participant to complete the three-part survey. In-service preschool teachers were able to save and leave the survey, and resume it later. The web-based survey took approximately 20 minutes to complete. At the end of the questionnaire participants had the option to enter their name and mailing address to receive a gift card. This information was kept separate from the survey questions and was permanently deleted after the gift cards were mailed. I sent a $5 Starbuck's gift card to the in-service preschool teachers as a thank you for their participation in the survey. The survey linked to the data collection website, psychdata.com, was available from January 28, 2013 to March 1, 2013. The participants' privacy

and the confidentiality of their responses were secured through numeric coding

Measures

A four-section questionnaire was developed for this study to gather the responses from pre-service teachers and in-service preschool teachers. A demographic questionnaire designed for this study was utilized to gather information about the participants; also used were the instruments developed by Platas (2008): the KMD and the Beliefs Survey.

Demographic Questionnaire

For the first section of the survey, two demographics questionnaires (Appendix D) were created: one for pre-service teachers and the other for in-service preschool teachers. The demographics questionnaire for pre–service teachers consisted of 12 items that addressed gender, age, ethnicity, major, classification, completed math courses, certifications, working experiences with preschool children, job title, preschool children's age group, years of working experiences, and professional development. The demographics questionnaire for in-service public preschool teachers included 11 items that addressed gender, age, ethnicity, certifications, school district, education level, completed math courses, professional development, years of working experiences, preschool children's age group, and job title.

Knowledge of Mathematical Development Survey (KMD)

The KMD is a set of 20 multiple-choice questions that tests preschool teachers' knowledge in the area of verbal counting sequence, counting, ordinal number of words, addition/subtraction, divisions of sets, written number symbols and words. In each survey question, the teacher-respondents are to choose which of two math skills preschool children are likely to learn first. If the respondents think that both choices are of equal difficulty, then

they may choose the option of “Same.” However, if the respondent does not know which skill is easier for a child to learn, he or she can choose the option “Do not know.” The response was coded to reflect the correct answer, based on the recommendations of the author of the instruments (Platas, 2008). In this study, scoring was based on the number of correctly identified sequences. The total KMD score was calculated for each teacher by adding the number of correct responses. The total score is represented as the percentage of correct items. The items were arranged in order from highest to lowest frequencies of correct answer. The Cronbach alpha value was 0.81 (Platas, 2008).

Beliefs Survey

The Beliefs Survey is a set of 40 beliefs statements about mathematics teaching and learning. It has a 6-point Likert scale; responses range from *strongly agree to strongly disagree*. The Belief Survey evaluated the preschool teacher’s perspective in four areas that were grouped into four subscales: (1) age appropriateness of mathematics instruction in the early childhood classroom (2) locus of generation of mathematical knowledge (3) social and emotional vs. mathematical development as primary goal of preschool, and (4) teacher comfort in mathematics instruction (Platas, 2008). Scores for the subscales were created by adding the item ratings in each subscale and dividing by the number of items. Cronbach alpha was used in order to estimate the reliability for the domains of the Beliefs Survey. The author reported values ranged from 0.83 to 0.93 (Platas, 2008). The author's Cronbach alphas for validation study of Beliefs Survey were as follows: locus of generation of mathematical knowledge subscale, $\alpha = 0.83$; age-appropriateness of mathematics instruction in the early childhood

classroom subscale, α = 0.93; social and emotional versus mathematical development as primary goals of preschool subscale, α = 0.86; teacher comfort in mathematics instruction subscale, α = 0.90 (Platas, 2008, p.100).

Limitations of the Study

One limitation of this study was the small sample size. Ninety-eight pre-service teachers and 77 in-service preschool teachers participated the surveys. A second limitation was the study setting was limited geographically. Third, the KMD only focused on number and operation, and the KMD did not measure other areas of mathematics for preschool children.

Data Analysis

This study explored pre-service teachers' and in-service preschool teachers' Knowledge of Mathematical Development Survey (KMD) and Beliefs Survey. In this study, raw data was entered by the researcher into the Statistical Package for the Social Science version19.0 (SPSS 19.0). The responses to the demographic questions were reported as frequencies and percentages. Major descriptive statistics such as means, standard deviations, and ranges were used. Cronbach's alphas were computed to measure reliabilities for the KMD and four subscales of Beliefs Survey.

Statistical Analysis

Various descriptive analyses were conducted to identify item frequencies, percentages, item mean scores, and standard deviations to answer Research Questions 1, 2, 4, and 5. In order to obtain answers for Research Questions 1 and 2, the 20 item KMD was reported in

frequencies and percentages for each item. A total KMD score based on the number of correct items was reported as a mean and standard deviation. The total KMD score was represented as the percentage of correct items. The items were arranged in order from the highest to lowest frequencies of correct answers.

To get answers for Research Questions 4 and 5, the Belief Survey was analyzed by calculating frequencies and percentages for the 40 items. Adding the items and dividing by the total number of items calculated subscale scores for the Beliefs survey. Subscale scores were based on scales of 1 through 6. Scores of the four subscales were reported as means and standard deviations.

Finally, the Research Questions 3 and 6 were answered using a correlation research design. Using SPSS 19.0 software, ANOVAs (analyses of variance) were run, in order to study the relationship on KMD and Belief Survey between pre-service and in-service preschool teachers. With ANOVA, according to Roberts (2004), there are "[t]wo *or more* different groups measured on the same construct, typically on the same occasion" (e.g. pre-service teacher vs. in-service preschool teachers). As Hinkle, Wiersma, and Jurs (2003) noted, "One-way ANOVA involves the analysis of one independent variable with two or more levels"(p. 333).

ANOVA is concerned with the differences between means of groups, not differences variances. The name analysis of variance comes from the way the procedure uses variance to decide whether the means are different. The ANOVA statistical procedure examines what the difference is within the groups, and examines how that variation translates into differences between the groups (George & Mallery, 2010; Pallant, 2007). In this study, one-way ANOVAs were conducted for tests of statistical significance involving independent variables with two or

more groups. Only the results of statistically significant ANOVAs (or Mann-Whitney *U* tests where appropriate) were reported.

Meeting the Assumptions of ANOVA

The three primary assumptions underlying the one-way ANOVA include (1) random and independent samples, (2) normal distribution of dependent variables, and (3) homogeneity of variance (i.e. equal variances of the population distributions) (Hinkle, Wiersma, & Jurs, 2003). A balanced design is a desirable condition when conducting an ANOVA.

Random and Independent Sample

Although each of the in-service teachers in the preschools and Head Start programs had an opportunity to participate in this study, 77 in-service preschool teachers actually took the survey, marking an 88% return rate on the surveys. Ninety-eight pre-service teachers took the survey, which also marked an 88% return rate on the surveys. Pre-service and in-service teachers took the KMD and Beliefs Survey independently, and only once. Hence, the assumption of independent sampling was met.

Normal Distribution of Dependent Variables

Kurtosis and skewness values of dependent variables were checked to determine if a distribution of scores was normal (Field, 2000). According to Huck (2004), "…..skewness is not considered to be too extreme if the coefficient of skewness assumes a value anywhere between -1.0 and +1.0" (p. 29-30). Moreover, skewness and kurtosis values in the range of -2.0 to +2.0 can also be acceptable (Brown, 2008). Leech and Onwuegbuzie (2002) noted that skewness and kurtosis coefficients outside the -2 to +2 range, but still within the -3 to +3 boundaries indicate a slight departure from normality. Table 1 list the KMD and four subscales of Belief Survey

(dependent variables), whose skewness and kurtosis values were beyond the -1.0 to +1.0 ranges. Two subscales (social & age-appropriateness) had values acceptable at the -2.0 to +2.0 ranges (see Table 1).

Table 1

KMD and Subscales of Beliefs Survey (Dependent Variables): Skewness and Kurtosis

Dependent Variable	Skewness	Kurtosis
	Acceptable at -3 to +3 range	
KMD	-0.788	0.239
Locus of Generation	0.326	0.555
Teacher Comfort	-0.703	-0.006
Age Appropriateness	-1.479	3.544
Social	-1.363	3.234

Homogeneity of Variance

Most of the ANOVAs met the homogeneity of variance assumption, examined using Levene's test ($\alpha = .05$). A handful met the assumption at $\alpha = .01$. In either case, eta-square (η^2) effect sizes were calculated. If the homogeneity of variance assumption was still not met at the = .01 level, alternate statistical tests were used, depending on the number of levels in the independent variable. In the instances where the independent variable had two levels (e.g. gender), Mann-Whitney *U* tests were run, and an effect size (r^2) was calculated (Clark-Carter, 1997). Hinkle, Wiersma, and Jurs (2003) write,

> . . . the Mann-Whitney *U* test is statistically more powerful and has been shown to be better alternative to the two-sample *t* test for independent means. Since it is more sensitive and thus more likely to lead to the rejection of the null hypothesis when it is

false. The authors recommend the use of the Mann-Whitney *U* test when the assumptions underlying the *t* test normality and homogeneity of variance cannot be adequately met. (p. 576)

Balanced Design

Balanced design is a desirable condition when conducting an ANOVA (Cobb, 1998). Balanced design allows for a more robust analysis with regard to the assumption of ANOVA (Hinkle, Wiersma, & Jurs, 2003). Furthermore, sample sizes can be considered equal if the larger group is not more than 1.5 times larger than the smaller group (Morgan, Leech, Gloeckner, & Barrett, 2004). For this study, the sample size of the large group (n = 98) is not more than 1.5 times larger than the small group (n = 77). Thus, it can be viewed as a balanced design.

Effect Sizes Used

Two types of effect-size measures were calculated: eta-square η^2 (for ANOVAs) and r^2 (for Mann-Whitney *U* tests). While Cohen (1988) presented benchmarks for effect-size magnitudes, he did not expect these to be rigidly applied, but instead taken into account in the research-specific context. Nevertheless, when context-specific effect size standards are not present in the literature, Cohen's (1988) benchmarks are considered a reference point. Table 2 gives Cohen's (1988) benchmarks for effect size magnitudes (Cohen, 1988; Henson, 2006), which scale this study followed (see Table 2).

Table 2

Cohen's (1998) Benchmarks for Effect Size Magnitudes

Effect size magnitudes	Effect size measures	
	η^2	r^2
Small	0.01	0.01
Medium	0.09	0.09
Large	0.25	0.25

All statistical tests conducted at the $p = .05$ level. Namely, if the p value (sig. value) is equal or less than .05, then there is a significant difference in the mean scores on KMD or Beliefs Survey of the two groups (George & Mallery, 2010; Pallant, 2007).

Results

Introduction

This section describes the demographic profiles of pre-service and in-service preschool teachers, and the findings of pre-service and in-service preschool teachers' knowledge of children's mathematical development and beliefs about teaching mathematics in preschool. Data screening and demographic explanation of this study are presented. The results are then reported according to six research questions and are organized in the related tables.

Data Screening

Coding for Beliefs Survey

In order to answer Research Questions number 4 and 5, the Belief Survey was analyzed by calculating frequencies and percentages for the 40 items. The four subscales of Beliefs Survey were coded prior to obtaining a subscale score (see Table 3).

Table 3

Reverse Coding for Beliefs Survey

Four Domains	Number of items and Reverse Coding
Age Appropriateness	Items: 2, 3, 4, 15, 22, 29, 31, 35, 37, 39 Reverse Coding: 4, 15, 22, 35, 39
Locus of Generation of Mathematical Knowledge	Items: 6, 8, 10, 13, 18, 19, 23, 25, 32, 33, 36, 38 Reverse Coding: 6, 10, 13, 18, 19, 25, 32, 33, 36, 38
Socio-Emotion Vs. Mathematical Development as Preschool Goals	Items: 1, 7, 9, 12, 16, 20, 26, 28 Reverse Coding: 1, 7, 9, 12
Teacher Comport in Mathematics Instruction	Items: 5, 11, 14, 17, 21, 24, 27, 30, 34, 40 Reverse Coding: 5, 21, 27, 30, 40

Descriptive Statistics

Description of Demographic Variables for Pre-service Teachers

The participants were recruited from 112 pre-service teachers from a university in the north Texas. Recruitment of pre-service teachers came from those enrolled in early childhood courses and development and family studies courses at the university during the spring semester of 2013 as well as those seeking EC-6 certification. There were 112 students in the four sections of the Environmental Processes and Assessment and Introduction to early childhood education courses. The final numbers of study participants were 98 with an 88% return rate on the surveys. The participants involved in the study were undergraduate students; 34.7% were juniors and 65.3% were seniors. Table C1 displays the demographic characteristics of the pre-service teachers who participated in this study.

In the sample, the majority of pre-service teachers were female (90. 8%). The age range of pre-service teachers was 18 to more than 60 years. Respondents between the ages of 18 and

24 were the largest age group of pre-service teachers (81.6%). In the sample, the majority of participants were Caucasian/White (57.1%), followed by Hispanic/Latino/Latina (28.6%), African-American Black (8.2%) and Asian/Asian- American/Pacific Islander (4.1%). Of 75 pre-service teachers, 76.5% majored in early childhood study or development and family studies. Pre-service teachers were asked to identify the mathematics courses they had completed. Respondents selected all categories that applied. Approximately 91.8% pre-service teachers had completed College Algebra, 78.6% had completed Math for Elementary Education Majors I, 68.4% had completed Math for Elementary Education Majors II, and 54.1% had completed College Level Math. In terms of certifications, of 98 participants, 55.1% were seeking ESL Generalist EC-6, 18.4% were seeking Generalist EC-6, 16.3% were seeking Generalist EC-6 with Special Education EC-12, and 10.2% were seeking Bilingual Generalist EC-6. In terms of working experiences with preschool children, 77.6% of pre-service teachers had experience working with preschool children and 22.4% pre-service teachers did not. Pre-service teachers' descriptions of their job titles were: volunteer (65.8%), assistant teacher (25%), and lead teacher (7.9%). In terms of preschool age group, 58.7% pre-service teachers had experience with combined age groups of 3 and 4 year olds, 36% had experience with 4 year olds only, and 5.3% had experience with 3 year olds only.

In terms of the number of years pre-service teachers had worked with preschool children; 39.8% pre-service teachers had less than 1 year experience working with preschool children, 27.6% had worked with preschool children for one to two years, and 24.5% pre-service teachers had worked with preschool children for three to five years. Only 7.1% pre-service teachers had worked with preschool children for six to ten years, and 1.0% had worked

with preschool children for eleven to fifteen years. A professional development participation survey in the area of mathematics for preschool children over the last 3 years resulted in 82.7% indicating that they had not participated in mathematics for preschool children in their professional development. Only 17.3% pre-service teachers indicated that they had participated in mathematics for preschool children in their professional development (see Table C1).

Description of Demographic Variables for In-service Preschool Teachers

Seventy-seven in-service preschool teachers participated, all of whom worked in early childhood schools and Head Start programs. In-service preschool teachers were recruited from 13 different school districts, which accounted for 16 public preschools. Eighty-eighty in-service preschool teachers accessed the on-line survey; however, only 77 in-service preschool teachers were able to complete it. The final number of study participants was 77 with an 88% return rate on the surveys. Table C2 displays the demographic characteristics of the in-service preschool teachers who participated in this study. In the sample, the majority of in-service preschool teachers were female (98.7%). The ages of the in-service preschool teachers ranged from 18 to more than 60 years. About 28.6% were between the ages of 40 and 49, 20.8% were between the ages 30 and 35, 18.2% were between the ages 36 and 39, and another 18.2% were between the ages of 50 and 59 years old.

In the sample, the majority of participants were Caucasian/White (74%), followed by Hispanic/Latino/Latina (13%), Asian/Asian-American/Pacific Islander (5.2%), and African-American Black (2.6%). In-service preschool teachers were asked to identify more specifically their certifications. Respondents selected all categories that applied. In terms of qualifications, the teachers had Pre K-4 Certifications (35.1%), ESL Generalist EC-6 Certification (31.2%),

Special Education/Kindergarten Certification (23.4%), Pre K-6 Certification (19.5%), and Elementary with EC Endorsement Certification (18.2%). Also, in-service preschool teachers were asked to identify the highest level of education that they had completed. In-service preschool teachers had Bachelor's Degree (74%), Master's Degree (24.7%), and Doctoral Degree (1.3%). In-service preschool teachers were asked to identify what mathematics courses they had completed. Teachers selected all categories that applied. In-service preschool teachers in this study completed College Level Math (62.3%), College Algebra (57.1%), Math for Elementary Education Majors I (46.8%), and Math for Elementary Education Majors II (26%). A professional development participation survey in the area of mathematics for preschool children over the last 3 years resulted in 87% in-service preschool teachers indicating that they had participated in mathematics for preschool children in their professional development. Only 13% In-service preschool teachers indicated that they had not participated in mathematics for preschool children in their professional development.

In terms of the number of years in-service preschool teachers had worked with preschool children; only 7.8% in-service teachers had experience working with preschool children for one to two years, and 32.5% had worked with preschool children for three to five years. In terms of preschool age group, 54.5% in-service preschool teachers had experience with combined age group of 3 and 4 year olds, 40.3% had experience with the 4 year old age group only, and 5.2% had experience with the 3 year old age group only. In describing their job titles, 27.3% identified as being Pre-K teachers, and 19.5% identified as being Special Education Pre-K teachers. Teachers of Preschool Programs for Children with Disabilities (PPCD) (18.2%), Head Start teachers (18.2%), ESL Pre-K teachers (6.5%), Bilingual Head Start teachers (2.6%),

Bilingual Pre-K teachers (2.6%), Instructional Specialists (2.6%), Principal (1.3%), and Assistant Principal (1.3%) composed the rest of the population sample (see Table C2).

Reliability of KMD and Beliefs Survey

Cronbach's alpha was used to assess the internal consistency, which is the extent to which tests assess the same characteristic, skill, or quality. Cronbach's alpha was used to determine reliability for both KMD and Beliefs Survey subscales. Reliability for the KMD and Beliefs Survey subscale was based on a total sample of 175 teachers. Reliability for the KMD was calculated using inter-item correlation. The Cronbach's alpha value was 0.81. This value is similar with the reliability reported by the author (Platas, 2008).The Beliefs Survey's Cronbach's alpha for the whole scale was 0.91 for the 40 questions. This value is similar with the Cronbach's alpha of 0.83 to o.93 reported by the author.

For this study, Cronbach's alpha subscale for age-appropriateness of mathematics instruction in the early childhood classroom was 0.92; locus of generation of mathematical knowledge was 0.66; social and emotional versus mathematical development as primary goals of preschool was 0.86; and teacher comfort in mathematics teaching was 0.92 (see Table C3). The reliability alpha value for the KMD and Beliefs Survey was comparative to samples from the previous studies. A reliability coefficient of .70 or higher is considered acceptable in most social science research situations (Creswell, 2002). Nunnaly (1978) has indicated .70 to be an acceptable reliability coefficient but lower thresholds are sometimes used in the literature. In short, the scores from the KMD and Beliefs Survey met the criteria for reliability.

Statistical Analyses

Results for Research Question 1

Research Question 1 asked pre-service teachers what they know about children's mathematical development. The total KMD mean score was 12.27 with a standard deviation of 3.71. This result indicated that the average pre-service teachers identified the correct answer for 12 of the 20 items. Table 4 reveals the correct answers for the KMD, with frequencies and percentages reported for correct and incorrect responses to each items. The items are arranged in order from highest to lowest frequencies of correct responses (see Table 4).

Table 4

Frequencies and Percentages of Responses to KMD for Pre-service Teachers

Item Number	Correct Response to Item	Correct		Incorrect	
		f	%	*f*	%
KMD 1	Sam says the counting words in order from 1 to 10	90	91.8	8	8.2
KMD 3	Pauli counts a touchable group of seven buttons	88	89.8	10	10.2
KMD 12	Kaiden says the counting words in order from 1 to 6	81	82.7	17	17.3
KMD 2	Jamie says the counting words in order from 1 to 10	78	79.6	20	20.4
KMD 20	Daevon recognizes one digit numerals	77	78.6	21	21.4
KMD 5	Ali counts a row of eight teddy bears	73	74.5	25	25.5
KMD 8	Micah says the counting words in order from 1 to 6	72	73.5	26	26.5
KMD 11	Pilar counts a row of seven buttons	70	71.4	28	28.6
KMD 16	Sage counts a row of seven buttons	67	68.4	31	31.6
KMD 15	Kim divides twelve cookies between two puppets equally	64	65.3	34	34.7
KMD 13	Amari is presented with two groups of buttons, one with five buttons and one with two buttons. When asked "How many altogether?" in the two groups, Amari counts all of the buttons beginning with the group of five buttons	63	64.3	35	35.7
KMD 17	Justine recognizes one digit numerals	63	64.3	35	35.7

(table continues)

Table 4 (*continues*).

Item Number	Correct Response to Item	Correct		Incorrect	
		f	%	*f*	%
KMD 18	In a line of five toy sheep facing the same direction, Indigo answers the question, "Point to the first sheep in line."	59	60.2	39	39.8
KMD 19	Peyton counts a row of 8 buttons	59	60.2	39	39.8
KMD 6	Shea answers the question "Here are two groups of teddy bears. How many all together?" when presented with two groups of two teddy bears.	57	58.2	41	41.8
KMD 7	Jaiden counts a row of six buttons	54	55.1	44	44.9
KMD 10	Cyprus answers the question, "What is five plus one?"	38	38.8	60	61.2
KMD 9	Cimarron says the counting words in order from 1 to 10	23	23.5	75	76.5
KMD 4	Angel matches seven forks in one-to-one correspondence with seven plates.	16	16.3	82	83.7
KMD 14	Teagan answers the following subtraction question: "If you have these three cookies and you give me one, how many cookies will you have left?"	10	10.2	88	89.8

Note. n = 98.

As shown in Table 4, the KMD scores indicated that pre-service teachers were able to identify the correct sequence of preschool children's mathematical development in 60% of the 20 items. Pre-service teachers were able to identify the process of preschool children's developing mathematical skills as shown by the following questions: KMD 1 (91.8%), KMD 3 (89.8%), KMD 12 (82.7%), KMD 2 (79.6%), KMD 20 (78.6%), KMD 5 (74.5%), and KMD 8 (73.5%). However, pre-service teachers found it difficult to identify the process of preschool children developing mathematical skills, as shown by the following KMD questions: KMD 10 (38.8%), KMD 9 (23.5%), KMD 4 (16.3%), and KMD 14 (10.2%) (see Table 4).

Incorrect responses included the alternate statement as well as "Same" and "Do not know." The frequencies and percentages for these incorrect responses are displayed in Table C4. As shown in Table C4, pre-service teachers selected "Same" for all 20 KMD questions, and

selected “Do not know” for nineteen of the KMD 20 questions. Thirty five of the pre-service teachers answered “Same” on KMD Questions 7 and 10; twenty one of the pre-service teachers answered “Same” on KMD Questions 11 and 16; sixteen answered “Same” on KMD Questions 8 and 17; ten answered “Same” on KMD Questions 4 and 5; and, finally thirty-two answered “Same” on KMD Question18.

Patterns of incorrect responses were reported from 3.1% to 6.1% for those that selected “Do not know” for twelve of the 20 items; and 7.1% to 13.3% for those that selected “Do not know” for seven of the 20 items. Thirteen pre-service teachers answered “Do not know” on KMD Question 13; twelve answered “Do not know” for KMD Question 6; and ten answered “Do not know” on KMD Questions 15 and 4 (see Table C4).

Results for Research Question 2

Research Question 2 asked what in-service preschool teachers know about children’s mathematical development. The total KMD mean score was 15.80 with a standard deviation of 2.82. This result indicated that the average in-service preschool teachers identified the correct answer for 16 of the 20 items. Table 5 shows the correct answers for KMD, with frequencies and percentages reported for correct and incorrect responses to each items. The items are arranged in order from highest to lowest frequencies of correct responses (see Table 5).

Table 5

Frequencies and Percentages of Responses to KMD for In-service Preschool Teachers

Item Number	Correct Response to Item	correct		Incorrect	
		f	%	*f*	%
KMD 12	Kaiden says the counting words in order from 1 to 6	74	96.1	3	3.9
KMD 1	Sam says the counting words in order from 1 to 10	73	94.8	4	5.2
KMD 2	Jamie says the counting words in order from 1 to 10	73	94.8	4	5.2
KMD 3	Pauli counts a touchable group of seven buttons	72	93.5	5	6.5
KMD 8	Micah says the counting words in order from 1 to 6	72	93.5	5	6.5
KMD 11	Pilar counts a row of seven buttons	71	92.2	6	7.8
KMD 20	Daevon recognizes one digit numerals	71	92.2	6	7.8
KMD 16	Sage counts a row of seven buttons	68	88.3	9	11.7
KMD 6	Shea answers the question “Here are two groups of teddy bears. How many all together?” when presented with two groups of two teddy bears	66	85.7	11	14.3
KMD 7	Jaiden counts a row of six buttons	66	85.7	11	14.3
KMD 19	Peyton counts a row of 8 buttons	66	85.7	11	14.3
KMD 13	Amari is presented with two groups of buttons, one with five buttons and one with two buttons. When asked “How many altogether?” in the two groups, Amari counts all of the buttons beginning with the group of five buttons	64	83.1	13	16.9
KMD 18	In a line of five toy sheep facing the same direction, Indigo answers the question, “Point to the first sheep in line.”	63	81.8	14	18.2
KMD 15	Kim divides twelve cookies between two puppets equally	62	80.5	15	19.5
KMD 17	Justine recognizes one digit numerals	62	80.5	15	19.5
KMD 5	Ali counts a row of eight teddy bears	60	77.9	17	22.1
KMD 9	Cimarron says the counting words in order from 1 to 10	51	66.2	26	33.8
KMD 10	Cyprus answers the question, “What is five plus one?”	45	58.4	32	41.6
KMD 4	Angel matches seven forks in one-to-one correspondence with seven plates.	23	29.9	54	70.1
KMD 14	Teagan answers the following subtraction question: “If you have these three cookies and you give me one, how many cookies will you have left?”	14	18.2	63	81.8

Note. n = 77.

As shown in Table 5, the KMD scores indicate that in-service preschool teachers were able to identify the correct sequence of preschool children's mathematical development for 80% of the 20 items. In-service preschool teachers were able to identify the majority of the time the process of preschool children developing mathematical skills. From 92.2% to 96.1% of the in-service preschool teachers selected correct response for seven of the 20 items as shown by the following KMD questions: KMD 12 (96.1%), KMD 1 (94.8%), KMD 2 (94.8%), KMD 3 (93.5%), KMD 8 (93.5%), KMD 11 (92.2%), and KMD 20 (92.2%). From 80.5% to 88.3% of the in-service preschool teachers selected correct response for eight of the 20 items. However, a few in-service preschool teachers had some difficulty identifying the process of developing math skills in preschool children. From 18.2% to 29.9% of the in-service preschool teachers selected the correct response for two of the 20 items as shown by the following KMD questions: KMD 4 (29.9%) and KMD 14 (18.2%) (see Table 5).

Incorrect responses included the alternate statements "Same" and "Do not know." The frequencies and percentages for these incorrect responses are displayed in Table C5. As shown in table C5, in -service preschool teachers selected "Same" for nineteen of the 20 items, and selected "Do not know" for fourteen of the 20 items. Patterns of incorrect responses ranged from 11.7% to 19.5% of the in-service preschool teachers selected "Same" for four of the 20 items. Five of the in-service preschool teachers answered "Same" on KMD Questions 8, 16, and 17; two of in-service preschool teachers answered "Same" on KMD Questions 5,6,12, and 20. Patterns of incorrect responses were reported from 1.3% to 7.8% for the in-service preschool teachers that selected "Do not know" for eleven of the 20 items. Twelve of in-service preschool

teachers answered “Do not know” on KMD Question 10; eight answered “Do not know” on KMD Question 13; and seven answered “Do not know” on KMD Question 14 (see Table C5).

Results for Research Question 3

Research Question 3 asked what differences are there on the KMD between pre-service teachers and in-service preschool teachers. The homogeneity of variance assumption was met at $\alpha = .01$ level (Levene Statistic = 5.63, $p = 0.019$). Table 6 presents the results of the one-way ANOVA for teachers (pre-service vs. in-service) and KMD, with $n_{\text{pre-service}} = 98$ and $n_{\text{in-service}} = 77$.

These findings indicate that there was a statistically significant difference ($p = .000$) between the pre-service teachers ($M = 12.27$) and the in-service preschool teachers ($M = 15.80$) in relation to KMD at the .05 significance level. The effect size (η^2) of 0.22 is considered large (Cohen, 1988) (see Table 6).

Table 6

Analysis of Variance for Teachers (pre-service teachers vs. in-service preschool teachers) and KMD

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between	536.37	1	536.37	47.79***	.000	0.22
Within	1941.78	173	11.22			
Total	2478.15	174				

Note. *$p < 0.05$, **$p < 0.01$, ***$p < .001$.

Results for Research Question 4

Research Question 4 asked about the beliefs of pre-service teachers about teaching mathematics in preschool classroom. Descriptive statistics, as well as data from 98 pre-service teachers, was used to address Question 4. The Beliefs survey’s Cronbach’s alpha for the whole scale was 0.91 for the 40 questions. For this study, Cronbach’s alpha subscale for age-

appropriateness of mathematics instruction in the early childhood classroom was 0.92; locus of generation of mathematical knowledge was 0.66; social and emotional versus mathematical development as primary goals of preschool was 0.86; and teacher comfort in mathematics teaching was 0.92 (see Table C3).

The Beliefs Survey has a 6-point Likert scale; responses range from *strongly agree to strongly disagree*. The items were grouped into four subscales. The agree identification ranged from the *strongly agree to somewhat agree*, and the disagree identification ranged from *somewhat disagree to strongly disagree* responses. Adding the item ratings in each subscale and dividing by number of items calculated scores for the subscales. Table 7 presents the means and standard deviations of Beliefs Survey.

Table 7

Means and Standard Deviations for the Beliefs Subscales Scores for Pre-Service Teachers

Scale	*M*	*SD*
Age-Appropriateness	4.77	0.85
Locus of Generation of Mathematical Knowledge	3.70	0.61
Primary Classroom Goals	4.70	0.80
Teachers Comfort in Mathematics Instruction	4.60	0.76

Note. n = 98.

As shown in Table 7, the highest subscale mean score was for age-appropriateness of mathematics instruction in the early childhood classroom (*M* = 4.77, *SD* = 0.85). The lowest subscale mean score was for locus of generation of mathematical knowledge (*M* = 3.70, *SD* = 0.61) (see Table 7).

Table C6 displays the high frequencies and percentages of age-appropriateness of mathematics instruction subscale for pre-service teachers. The subscale of age-appropriateness of mathematical instruction for pre-service teacher's responses identified a clear majority that

believed “preschoolers are capable of learning math” (98.9%), and “math is a worthwhile and necessary subject for preschoolers” (92.9%). The lowest agreement was on “it is better to wait until kindergarten for math activities” (9.2%), and “mathematical activities are in appropriate use of time for preschoolers; because they aren’t ready for them” (5%) (see Table C6).

Table C7 presents the high frequencies and percentages of locus of generation of mathematical knowledge subscale for pre-service teachers. Most pre-service teachers believed that “teachers can help preschoolers learn mathematics” (99%), and “the teacher should play a central role in preschool mathematics activities” (93.9%). There was significantly less agreement, however, on the area of “teachers should help preschool children memorize number facts” (32.6%), and “math work sheets are appropriate for preschool teachers” (9.1%) (see Table C7).

Table C8 displays the frequencies and percentages of social and emotional versus mathematical development as primary goals of preschool subscale for pre-service teachers. The subscale of primary goals indicated that pre-service teachers’ believed that “math is an important part of the preschool curriculum” (97%), that “math activities are a very important part of the preschool experience” (94%) and that “math activities are good opportunities to develop social skills in preschool” (90.8%). The lowest agreement was on “if a preschool teacher spends time in math activities in the classroom, social and emotional development will be neglected” (8.1%), and “preschool math will weaken preschoolers’ self-confidence” (6.2%) (see Table C8).

Table C9 presents the high frequencies and percentages of teacher comfort in mathematics instruction subscale for pre-service teachers. In this subscale, pre-service teachers

indicated that they were “I am knowledgeable enough to teach math in preschool” (91.9%), and “I can think of many math activities that would be appropriate for preschoolers” (90.8%). The lowest agreement was on “Teaching mathematics to preschool is/would be uncomfortable for me” (16.3%), and “I don’t know enough math to teach it in preschool” (4.1%) (see Table C9).

Results for Research Question 5

Research Question 5 asked about the beliefs of in-service preschool teachers about teaching mathematics in preschool classroom. Descriptive statistics, as well as data from 77 in-service teachers, was used to address Question 5. The Beliefs Survey has a 6-point Likert scale; responses range from *strongly agree to strongly disagree*. The items were grouped into four subscales. The agree identification ranged from the *strongly agree to somewhat agree*, and the disagree identification ranged from *somewhat disagree to strongly disagree* responses. Adding the item ratings in each subscale and dividing by number of items calculated scores for the subscales. Table 8 presents the means and standard deviations of Beliefs Survey (see Table 8).

Table 8

Means and Standard Deviations for the Beliefs Subscales Scores for In-Service Preschool Teachers

Scale	*M*	*SD*
Age Appropriateness	5.46	0.61
Locus of Generation of Mathematical Knowledge	3.70	0.62
Primary Classroom Goals	5.41	0.60
Teachers Comfort in Mathematics Instruction	5.50	0.73

Note. n = 77.

As shown in Table 8, the highest subscale mean score was for teacher comfort in mathematics instruction (*M* = 5.50, *SD* = 0.73). The lowest subscale mean score was for locus of generation of mathematical knowledge (*M* = 3.70, *SD* = 0.62) (see Table 8).

Table C10 displays the frequencies and percentages of age-appropriateness of mathematics instruction subscale for in-service preschool teachers. The highest agreements were that “mathematical activities are age-appropriate for preschoolers (97.4%), that math is a worthwhile and necessary subject for preschoolers” (97.4%), that “preschoolers are capable of learning of math” (96.1%), and, finally, that “children are ready for math activities in preschool” (96.1%). The lowest agreements were on “academic subjects such as mathematics are too advanced for preschoolers” (5.2%), and “it is better to wait until kindergarten for math activities” (3.9%) (see table C10).

Table C11 presents the frequencies and percentages of locus of generation of mathematical knowledge subscale for in-service preschool teachers. In this area, in-service preschool teachers’ highest levels of agreement were on the subjects of whether “teachers can help preschoolers learn mathematics” (97.4%), and whether “the teacher should play a central role in preschool mathematics activities” (96.2%). The lowest levels of agreement were on whether “teachers should help preschool children memorize number facts” (16.9%), and whether “math work sheets are appropriate for preschool teachers” (13%) (see Table C11).

Table C12 displays the frequencies and percentages of social and emotional versus mathematical development as primary goals of preschool subscale for in-service preschool teachers. This subscale of social and emotional versus mathematical development as primary goal of preschool indicated that in-service preschool teachers’ high agreements were on “math is an important part of the preschool curriculum” (98.7%), “math activities are a very important part of the preschool experiences” (98.7%), and “math activities are good opportunities to develop social skills in preschool” (97.4%). The lowest agreement was on “preschool children

are not socially or emotionally ready for math activities" (6.5%), and "if a preschool teacher spends time in math activities in the classroom, social and emotional development will be neglected" (5.2%) (see Table C12).

Table C13 presents the frequencies and percentages of teacher comfort in mathematics instruction subscale for in-service preschool teachers. This subscale indicated that in-service preschool teachers had high levels of agreement on the subjects of "I can think of many math activities that would be appropriate for preschoolers" (97.4%), "I can create effective math activities for preschoolers" (97.4%), "I know how to support math learning in preschool" (97.4%), and "I am knowledgeable enough to teach math in preschool" (96.1%). The lowest levels of agreement were on "math is/would be a difficult subject for me to teach in preschool" (6.5%), "I don't know enough math to teach it in preschool" (6.5%), and "I don't know how to teach math to preschoolers" (5.2%) (see Table C13).

Results for Research Question 6

Research Question 6 asked what differences are on the four subscales of the Beliefs Survey between pre-service teachers and in-service preschool teachers.

Age-Appropriateness of Mathematics Instruction

The homogeneity of variance assumption was met at $\alpha = .01$ level (Levene Statistic = 6.99, $p = 0.009$). Table 9 presents the results of the one-way ANOVA for teachers (pre-service vs. in-service) on the age-appropriateness of mathematics instruction of Beliefs, with $n_{\text{pre-service}} = 98$ and $n_{\text{in-service}} = 77$. These findings indicate that there was a statistically significant difference ($p = .000$) between the pre-service teachers ($M = 4.77$) and the in-service preschool teachers ($M = 5.46$) in relation to age-appropriateness of mathematics instruction of Beliefs at the .05

significance level. The effect size (η^2) of 0.17 is considered medium to large (Cohen, 1988) (see Table 9).

Table 9

Analysis of Variance for Teachers (pre-service teachers vs. in-service preschool teachers) and Age-Appropriateness of Mathematics Instruction

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between	20.81	1	20.81	36.25***	.000	0.17
Within	99.32	173	0.57			
Total	120.13	174				

Note. *$p < 0.05$, **$p < 0.01$, ***$p < .001$.

Locus of Generation of Mathematical Knowledge

The homogeneity of variance assumption was met at $\alpha = .01$ level (Levene Statistic = 0.09, $p = 0.77$). Table 10 presents the results of the one-way ANOVA for teachers (pre-service vs. in-service) and locus of generation of mathematical knowledge of Beliefs, with $n_{\text{pre-service}} = 98$ and $n_{\text{in-service}} = 77$. These findings indicate that there was no a statistically significant difference ($p = 0.86$) between the pre-service teachers ($M = 3.70$) and the in-service preschool teachers ($M = 3.70$) in relation to locus of generation of mathematical knowledge of Beliefs at the .05 significance level (see Table 10).

Table 10

Analysis of Variance for Teachers (pre-service teachers vs. in-service preschool teachers) and Locus of Generation of Mathematical Knowledge

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between	0.011	1	0.01	0.03	0.86	
Within	64.26	173	0.37			
Total	64.27	174				

Social and Emotional versus Mathematical Development as Primary Goals of Preschool

The homogeneity of variance assumption was met at α = .01 level (Levene Statistic = 5.53, p = 0.02). Table 11 presents the results of the one-way ANOVA for teachers (pre-service vs. in-service) and social and emotional versus mathematical development as primary goals of preschool, with $n_{\text{pre-service}}$ = 98 and $n_{\text{in-service}}$ = 77. These findings indicate that there was a statistically significant difference (p = .000) between the pre-service teachers (M = 4.70) and the in-service preschool teachers (M = 5.41) in relation to social and emotional versus mathematical development as primary goals of preschool of Beliefs at the .05 significance level. The effect size (η^2) of 0.18 is considered medium to large (Cohen, 1988). (see Table 11).

Table 11

Analysis of Variance for Teachers (pre-service teachers vs. in-service preschool teachers) and Social and Emotional versus Mathematical Development as Primary Goals of Preschool

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between	20.01	1	20.01	38.31***	.000	0.18
Within	90.35	173	0.52			
Total	110.36	174				

Note. *p < 0.05, **p < 0.01, ***p < .001.

Teacher Comfort in Mathematics Instruction

The homogeneity of variance assumption was met at α = .01 level (Levene Statistic = 0.52, p = 0.47). Table 12 presents the results of the one-way ANOVA for teachers (pre-service vs. in-service) and teacher comfort in mathematics instruction, with $n_{\text{pre-service}}$ = 98 and $n_{\text{in-service}}$ = 77. These findings indicate that there was a statistically significant difference (p = .000) between the pre-service teachers (M = 4.60) and the in-service preschool teachers (M = 5.50) in relation to teacher comfort in mathematics instruction of Beliefs at the .05 significance level. The effect size (η^2) of 0.26 is considered medium to large (Cohen, 1988) (see Table 12).

Table 12

Analysis of Variance for Teachers (pre-service teachers vs. in-service preschool teachers) and Teacher Comfort in Mathematics Instruction

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between	34.01	1	34.01	60.62***	.000	0.26
Within	97.04	173	0.56			
Total	131.05	174				

Note. *$p < 0.05$, **$p < 0.01$, ***$p < .001$.

Discussion

Few studies have measured what preschool teachers know about children's mathematical development and their beliefs about mathematical teaching in the preschool classroom by using both the KMD and the Beliefs Survey (Cox, 2011; Platas, 2008).

The purposes of this study were to investigate pre-service and in-service preschool teachers' knowledge of children's mathematical development and their beliefs about teaching mathematics in preschool classrooms, and to determine how experience differentiates the two groups. In order to gather the responses from pre-service teachers and in-service preschool teachers, a four-section questionnaire was developed for this study. A demographic questionnaire designed for this study was utilized to gather information about the participants; also used were the instruments developed by Platas (2008): the KMD and the Beliefs Survey.

The KMD is a set of 20 multiple-choice questions that tests preschool teachers' knowledge and development in the area of verbal counting sequence, counting, ordinal number of words, addition/subtraction, divisions of sets, written number symbols and words. In each survey question, the teacher-respondents were to choose which one of math skills preschool children are likely to learn first. If the respondents think that both choices are of equal difficulty, then they may choose the option of "Same." However, if the respondent does not

know which skill is easier for a child to learn, he or she can choose the option "Do not know." The response was coded to reflect the correct answer, based on the recommendations of the author of the instruments (Platas, 2008).

The Beliefs Survey is a set of 40 beliefs statements about mathematics teaching and learning. It has a 6-point Likert scale; responses range from *strongly agree to strongly disagree*. The items were grouped into four subscales. The Belief survey evaluated the preschool teacher's perspective in four areas that are grouped into four subscales: (1) age-appropriateness of mathematics instruction in the early childhood classroom (2) locus of generation of mathematical knowledge (3) social and emotional vs. mathematical development as primary goal of preschool, and (4) teacher comfort in mathematics instruction (Platas, 2008). In addition, this research focused on public pre-service and in-service preschool teachers from a public university in north Texas and public school districts in south Texas. Ninety-eight pre-service teachers were recruited form public university in north Texas; 77 in-service public preschool teachers were recruited from 13 different school districts who worked in early childhood schools and Head Start programs that account for 16 public preschools in south Texas. All in-service preschool teachers are certified teachers who completed the surveys as volunteers.

Pre-service Teachers' Knowledge about Children's Mathematical Development

Research Question 1 asked what pre-service teachers know about children's mathematical development. The Cronbach's alpha value was 0.81. The total KMD mean score was 12.27 with a standard deviation of 3.71. The results of this study indicate that the average pre-service teachers identified the correct answer for 12 of the 20 items. This finding implies

that pre-service teachers' knowledge of mathematical development is somewhat limited; only 60% of the pre-service teachers correctly responded to 12 items. The results of Research Question 1 indicate that most pre-service teachers had difficulty identifying the process by where preschool children develop mathematical skills and the order of mathematical development. In order to teach preschool children mathematics in their most crucial years, pre-service teachers need to be equipped with the right skills, education, and collaborative experiences; which can include modeling, classroom observation, coaching, and study groups (Copley, 2004).

Researchers report that for most colleges and universities in the United States, the teaching of mathematical development does not offer a substantial amount of information on the topic, or equip pre-service teachers with adequate skills for teaching mathematics to preschool children (Cox, 2011; Ginsburg et al., 2008; Platas, 2008). Early childhood education courses offer few or no requirements for mathematics education for pre-service teachers (Baroody, 2004; Ginsburg et al., 2008; Platas, 2008). This leaves those with lower levels of education with no preparation to teach math in preschool (Baroody, 2004; Ginsburg et al., 2008; Sarama et al., 2004). Students who graduate from undergraduate teacher preparation programs often go into teaching with little or no training in teaching mathematics in early childhood (Copley, 2004; Cox, 2011; Ginsburg et al., 2008; NRC, 2009; Platas, 2008; Sarama et al., 2004). The NAEYC and the NCTM (2002) have developed specific recommendations related to high quality mathematics instruction in the early childhood classrooms. The more professional training that pre-service teachers receive, the more competent they will be in the classroom.

In-service Preschool Teachers' Knowledge about Children's Mathematical Development

Research Question 2 asked what in-service preschool teachers know about children's mathematical development. The total KMD mean score was 15.80 with a standard deviation of 2.82. This result indicates that the average in-service preschool teachers identified the correct answer for 16 of the 20 items. However, some in-service preschool teachers had difficulty identifying the process of developing mathematical skills in preschool children. From 18.2% to 29.9% selected the correct response for two of the 20 items as shown by the following KMD questions: KMD 4 (29.9%) and KMD 14 (18.2%). Also, incorrect responses included the alternate statements "Same" and "Do not know" responses. In -service preschool teachers selected "Same" for nineteen of the 20 items, and selected "Do not know" for fourteen of the 20 items. Even though in-service preschool teachers may know about children's mathematical development, this finding implies that in-service preschool teachers' knowledge of mathematical development is somewhat limited. Some in-service preschool teachers had difficulty identifying the process by where preschool children develop mathematical skills and the order of mathematical development.

Current research indicates that such an undertaking requires an understanding of whether children are able to learn mathematics at such a young age; children are able to obtain mathematical knowledge and acquire sufficient mathematics skills for everyday use starting from birth to the age of five (Baroody, et al., 2006; Clements & Sarama, 2007). At the preschool age, young children are building their own perceptions of what math is; what it means to know math, how to engage in mathematical thinking and learning through play, and about themselves as math learners (Copley, 2000; Copley, 2010; NAEYC & NCTM, 2002).

Many studies have indicated the relationship between preschool teachers' quality of teaching, and the quality of education they had received from their universities or training programs (Copley, 2004; NRC, 2009; Platas, 2009; Sarama et al., 2004). The findings in Platas' previous research (2008) indicated that preschool teachers need to have a specific level of competency in their teaching, which can be measured through an assessment of their knowledge about mathematics teaching. This survey showed teachers' knowledge of mathematical development and determines their ability to make a significant impact in young children's development of mathematical concepts and goals.

However, examination of current standards, curricula, and instruction in early childhood education revealed that many early childhood settings do not provide adequate learning experiences in mathematics (Clements et al., 2004; Ginsburg et al., 2008; NAEYC & NCTM, 2002; NRC, 2009). The relative lack of high-quality mathematics instruction, especially in comparison to literacy, art, and developing positive social skills, reflects a lack of attention to mathematics throughout the childhood education system, and speaks to the preparation and professional training necessary for educators (Clements et al, 2004; Copley, 2004; Feiler, 2004; Ginsburg et al., 2008; NRC, 2009; Sarama et al., 2004). Also, some early childhood programs do not focus on high quality mathematics instruction, despite research supporting the theory that early mathematics experiences promote readiness skills and can influence mathematical outcomes later in education (Brenneman et al; 2009; Clements et al., 2004; Ginsburg et al., 2008; NRC, 2009; Platas, 2008). It is important for teachers to know how to support children's mathematical development, in order to develop effective and appropriate mathematics instruction in the preschool classroom.

Difference on Knowledge of Mathematical Development between Pre-service Teachers and In-service Preschool Teachers.

Research Question 3 asked about the differences on knowledge of children's mathematical development as measured on the KMD between pre-service teachers and in-service preschool teachers. The findings of this study indicate that there was a statistically significant difference between the pre-service teachers (M = 12.27) and the in-service teachers (M = 15.80) in relation to their Knowledge of Mathematical Development. This result showed that the in-service preschool teachers' total KMD scores were higher than the KMD scores of pre-service teachers. The findings imply that pre-service teachers' knowledge of mathematical development is somewhat limited; only 60% of the pre-service teachers correctly responded to 12 items. On the other hand, 80% of the in-service preschool teachers correctly responded to 16 items. The results of Research Question 3 indicate that most pre-service teachers were less likely to correctly identify the process by where preschool children develop mathematical skills and the order of mathematical development. These findings are generally in line with other research, which indicate that teachers' knowledge of mathematical development determines their ability to make a significant impact in the development of mathematical concepts and goals in young children (Cox, 2011; Platas, 2008). Current research found that in most colleges and universities in the United States the teaching of mathematical development does not offer a substantial amount of information on the topic, or equip pre-service teachers with adequate skills for teaching mathematics to preschool children (Cox, 2011; Ginsburg et al., 2008; Platas, 2008). In addition, early childhood education courses offer few or no requirements for mathematics education for pre-service teachers (Baroody, 2004; Ginsburg et al., 2008; Platas,

2008). This leaves those with lower levels of education with no preparation to teach math in preschool (Baroody, 2004; Ginsburg et al., 2008; Sarama et al., 2004). Moreover, the education they gain while in teacher preparation programs is often not adequate for them to be efficient in their new role as preschool teachers, especially in mathematics instruction (Copley, 2004; Ginsburg et al., 2008; NRC, 2009; Platas, 2008, Sarama et al., 2004). Current studies of preschool teachers' knowledge of children's mathematical development has indicated that students who graduate from undergraduate teacher preparation programs often go into teaching with little or no training in teaching mathematics in early childhood (Copley, 2004; Cox, 2011; Ginsburg et al., 2008; NRC, 2009; Platas, 2008; Sarama et al., 2004).

For the overall sample in this study, results revealed that 39.8% pre-service teachers had less than one year of experience working with preschool children, and that only 17.3% pre-service teachers had participated in mathematics for preschool children in their professional development over the last three years. On the other hand, 87% in-service preschool teachers indicated that they had participated in mathematics for preschool children in their professional development. This may explain the results of the survey that found the KMD scores of in-service preschool teachers to be higher than the scores of pre-service teachers. This findings suggest that the level of knowledge and beliefs of preschool teachers has been significantly influenced by their training experiences and level of education received**.** The more professional training that pre-service teachers receive, the more competent they will be in the classroom.

This study emphasizes the importance of both pre-service and in-service preschool teachers' professional development necessary to improve their knowledge of mathematical development. However, current research reveals that many widely used early childhood

curricula do not provide sufficient guidance on mathematics pedagogy or content (Clements et al., 2004; Copple & Bredekamp, 2009; Ginsburg et al., 2008; NRC, 2009). Examination of current standards, curricula, and instruction in early childhood education reveals that many early childhood settings do not provide adequate learning experiences in mathematics for preschool children (Clements et al., 2004; Ginsburg et al., 2008; NAEYC & NCTM, 2002; NRC, 2009).

Professional development is very important for career development, as well as in adapting with the relevant changes in early childhood education. In this regard, both pre-service and in-service preschool teachers require professional development to improve their knowledge in mathematical development. Preschool teachers also need to understand how children learn mathematical knowledge by assessing their understanding and monitoring their progress (Clements & Sarama, 2008; Clements et al., 2008; Ginsburg et al., 2008; Platas, 2008).

Therefore, it is important for pre-service and in-service preschool teachers to know how to support children's mathematical development in the preschool classroom, in order to develop effective and appropriate classroom instruction and provide high quality mathematical teaching for preschool children.

Pre-service Teachers' Beliefs about Teaching Mathematics in Preschool Classroom

Research Question 4 asked about the beliefs of pre-service teachers about teaching mathematics in the preschool classrooms. The Belief subscales evaluated pre-service teachers' agreement with four components of mathematics curriculum in preschool classroom. High scores indicated higher agreement with the subscale. The high scores were age-appropriateness of mathematics instruction (M = 4.77), social and emotional versus mathematical development as primary goals of preschool (M = 4.70), and teacher comfort in

mathematics teaching (*M* = 4.60). These findings of high agreement implicated the importance of mathematics activities and learning in the preschool classroom. The subscale mean score for locus of generation of mathematical knowledge was (*M* = 3.70). This result reflected that most pre-service teachers believed that teachers can help preschoolers learn mathematics as well as the teacher played a central role in preschool math activities. The subscale scores in locus of generation of mathematical knowledge were most like the pre-service teachers with experiences with preschool children (77.6%). However, 65.8% pre-service teachers worked with preschool children as volunteer, and almost 40% had less than one year working experience. This may account for low scores in locus of generation of mathematical knowledge from pre-service teachers. Pre-service teachers believe it is the teacher's responsibility to intentionally teach mathematics to young children. Therefore, they need appropriate education and training to learn how to teach mathematics to young children. Previous researches have indicated that both pre-service and in-service preschool teachers have their own personal beliefs when it comes to the issue of teaching preschool children (Cox, 2011; Platas, 2008). The differences in experience and education will affect the beliefs associated with teaching mathematics. Teachers derive their behaviors, attitudes, and ethics from their own personal and professional philosophies on teaching (Platas, 2008; Rosenfeld, 2010). Rosenfeld (2010) conducted a study interviewing pre-service teachers regarding their beliefs about their own mathematics teaching abilities. Pre-service teachers also reflected on the experiences and knowledge that they needed to increase their comfort and confidence in teaching mathematics. The participants in the study generally felt that they were unprepared to teach math until they were already in the

classroom. It is therefore essential that pre-service teachers acquire adequate skills for mathematics development in early childhood education.

In-service Preschool Teachers' Beliefs about Teaching Mathematics in Preschool Classroom

The Research Question 5 asked about the beliefs of in-service preschool teachers about mathematics in preschool classroom. The Beliefs subscales evaluated in-service preschool teachers' agreement with four components of mathematics curriculum in preschool classroom. High scores indicated higher agreement with the subscale. The high scores were teacher comfort in mathematics teaching (*M* = 5.50), age-appropriateness of mathematics instruction (*M* = 5.46), and social and emotional versus mathematical development as primary goals of preschool (*M* = 5.41).These findings of high agreement signify the importance of mathematics activities and learning in preschool classrooms. Also, most in-service preschool teachers believed that they can provide effective math activities for preschoolers as well as support mathematical learning in preschool children. The subscale mean score for locus of generation of mathematical knowledge was (*M* = 3.70). This result reflects that most in-service preschool teachers believed that they can help preschoolers learn mathematics, they were also of the opinion that as teachers and they play a central role in preschool math activities. The locus of generation of mathematical knowledge in the classroom specifies how much of the responsibility for learning is on the teachers and how much of it is on the child (Platas, 2008).

Although most in-service preschool teachers agreed that teachers can help preschoolers learn mathematics, and that teachers play a central role in preschool math activities, current research has found that preschool teachers do not have adequate knowledge of mathematics to impart sufficient skills in the subject to preschool children (Combro, Jablon, & Stetson, 2011;

NRC, 2009). They are expected to use the knowledge of children's learning progression to design teaching strategies that encourage young children to enjoy mathematics and perform well in the subject (Copley, 2010; Platas, 2008). However, preschool teachers still face difficulties in designing appropriate mathematics curriculum for their children (Clements et al., 2004; Copple & Bredekamp, 2009; Ginsburg & Golbeck, 2004; Ginsburg et al., 2008; NRC, 2009).

Previous research studies have indicated that both pre-service and in-service preschool teachers have their own personal beliefs when it comes to the issue of teaching preschool children (Cox, 2011; Platas, 2008). Teachers often underestimate their children's ability to learn and practice mathematics because teachers believe that preschool children are incapable of learning mathematics (Copple, 2004; NRC, 2009). In spite of their teachers' beliefs, preschool children can be motivated to use mathematical skills in their daily interactions with one another (Brenneman et al., 2009; Copley, 2000; Copley, 2010). Preschool teachers' beliefs are significant in influencing their teaching methods and techniques (Cox, 2011; Platas, 2008). To develop math teaching and learning in preschool, administrators should reform both the contents of what is taught to young children and the methodology used in teaching mathematics at the preschool level.

Difference of Beliefs about Mathematics Teaching between Pre-service Teachers and In-Service Preschool Teachers

Research Question 6 asked about the differences between pre-service teachers and in-service preschool teachers on the four subscales of the Beliefs Survey. The findings of this study indicated that there was statistically significant difference between the pre-service teachers and in-service preschool teachers in relation to age-appropriateness of mathematics instruction,

social and emotional versus mathematical development as primary goal of preschool, and teacher comfort in mathematics instruction. These findings of high agreement implicated the importance of mathematics activities and learning in preschool classroom. Also, both pre-service teachers and in-service preschool teachers believed that they can promote create effective math activities for preschoolers as well as support math learning in preschool. Pre-service and in-service preschool teachers varying levels of experience may explain why there was a significant difference between the Beliefs Survey. In-service preschool teachers who have more experiences in teaching mathematics will have a different perspective based from their own teaching experiences compared to those who have limited or no experiences in teaching mathematics to preschool children. Previous research indicated that both pre-service and in-service preschool teachers who had more early childhood education and working experience with preschool children were highly associated with beliefs score (Platas, 2008). This implies that the level of knowledge and beliefs of preschool teachers has been significantly influenced by their training experiences and level of education received**.** Due to their years of experiences, more in-service preschool teachers seem to have a positive outlook on the performance of their children.

On the other hand, the findings of this study indicated that there was no a statistically significant difference between the pre-service teachers and in-service preschool teachers in relation to locus of generation of mathematical knowledge of Beliefs. The locus of generation of mathematical knowledge reflects how much of the responsibility for learning is on the teachers and how much of it is on the child (Platas, 2008). Although both groups believe it is the teacher's responsibility to intentionally teach mathematics to young children, current research

finds that many widely used early childhood curricula do not provide sufficient guidance on mathematics pedagogy or content (Clements et al., 2004; Copple & Bredekamp, 2009; Ginsburg et al., 2008; NRC, 2009).

Preschool teachers' beliefs are significant in influencing their teaching methods and techniques (Cox, 2011; Platas, 2008). Both pre-service and in-service preschool teachers must have adequate knowledge and strong beliefs in a particular content area and often integrate the subjects they are asked to teach (Lee & Ginsburg, 2007; Platas, 2008). They should have knowledge of creative instructional strategies, and understand common misconception errors when it comes to the mathematical development of young children (Baroody et al., 2006; Platas, 2008; Seo & Ginsburg, 2004)**.** The implementation of curriculum needs to consider materials, encourage, promote, and assess mathematical skills and knowledge development (Clements & Sarama, 2007; Clements & Sarama, 2008; Clement et al., 2008; Copley, 2010; Ginsburg et al., 2008; NAEYC & NCTM, 2002, Platas, 2008). Early childhood teachers should consider including mathematics in their respective curriculums, which can provide opportunities for young children to develop vocabulary and concepts about mathematical learning (Brenneman et al., 2009; Clements & Sarama, 2009; Copple & Bredekamp, 2009; Ginsburg et al., 2008; Klibanoff et al., 2006; NAEYC &NCTM, 2002; TEA & UT System, 2008).

The NAEYC and NCTM (2002) joint position statement addressed that math is for everyone, and all children should have chance to learn mathematics with depth and understanding. Continuing professional development and pre-service education experience provide teachers with the confidence to build positive mathematical attitudes (Copley, 2004; NAEYC & NCTM, 2002; NRC, 2009, Sarama et al., 2004).

It is important that pre-service teachers and in-service preschool teachers acquire adequate skills for mathematics development in early childhood education. They need to develop appropriate education and training to learn how to teach mathematics to young children.

Recommendations and Conclusions

There has been limited research conducted what pre-service and in-service preschool teachers know about preschool children's mathematical development and their beliefs about teaching mathematics in preschool classrooms. This study provides a perspective view on pre-service and in-service preschool teachers' knowledge of children's mathematical development and their beliefs about teaching mathematics in preschool classrooms.

Results of this study reveal that there was a statistically significant difference between the pre-service teachers and the in-service preschool teachers in relation to their Knowledge of Mathematical Development. Also, the study found a significant variation in the knowledge and beliefs of pre-service and in-service preschool teachers on age-appropriateness of mathematics instruction, social and emotional vs. mathematical development as primary goal of preschool, and teacher comfort in mathematics instruction. These findings demonstrate the importance of mathematics activities and learning play in preschool classrooms. More specifically, these findings suggest that the level of knowledge and beliefs of preschool teachers is significantly influenced by their training experiences and level of education.

The information contained in KMD and Beliefs Survey used in this research can be helpful for the preparation and professional development of current pre-service teachers and in-service preschool teachers. The KMD and Belief Survey are useful resource tools to provide

information when creating early childhood programs and courses for pre-service teachers. If instructors were to measure pre-service teachers' knowledge of children's mathematical development and their beliefs about mathematical instruction in preschool classroom before their students began the course, they could teach/implement effective mathematical teaching strategies, and pre-service teachers could gain an understanding of children's mathematical development before they began instructing students.

Recent research findings have revealed three main challenges that early childhood educators face in regard to support for mathematical development: inadequate classroom support and teacher training, teachers' beliefs about their support for mathematics in early childhood development, and inadequate facilities for monitoring development in mathematics among young children (Clements et al., 2004; Ginsburg et al., 2008; NAEYC, 2011b; NAEYC & NCTM, 2002; NRC, 2009; Platas, 2008). Many early childhood educators are aware of the importance of mathematical knowledge development in preschool. Unfortunately, there are limited studies in early childhood education that focus on the importance of preschool children's math knowledge development (Baroody et al., 2006; Clements et al., 2004; Cox, 2011; Ginsburg et al., 2008; Platas, 2008). The significance of the study derives from an analysis of the quality of knowledge and beliefs held by both pre-service and in-service teachers regarding children's mathematical development. This finding has implications for the quality of education pre-service teachers and in-service preschool teachers will deliver to preschool children. In order to promote mathematical knowledge development and provide high quality mathematics instruction in early childhood education, early childhood teachers should understand preschool children's cognitive, physical, social, emotional, and language development. Preschool teachers

in early childhood education should possess adequate knowledge and skills in mathematics; appropriate beliefs about the abilities of young children to learn math; and knowledge of developmentally appropriate methods of math instruction (Baroody, 2004; Clements, 2004; Copley, 2010; Copple & Bredekamp, 2009; Ginsburg et al., 2008; Sarama et al., 2004).

Furthermore, this study is a contribution to the growing body of research about pre-service and in-service preschool teachers' knowledge about children's mathematical development and their beliefs about teaching mathematics in preschool classroom. Participants in this study may provide fresh ideas from the perspectives of both pre-service and in-service preschool teachers that may help improve mathematical instruction for preschool children.

Future research should explore a larger population of pre-service and in-service preschool teachers. The KMD only measured pre-service and in-service preschool teachers' knowledge in the areas of numbers and operations. In order to measure other areas of pre-service and in-service preschool teachers' understanding of children's mathematical development, the KMD should be extended to include the other areas of mathematics, such as geometry, problem solving, connection and representations. This study emphasizes the importance of both pre-service and in-service preschool teachers' professional development necessary to improve their knowledge of mathematical development. It is important for early childhood educators to provide high quality mathematical experiences for preschool children in order to provide a solid, positive foundation in mathematics.

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APPENDIX A

EXTENDED LITERATURE REVIEW

Mathematical Understanding in Children

Providing high quality early childhood mathematics program for preschool children is essential. The NAEYC and NCTM (2002) joint position statement addressed that math is for everyone, and all children should have the chance to learn mathematics with depth and understanding. Current research indicates that such an undertaking requires an understanding of whether children are able to learn mathematics at such a young age; children are able to obtain mathematical knowledge and acquire sufficient mathematics skills for everyday use starting from birth to the age of five (Baroody et al., 2006; Clements & Sarama, 2007). At the preschool age, young children are building their own perceptions of what math is; what it means to know math, how to engage in mathematical thinking and learning through play, and about themselves as math learners (Copley, 2000; Copley, 2010; NAEYC & NCTM, 2002).

Current much studies indicated that two areas of mathematics are particularly important for preschool children to learn: (a) numbers, which include whole numbers, operations, and relations; and (b) geometry, spatial thinking, and measurement (Clements & Sarama, 2007; Clements & Sarama, 2009; NRC, 2009). The main concepts for the National Council of Teacher of Mathematics for prekindergarten are one-to-one correspondence, number and counting, shapes, spatial senses, logical classification, and comparing parts and wholes (Charlesworth, 2005). Children develop math concepts through learning experiences; naturalistic, informal and structured (Charlesworth, 2005; Copley, 2000; Copley, 2010; NAEYC & NCTM, 2002). Children from age three to five years old should especially focus on naturalistic and informal instruction in mathematics (Charlesworth, 2005; Copley, 2000; Copley, 2010). In order to encourage children to focus on naturalistic explorations in math learning, preschool

teachers need to provide informal scaffolding through questions (Charlesworth, 2005). In addition, many researchers have studied preschool children's mathematical development and have come to understand their developmental progression (Baroody et al., 2006; Clement & Sarama, 2007; Seo & Ginsburg, 2004). Children learn in progression; that is, as they grow and mature they are able to use their intuition to identify numbers and shapes, and can also undertake simple counting, addition or subtraction exercises (Baroody, et al., 2006; Clement et al., 2004; Clements & Sarama 2007; Clements & Sarama, 2009; NRC, 2009; Seo & Ginsburg, 2004). In order to support early mathematical development in preschool children, researchers recommend that preschool teachers: (a) purposefully use a variety of teaching strategies to promote children's learning; (b) endeavor to understand each child's own mathematical ideas and strategies; and (c) help children develop strong relationships between concepts and skills (Clements et al., 2004, p. 4).

A rich body of research has provided insight into how children's proficiency develops in all areas of math, and the instruction needed to support it. However, examination of current standards, curricula, and instruction in early childhood education reveals that many early childhood settings do not provide adequate learning experiences in mathematics (Clements et al., 2004; Ginsburg et al., 2008; NAEYC & NCTM, 2002; NRC, 2009). The relative lack of high-quality mathematics instruction, especially in comparison to literacy, art, and developing positive social skills, reflects a lack of attention to mathematics throughout the childhood education system, and speaks to the preparation and professional training necessary for educators (Clemets et al., 2004; Copley, 2004; Feiler, 2004; Ginsburg et al., 2008; NRC, 2009; Sarama et al., 2004). Also, preschool mathematics teachers do not take into consideration pre-

assessment of the children's abilities before engaging them in the subject (NRC, 2009). The implementation of curriculum needs to consider materials as well as promote/assess mathematical skills and knowledge development (Clements & Sarama, 2008; Clements, et al., 2008; Ginsburg et al., 2008; NAEYC & NCTM, 2002; Platas, 2008). Children construct their own mathematical knowledge development by interacting with others and environments (Copley, 2000; Copley, 2010; Kamii, 2004). Early childhood teachers should consider including mathematics in their curriculums, which can provide opportunities for young children to develop vocabulary and concepts about math learning (Brenneman et al., 2009; Clements & Sarama, 2009; Copple & Bredekamp, 2009; Ginsburg et al., 2008; Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges, 2006; NAEYC &NCTM, 2002; TEA & UT System, 2008). Early childhood teachers should promote the various connections between play and mathematics learning in order to promote children's learning of math skills, and enhance children's ability to develop and build mathematical knowledge (Copley, 2000; Copley, 2010; Copple & Bredekamp, 2009; NAEYC & NCTM, 2002; TEA & UT System, 2008).

The Guidelines for Supporting Preschool Mathematics Teaching

The National Council of Teachers of Mathematics (NCTM, 2000) emphasizes the need to provide high quality early childhood mathematics programs in preschools. The NCTM emphasis six principles of high-quality mathematics instruction: equity, curriculum, teaching, learning, and technology. These six principals provide for early childhood teachers to create various mathematical environments and to promote high quality mathematical teaching for all children. Six principles for school mathematics addressed by NCTM (2000) are as follows:

1. Equity: excellence in mathematics education required equity-high expectations and strong support all students.
2. Curriculum: a curriculum is more than a collection of activities; it must be coherent, focus on important mathematics, and well articulated across the grades.
3. Teaching: effective mathematics teaching requires understanding what students know and need to learn then challenging and supporting them to learn it well.
4. Learning: students must learn mathematics with understanding, actively building new knowledge from experience and previous knowledge.
5. Assessment: assessment should support the learning of important mathematics and furnish useful information to both teachers and students.
6. Technology: technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning (NCTM, 2000, p. 2-3).

The six principal should be in place to implement for all children to have high quality mathematical learning environments. Furthermore, the NAEYC and the NCTM (2002) published a position statement on the challenges of promoting early childhood mathematics and their recommendations in promoting early childhood mathematics, as well as their recommendations on the subject. Their recommendations are as follows:

1. Enhance children's natural interest in mathematics and their disposition to use it to make sense of their physical and social worlds.

2. Build on children's experience and knowledge, including their family, linguistic, cultural, and community backgrounds; their individual approaches to learning; and their informal knowledge.
3. Base mathematics curriculum and teaching practices on knowledge of young children's cognitive, linguistic, physical and social-emotional development.
4. Use curriculum and teaching practices that strengthen children's problem solving and reasoning processes as well as representing, communicating, and connecting mathematical ideas.
5. Ensure that the curriculum is coherent and compatible with known relationships and sequences of important mathematical ideas.
6. Provide for children's deep and sustained interaction with key mathematical ideas.
7. Integrate mathematics with other activities and other activities with mathematics.
8. Provide ample time, materials, and teacher support for children to engage in play, a context in which they explore and manipulate mathematical ideas with keen interest.
9. Actively introduce mathematical concepts methods, and language through a range of appropriate experiences and teaching strategies.
10. Support children's learning by thoughtfully and continually assessing all children's mathematical knowledge, skills, and strategies (p. 3).

It is important for early childhood teachers to know how to support children's mathematical development in the preschool classroom, in order to develop effective and appropriate classroom instruction and provide high quality mathematical teaching for preschool children.

Issues of Teachers Teaching Math in Preschool

Early childhood teachers need to create environments that provide young children with opportunities for learning mathematics and exploration of mathematical activities (Copley, 2000; Copley, 2010; Copple & Bredekamp, 2009; Ginsburg et al., 2008; NAEYC & NCTM, 2002; TEA & UT System, 2008). Previous research indicated that early childhood teachers have difficulty developing the quality of mathematics education in their programs because of their poor educational background and professional development (Bredekamp, 2004; Clements, et al., 2004; Copley, 2004; NAEYC & NCTM, 2002; NRC, 2009; Sarama, 2002). Current research finds that preschool teachers are uncomfortable with teaching mathematics to young children (Clements & Sarama, 2007; Copley, 2004; Ginsburg et al., 2008). They are fearful of what to teach and how to teach it (Copley, 2004; Ginsburg et al., 2008; Skipper & Collins, 2003). This situation directly correlates with early childhood teachers' lack of knowledge about teaching mathematics to preschool children. Preschool children can construct their own mathematical knowledge development through playing in, and interacting with their social and physical environment (Brenneman, et al, 2009; Copley, 2000; Copley, 2010; Kamii, 2004; NAEYC &NCTM, 2002; Platas, 2008). However, many widely used early childhood curricula do not provide sufficient guidance on mathematics pedagogy or content (Clements, 2004; Copple & Bredekamp, 2009; Ginsburg et al., 2008; NRC, 2009; Sarama et al., 2004).

Recently, educational reforms in early childhood have emphasized mathematical reasoning, problem solving, and connecting mathematical ideas and communicating mathematics to others (NRC, 2009). Other current study indicated that there are many activities involved in teaching mathematics to young children involving knowledge about the subject matter, pedagogical content knowledge, introduce of symbolism, and connecting everyday experience to abstract ideas (Ginsburg & Amit, 2008). The findings in Platas' previous research (2008) indicated that preschool teachers need to have a specific level of competency in their teaching, which can be measured through an assessment of their knowledge about math teaching. This implies that the level of knowledge and beliefs of preschool teachers has been significantly influenced by their training experiences and level of education received**.** In addition, preschool teachers must have adequate knowledge and strong beliefs in a particular content area and often integrate the subjects they are asked to teach (Lee & Ginsburg, 2007; Platas, 2008). They should have knowledge of creative instructional strategies, and understand common misconception errors when it comes to the mathematical development of young children (Baroody et al., 2006; NRC, 2009; Platas, 2008; Seo & Ginsburg, 2004)**.** Teachers need to measure children's prior mathematical knowledge and provide children to build their mathematical knowledge meaningful ways (Platas, 2008). A developmental model that coincides with the theories and research is needed to create the building blocks for a strong acquisition of mathematics (Sarama & Clements, 2004). Education and specialized training of preschool teachers is associated with young children's mathematics learning and development (Barnett, 2004; NRC, 2009). All of these issues can essentially be addressed by studying further within the context, knowledge, and ability of early educators for early childhood education.

Teachers' Knowledge of Mathematical Development

Few instruments measure preschool children's mathematics knowledge and skills, which makes developing assessment instruments for teachers' knowledge of young children's mathematical development an essential priority. These instruments, however, have limitations in their mathematical categories for preschool use (Clements et al., 2008; Platas, 2008). Platas (2008) mentioned that early mathematical development is an important step in the acquisition of mathematical knowledge by preschoolers and that it can be defined as "the increasingly complex mathematical constructions and goals that young children develop and work towards in their activities" (p. 3). It studies the teachers' knowledge of mathematical development to show their adeptness in understanding this definition and knowing how to implement developmentally appropriate programs to help their children achieve these goals. The KMD is the measure of learning and instruction skills, abilities that teachers possess, and how these things can be utilized in developing mathematics in early childhood education (Platas, 2008).

The KMD is an instrument for both pre-service and in-service preschool teachers to understand the extent of knowledge possessed by the preschool children. The survey shows teachers' knowledge of mathematical development and determines their ability to make a significant impact in young children's development of mathematical concepts and goals (Platas, 2008). The KMD is an important tool in assessing the level of mathematical development and skills of teachers, and it is necessary that teachers have full knowledge of its aspects and development strategies. This enables preschool teachers to understand and teach developmentally appropriate math skills to preschool children (Platas, 2008). When designing the KMD, two parameters were considered: the items included in the KMD should show the

current established and researched knowledge on the mathematical development in young children, and the items should show activities that can be done or that exist in the children's environment (Platas, 2008, p. 20). The sub-domains of the KMD include verbal counting sequence, counting/numerology, ordinal number words, addition/subtraction, division of sets and written number symbols, and words (Platas, 2008).

Preschool children progressively learn about the differences in numbers, which may become their basis for further expansion of their knowledge on number and operations (Clements et al., 2004; Clements & Sarama, 2007; Clements & Sarama, 2009; Platas, 2008). The two major mathematical operations carried out at the preschool level are numbers and operations. Under these broad topics, children learn about geometry, shape, pattern, algebra, measurement, symbols, spatial thinking, and problem solving (Clements, et al., 2004; Clements & Sarama, 2007; Clements & Sarama, 2009; Seo & Ginsburg, 2004; NRC, 2009). Preschool children have developed the skills of addition and subtraction of simple numbers, small sets, and operations, beginning with sets that are visible (Clements et al., 2004; Clements & Sarama, 2007; Baroody, 2004; Baroody, et al., 2006; Platas, 2008). Preschool children can solve addition and subtraction problems with small numbers when they are in the preschool classroom (Clements & Sarama, 2007). Clements and Sarama (2007) mentioned that in order for children to learn math concepts such as making shapes, counting, creating patterns, addition, subtraction, and formulating estimates that must be taught thorough, meaningful experiences. During free play time, young children can explore shapes and patterns, and create symmetries and measurement with various materials (Seo & Ginsburg, 2004). It is important for preschool teachers need to be more involved in free play time in order to promote children's

mathematics learning (Seo & Ginsburg, 2004). The explanations given above reveal how children learn mathematics in progression. Young children's mathematical development has come to understand the developmental progression (Baroody et al., 2006; Clements & Sarama, 2007; Seo & Ginsburg, 2004). Recent research has found that the amount of teacher's math-related talk promotes the development of children's mathematical knowledge development (Klibanoff, et al., 2006). Young children learn and develop various mathematical language and words through play with mathematics, such as the names of shapes and words for quantity (Ginsburg et al., 2008, p.5).

Cox (2011) conducted preschool caregivers' knowledge of mathematical development and beliefs about preschool mathematics curriculum. Her research indicated that preschool caregivers' knowledge of mathematical development is somewhat limited; only 55% of the preschool caregivers correctly responded to 11 items (p. 98-99).This result implied that most preschool caregivers had difficulty identifying the process by where preschool children develop mathematical skills and the order of mathematical development. By increasing preschool teachers' knowledge and understanding of mathematical development, children can also learn better, and as a result a more productive classroom atmosphere will be created (Akinsola, 2009; NRC, 2009). Early childhood teachers need to be required to use a curriculum that is adequate to meet their children's needs, especially for children with little prior knowledge of math (Baroody et al., 2006; Clements & Sarama, 2009; Copley, 2010; Coppel & Bredekamp, 2009; NAEYC & NCTM, 2002; TEA & UT System, 2008). Preschool teachers also need to understand how children learn mathematical knowledge by assessing their understanding and monitoring their progress (Clements & Sarama, 2008; Clements et al., 2008; Ginsburg et al., 2008; Platas,

2008). It is important for early childhood teachers to know how to promote children's mathematical development in the preschool classroom, in order to develop effective and appropriate classroom instruction.

Teachers' Beliefs about Mathematics Teaching and Learning

Preschool teachers have their own beliefs about teaching mathematics to young children (Platas, 2008). They are expected to use the knowledge of children's learning progression to design teaching strategies that encourage young children to enjoy mathematics and perform well in the subject (Copley, 2010; Platas, 2008). However, preschool teachers still face difficulties in designing appropriate mathematics curriculum for their children (Clements et al., 2004; Copple & Bredekamp, 2009; Ginsburg & Golbeck, 2004; Ginsburg et al., 2008; NRC, 2009). This problem has persisted because of two reasons: preschool teachers are not getting enough professional training in teaching math during their pre-service and in-service professional development, and school administrators may have put an old curriculum in place that does not accommodate modern flexibility in instructing students (Chien & Hui, 2010; NRC, 2009). Current research indicates that children have the capability of learning mathematics at the kindergarten level and beyond (Brenneman et al., 2009; Charlesworth, 2005). However, preschool teachers' beliefs about mathematics teaching and learning have undermined this development in young children (NRC, 2009). Preschool teachers' beliefs are significant in influencing their teaching methods and techniques (Cox, 2011; Platas, 2008). Furthermore, previous researches have indicated that both pre-service and in-service preschool teachers have their own personal beliefs when it comes to the issue of teaching preschool children (Cox, 2011; Platas, 2008). As a result of their beliefs, teachers can be blinded from seeing the true

potential of the young children they teach. If teachers are given beliefs survey, it is possible to discover their individual thoughts and expectations about teaching mathematics to preschoolers. Most preschool teachers consider these factors in math instruction: age-appropriateness, or what age is most appropriate for which math activity, whether children normally construct their mathematical knowledge naturally from their play or if they rely on their teachers to tell them exactly what to do, how to separate the goal of acquiring mathematical knowledge from the social and emotional development of the children, and how their own mathematical ability affects their ability to teach math to children (Copley, 2004; Ginsburg & Golbeck, 2004; Ginsburg et al., 2006; Platas, 2008, Sarama et al., 2004).

In order to obtain a useful beliefs survey, some important items must be considered for its design: it should be an effective study of teacher beliefs that have a direct link with the approach of teaching mathematics at preschool level; it should contain actual teachers' statements and concerns as seen in anecdotal reports and studies; and it should contain real-time activities that have been reported or observed in a preschool environment (Platas, 2008). Due to their years of experiences, more in-service preschool teachers seem to have a positive outlook on the performance of their children. Rosenfeld (2010) had explored a study interviewing pre-service teachers regarding their beliefs about their own mathematics teaching abilities. Moreover, pre-service teachers reflected on the experiences and knowledge that they needed to increase their comfort and confidence in teaching math. The participants in the study generally felt that they were unprepared to teach math until they were already in the classroom. Rosenfeld (2010) also reported that the other themes that surfaced in the interviews dealt with the use of external aids, such as the planned lesson objectives for judging

one's success in teaching, the value of knowing how to implement effective classroom management strategies, and the use of student learning evidences to determine teaching success. Other current research found that preschool teachers strongly believed that math is a necessary subject for preschoolers, that teachers should play a central role in preschool mathematics activities, that math is an important goal of the preschool curriculum, and that teachers are knowledgeable to teach math in preschool (Cox, 2011; Platas, 2008).

To develop math teaching and learning in preschool, administrators should reform both the contents of what is taught to young children and the methodology used in teaching mathematics at the preschool level.

Current Pre-Service Teacher's Mathematics Instruction

Pre-service teachers are the student teachers that go for training before undertaking teaching experience. It would emphasis that teachers of young children need to be equipped with the right skills, education, and experiences in order to teach preschool children in their most crucial years. However, the education early childhood teachers gain while in teacher preparation programs is often not adequate for them to be efficient in their new role as preschool teachers, especially in math instruction (Copley, 2004; Ginsburg et al., 2008; NRC, 2009; Platas, 2008; Sarama et al., 2004). Early childhood education programs offer few or no requirements for mathematics education (Baroody, 2004; Ginsburg et al., 2008; Platas, 2008). This leaves those with lower levels of education with no preparation to teach math in preschool (Baroody, 2004; Ginsburg et al., 2008; Sarama et al., 2004). Students who graduate from undergraduate teacher preparation programs often go into teaching with little or no training in teaching math in early childhood (Copley, 2004; Cox, 2011; Ginsburg et al., 2008; NRC, 2009;

Platas, 2008, Sarama et al., 2004). For example, two year early childhood education programs provide fewer opportunities to learn about mathematical development. In the State of California, only 9 of 109 community colleges have a course in mathematical development for early childhood education students (Chancellor's Office of the California Community Colleges, 2006). These courses are usually credited for one course, and are frequently combined with science content. Cox (2011) mentioned that the state of Texas has more requirements for math courses for pre-service teachers. Two - year colleges in Bell and Coryell Counties in Texas require that all degree programs include at least one math course, and early childhood degrees demand at least one math- based course; degrees for teacher certification requires four math-based courses. Furthermore, pre-service teachers from early childhood study in University of North Texas take four mathematics classes; College Algebra, Math method course, Math for Elementary Education I, and Math for Elementary Education II (UNT, 2012). Pre-service teachers graduating from the latter course often have more skills in mathematics development for preschool children than their counterparts (UNT, 2012). In addition, most colleges and universities in the United States leave learning about mathematical development to general child development courses, which do not offer a substantial amount of information on the topic, or equip adequate skills in teaching math to preschool children (Platas, 2008).

Continuing professional development and pre-service education experience provide teachers with the confidence to build positive mathematical attitudes (Copley, 2004; NAEYC & NCTM, 2002; NRC, 2009; Sarama et al., 2004). Pre-service teachers need to develop appropriate education and training to learn how to teach mathematics to young children. It is important

that pre-service teachers acquire adequate skills for mathematics development in early childhood education.

Professional Development for Pre-service and In-service Preschool Teachers

Previous researches have indicated the relationship between preschool teachers' quality of teaching, and the quality of education they had received from their universities or training programs (NRC, 2009). Among the 50 state-funded preschool programs, 41 require in-service teachers to have at least 15 hours of training per school year. This is not adequate enough to equip teachers with the right amount of skills to bring into the classroom (Barnett, et al., 2009; NRC, 2009). Preschool teacher's professional development should be on-going, and should be more extensive than one day a week workshops (Cwikla, 2004; NAEYC & NCTM, 2002; Sarama et al., 2004). Furthermore, training programs should allow teachers to deeply explore the content and pedagogy of mathematics related to their area (NAEYC & NCTM, 2002; Sarama et al., 2004). Professional development is very significant for career development, as well as in adapting with the relevant changes in early childhood education. Previous research indicated that early childhood teachers have difficulty developing the quality of mathematics education in their programs because of their poor educational back ground and professional development (Bredekamp, 2004; Clements et al., 2004; Copley, 2004; NAEYC & NCTM, 2002; NRC, 2009).

Early childhood teachers should incorporate a constant development approach to their teaching skills for their children. In this regard, both pre-service and in-service preschool teachers require professional development to improve their knowledge in mathematical development. In relation to professional development of early childhood teachers, the National Research Council (2009) recommends the provision of professional development to early

childhood teachers that helps them: (a) to understand the necessary mathematics, the crucial teaching learning paths, and the principles of intentional teaching and curriculum and (b) to learn how to implement a curriculum (p. 3-4).

Education and specialized training of preschool teachers are associated with young children's learning and development (Barnett, 2004). Evaluation of the impact of early childhood education teacher preparation programs and professional development conclude that benefits of high quality preschool education can only be achieved if teachers are professionally prepared and well-compensated (Barnett, 2004; NRC, 2009). Current research indicates a positive correlation between teacher professional development, increasing young children's skills in mathematics, and increasing teachers' involvement in mathematical activities (NRC, 2009). Preschool teachers should learn to be more cognisant of the way they teach and related to children. Focusing on children's progress facilitates teachers' understanding of how children learn math and how their curriculum and teaching approaches can further this development (Clements et al., 2004; NAEYC & NCAM, 2002; NRC, 2009; Sarama et al., 2004). Quality professional development for both pre-service and in-service preschool teachers in teaching mathematics should be required and pursued to achieve the objectives of mathematical development for young children (NAEYC & NCTM, 200).

In order to promote high quality mathematics education development, early childhood educators, program developers, and policy makers should: (a) create more effective early childhood teacher preparation and continuing professional development in mathematics; (b) Use collaborative processes to develop well-aligned systems of appropriate high quality standards, mathematics curriculum, and assessment; (c) design institutional structures and

policies that support teachers' mathematics learning, teamwork, and planning, and ; (d) provide necessary resources that will help overcome the barriers to increasing young children's mathematical proficiency in the classroom and community (NAEYC & NCTM, 2002, p. 3). It is essential that preschool teachers' have professional development in order to effectively plan developmentally appropriate mathematics instruction for all preschool children.

APPENDIX B

DETAILED METHODOLOGY

Purpose of the Study

The purposes of this study were to investigate pre-service teachers and in-service preschool teachers' knowledge of children's mathematical development and their beliefs about mathematics in preschool classroom, and to determine how experience differentiates the two groups. This research study employs a non-experimental research design with convenient sampling. The KMD and the Beliefs Survey were used to investigate differences between pre-service and in-service preschool teacher's knowledge of children's mathematical development, and their beliefs about teaching mathematics. This study used the instruments developed by Platas (2008): the KMD, and the Beliefs Survey. Demographic questionnaire designed for this study was utilized to gather information about the participants. The KMD is a set of 20 multiple-choice questions that tests preschool teachers' knowledge and development in the area of verbal counting sequence, counting, ordinal number of words, addition/subtraction, divisions of sets, written number symbols and words. In each survey question, the teacher-respondents are to choose which of two math skills preschool children are likely to learn first. If the respondents think that both choices are of equal difficulty, then they may choose the option of "Same." However, if the respondent does not know which skill is easier for a child to learn, he or she can choose the option "Do not know." The response was coded to reflect the correct answer, based on the recommendations of the author of the instruments (Platas, 2008).The Beliefs Survey is a set of 40 beliefs statements about mathematics teaching and learning. It has a 6-point Likert scale; responses range from *strongly agree to strongly disagree*. The items were grouped into four subscales. The Belief Survey evaluated the preschool teacher's perspective in four areas that are grouped into four subscales: (1) age-appropriateness of mathematics

instruction in the early childhood classroom (2) locus of generation of mathematical knowledge (3) social and emotional vs. mathematical development as primary goal of preschool, and (4) teacher comfort in mathematics instruction (Platas, 2008, p.6). Scores for the subscale was created by adding the item ratings in each subscale and dividing by number of items. The significance of the study will be extracted from the quality of knowledge and beliefs held by both pre-service and in-service teachers regarding children's math development, as this subject has great implications in the quality of education these teachers will deliver to young children.

Definition of Terms

For the purpose of this study, the following definitions were operationally defined as follows.

Knowledge of Early Mathematical Development

The term refers to knowledge of early mathematical development as "the increasingly complex mathematical constructions and goals that young children develop and pursue in their activities" (Platas, 2008, p.3).

Beliefs

The term refers to construct a guiding of early childhood education teachers' beliefs about the teaching and learning of mathematics in the early childhood classroom, use Dewey's (1933) classic assertion that belief "covers all the matters of which we have no sure knowledge and yet which we are sufficiently confident of to act upon and also the matters that we now accept as certainly true, as knowledge, but which nevertheless may be questioned in the future…." (p. 6).

Pre-service Preschool Teachers

The term refers to aspiring teachers of early childhood education who are qualified to teach, are majoring early childhood education, and are seeking EC-6 Certifications.

In-service Public Preschool Teachers

The term refers to teachers who are currently teaching in the preschool level of education and certified teachers. Their experience ranges from a few months to more than twenty years.

Research Questions

The researcher will compare and evaluate in-service and pre-service preschool teachers' knowledge and beliefs of mathematical development and teaching. The researcher will answer the following research questions:

To what extent, if any, is there a difference between in-service teachers and pre-service preschool teachers with regard to their knowledge of children's mathematical development and their beliefs about how to teach mathematics to preschool children?

Specifically, the following sub-questions will be answered by the study:

Research Question 1

To what extent, if any, do pre-service teachers know about preschool children's mathematical development?

Research Question 2

To what extent, if any, do in-service preschool teachers know about preschool children's mathematical development?

Research Question 3

What differences, if any, are there between pre-service teachers and in-service preschool teachers' responses on the Knowledge of Mathematical Development Survey?

Research Question 4

What are pre-service teachers' beliefs about teaching mathematics in preschool classrooms?

Research Question 5

What are in-service preschool teachers' beliefs about teaching mathematics in preschool classrooms?

Research Question 6

What differences, if any, are there between pre-service teachers and in-service preschool teachers' responses on the Beliefs Survey?

APPENDIX C

COMPLETE/UNABRIDGED RESULTS

Table C1

Frequencies and Percentages of Demographic Variables for Pre-service Teachers

Variables		*f*	%
Gender	Female	89	90.8
	Male	9	9.2
Age	18-24 years	80	81.6
	25-29 years	9	9.2
	30-35 years	5	5.1
	36-39 years	1	1.0
	40-49 years	3	3.1
Ethnic Identity	African-American Black	8	8.2
	Asian/Asian-American/ Pacific Islander	4	4.1
	Caucasian/White	56	57.1
	Hispanic/Latino/Latina	28	28.6
	Native American/American Indian/Alaskan Native	1	1.0
	Other	1	1.0
Major in Early Childhood study or Development & Family Study	Yes	75	76.5
	No	23	23.5
Classification	Junior	34	34.7
	Senior	64	65.3
Completed Math Course	College Level math	53	54.1
	College Algebra	90	91.8
	Math for Elementary Education Majors I	77	78.6
	Math for Elementary Education Majors II	67	68.4
Certifications	Bilingual Generalist EC-6	10	10.2
	ESL Generalist EC-6	54	55.1
	Generalist EC-6	18	18.4
	Generalist EC-6 with special education EC-12	16	16.3
Working experience with preschool children	Yes	76	77.6
	No	22	22.4

(table continues)

Table C1 (*continues*).

Variables		*f*	%
Job Title	Lead Teacher	6	7.9
	Assistant Teacher	19	25
	Substitute Teacher	1	1.3
	Volunteer	50	65.8
Pre-school age group	Three	4	5.3
	Fours	27	36
	Mixed Threes & Fours	44	58.7
Working experiences Years	Less than one year	39	39.8
	1-2	27	27.6
	3-5	24	24.5
	6-10	7	7.1
	11-15	1	1.0
Participate in professional development	Yes	17	17.3
	No	81	82.7

Note. n = 98.

Table C2

Frequencies and Percentages of Demographic Variables for In-service Preschool Teachers

Variables		*f*	%
Gender	Female	76	98.7
	Male	1	1.3
Age	18-24 years	1	1.3
	25-29 years	9	11.7
	30-35 years	16	20.8
	36-39 years	14	18.2
	40-49 years	22	28.6
	50-59 years	14	18.2
	60 and above	1	1.3
Ethnic Identity	African-American Black	2	2.6
	Asian/Asian-American/ Pacific Islander	4	5.2
	Caucasian/White	57	74.0
	Hispanic/Latino/Latina	10	13.0
	Native American/American Indian/Alaskan Native	1	1.3
	Other	3	3.9
Certifications	Bilingual Generalist EC-6	7	9.1
	Elementary with EC Endorsement	14	18.2
	Pre K-4	27	35.1
	Pre K-6	15	19.5
	Special Education/Kindergarten	18	23.4
	ESL Generalist EC-6	24	31.2
	Generalist EC-6	9	11.7
	Generalist EC-6 with special education EC-12	24	31.2
School District	Denton ISD	16	20.8
	Denison ISD	3	3.9
	Frisco ISD	22	28.6
	Lewisville ISD	5	6.5
	McKinney ISD	18	23.4
	Plano ISD	1	1.3
	Other	12	15.6

(table continues)

Table C2 (*continues*).

Variables		*f*	%
Degree	Bachelor's Degree	57	74.0
	Master's Degree	19	24.7
	Doctors'	1	1.3
Completed Math Course	College Level math	48	62.3
	College Algebra	44	57.1
	Math for Elementary Education Majors I	36	46.8
	Math for Elementary Education Majors II	20	26.0
Participate in professional development	Yes	67	87.0
	No	10	13.0
Years of work experience	1-2	6	7.8
	3-5	25	32.5
	6-10	21	27.3
	11-15	17	22.1
	16-19	3	3.9
	20 or more years	5	6.5
Pre-school age group	Three	4	5.2
	Fours	31	40.3
	Mixed Threes & Fours	42	54.5
Job Title	Principal	1	1.3
	Assistant Principal	1	1.3
	Instructional Specialist	2	2.6
	Head Start Teacher	14	18.2
	Bilingual Head Start Teacher	2	2.6
	Pre-K Teacher	21	27.3
	Bilingual Pre-K Teacher	2	2.6
	ESL Pre-K Teacher	5	6.5
	SPED Pre-K Teacher	15	19.5
	PPCD Teacher	14	18.2

Note. n = 77.

Table C3

Cronbach's Alpha for KMD and Beliefs Survey

Survey	Number of Items	Cronbach's Alpha
KMD	20	0.81
Belief		
Age-Appropriateness of Mathematics as a preschool subject	10	0.92
Classroom Locus of Generation of Mathematical Knowledge	12	0.66
Primary Classroom Goals: Social and Emotional Vs. Mathematical Development	8	0.86
Teacher Comfort with Classroom Support of Mathematical Development	10	0.92

Note. N = 175.

Table C4

Frequencies and Percentages of Responses either "Same" or "Do not Know" for Pre-service Teachers

Item Number	Same		Do not know	
	f	%	*f*	%
KMD 9	36	36.7	5	5.1
KMD 7	35	35.7	3	3.1
KMD 10	35	35.7	13	13.3
KMD 18	32	32.7	3	3.1
KMD 19	28	28.6	6	6.1
KMD 14	22	22.4	6	6.1
KMD 11	21	21.4	7	7.1
KMD 16	21	21.4	4	4.1
KMD 15	20	20.4	10	10.2
KMD 8	16	16.3	3	3.1
KMD 17	16	16.3	6	6.1
KMD 2	14	14.3	4	4.1
KMD 12	11	11.2	3	3.1
KMD 4	10	10.2	10	10.2
KMD 5	10	10.2	8	8.2
KMD 20	9	9.2	9	9.2
KMD 6	8	8.2	12	12.2
KMD 13	11	11.2	3	3.1
KMD 1	6	6.1	0	0
KMD 3	6	6.1	3	3.1

Note. n = 98.

Table C5

Frequencies and Percentages of Responses either "Same" or "Do not know" for In-service Preschool Teachers

Item Number	Same		Do not know	
	f	%	*f*	%
KMD 10	15	19.5	12	15.6
KMD 9	13	16.9	2	2.6
KMD 14	10	13.0	7	9.1
KMD 18	9	11.7	1	1.3
KMD 4	8	10.4		
KMD 15	8	104	5	6.5
KMD 19	7	9.1	2	2.6
KMD 7	6	7.8	1	1.3
KMD 11	6	7.8		
KMD 8	5	6.5		
KMD 16	5	6.5	1	1.3
KMD 17	5	6.5	4	5.2
KMD 1	3	3.9		
KMD 2	3	3.9	1	1.3
KMD 5	2	2.6	2	2.6
KMD 6	2	2.6	6	7.8
KMD 12	2	2.6		
KMD 20	2	2.6	4	5.2
KMD 13	1	1.3	8	10.4

Note. n = 77.

Table C6

Frequencies and Percentages of Age-Appropriateness of Mathematics Instruction Subscale for Pre-service Teachers

#	Item	Agree		Disagree	
		f	%	*f*	%
4	*Preschoolers are capable of learning of math.	97	98.9	1	1.0
39	*Math is a worthwhile and necessary subject for preschoolers.	91	92.9	7	7.1
22	*Children are ready for math activities in preschool.	88	89.9	10	10.1
35	*Mathematical activities are age-appropriate for preschoolers.	85	86.7	13	13.2
15	*Most preschoolers are ready for participation in math activities.	77	78.6	21	21.4
29	Math is confusing to preschoolers.	30	30.5	68	69.4
37	Very few preschoolers are ready for math in preschool.	14	14.3	84	85.7
31	Academic subjects such as mathematics are too advanced for preschoolers.	11	11.2	87	88.8
2	It is better to wait until kindergarten for math activities.	9	9.2	89	90.8
3	Mathematical activities are an inappropriate use of time for preschoolers; because they aren't ready for them.	5	5.0	93	94.9

Note. *indicates this statement is reversed coded while calculating the average score of four domains. *Note. n* = 98.

Table C7

Frequencies and Percentages of Locus of Generation of Mathematical Knowledge Subscale for Pre-service Teachers

#	Item	Agree		Disagree	
		f	%	*f*	%
18	*Teachers can help preschoolers learn mathematics.	97	99.0	1	1.0
10	*The teacher should play a central role in preschool mathematics activities.	92	93.9	6	6.1
36	*Teachers should show preschoolers the correct way of doing mathematics.	72	73.4	26	26.5
8	Preschoolers learn mathematics without support from teachers.	69	70.4	29	29.6
13	*Preschoolers learn mathematics best through direct teaching of basic skills.	64	65.3	34	34.7
38	*Before kindergarten, preschool teachers should make sure preschoolers memorize verbal counting numbers.	61	62.3	37	37.7
6	*Math flashcards are appropriate for preschoolers.	50	51.0	48	49.0
19	*In preschool, children should learn specific procedures for solving math problems (i.e,. 2+4).	42	42.8	56	57.1
32	*Preschool teachers are responsible for making sure that preschoolers can learn the right answer in mathematics.	41	41.8	57	58.1
23	In preschool, children construct their mathematical knowledge without the help of a teacher.	39	39.8	59	60.1
25	*Teachers should help preschool children memorize number facts.	32	32.6	66	67.3
33	*Math work sheets are appropriate for preschool teachers.	9	9.1	89	90.8

Note. n = 98.

Table C8

Frequencies and Percentages of Social and Emotional versus Mathematical Development as Primary Goals Subscale for Pre-service Teachers

#	Item	Agree		Disagree	
		f	%	*f*	%
1	*Math is an important part of the preschool curriculum.	95	97.0	3	3.0
9	*Math activities are a very important part of the preschool experiences.	92	94.0	6	6.1
7	*Math activities are good opportunities to develop social skills in preschool.	89	90.8	9	9.2
16	Social and emotional development is the primary goal of preschool and time spent on math takes away from this goal.	35	63.0	36	64.2
12	*Supporting development in academic subject such as math is the primary goal of preschool education.	59	60.2	39	39.7
26	Preschool children are not socially or emotionally ready for math activities.	12	12.3	86	87.8
28	If a preschool teacher spends time in math activities in the classroom, social and emotional development will be neglected.	8	8.1	90	91.8
20	Preschool math will weaken preschoolers' self confidence.	6	6.2	92	93.8

Note. *indicates this statement is reversed coded while calculating the average score of four domains. *Note. n* = 98.

Table C9

Frequencies and Percentages of Teacher Comfort in Mathematics Instruction Subscale for Pre-service Teachers

#	Item	Agree		Disagree	
		f	%	*f*	%
5	*I am knowledgeable enough to teach math in preschool.	90	91.9	8	8.2
21	*I can think of many math activities that would be appropriate for preschoolers.	89	90.8	9	9.1
30	*I can create effective math activities for preschoolers.	87	88.8	11	11.2
27	*Math would be easy for me to incorporate into preschool curricula.	84	85.7	14	14.3
40	*I know how to support math learning in preschool.	78	79.6	20	20.4
14	I am unsure how to support math development for young children.	30	30.6	68	69.4
17	Math is/would be a difficult subject for me to teach in preschool.	24	24.4	74	75.5
34	I don't know how to teach math to preschoolers.	20	20.4	78	79.6
11	Teaching mathematics to preschools is/would be uncomfortable for me.	16	16.3	82	83.6
24	I don't know enough math to teach it in preschool.	4	4.1	94	95.9

Note. *indicates this statement is reversed coded while calculating the average score of four domains. *Note. n* = 98.

Table C10

Frequencies and Percentages of Age-Appropriateness of Mathematics Instruction Subscale for In-service Preschool Teachers

#	Item	Agree		Disagree	
		f	%	*f*	%
35	*Mathematical activities are age-appropriate for preschoolers.	75	97.4	2	2.6
39	*Math is a worthwhile and necessary subject for preschoolers.	75	97.4	2	2.6
4	*Preschoolers are capable of learning of math.	74	96.1	3	3.9
22	*Children are ready for math activities in preschool.	74	96.1	3	3.9
15	*Most preschoolers are ready for participation in math activities.	71	92.2	6	7.8
37	Very few preschoolers are ready for math in preschool.	7	9.1	70	90.9
29	Math is confusing to preschoolers.	6	7.8	71	92.3
3	Mathematical activities are an inappropriate use of time for preschoolers; because they aren't ready for them.	5	6.5	72	93.5
31	Academic subjects such as mathematics are too advanced for preschoolers.	4	5.2	73	94.8
2	It is better to wait until kindergarten for math activities.	3	3.9	74	96.1

Note. *indicates this statement is reversed coded while calculating the average score of four domains. *Note. n* = 77.

Table C11

Frequencies and Percentages of Locus of Generation of Mathematical Knowledge Subscale for In-service Preschool Teachers

#	Item	Agree		Disagree	
		f	%	*f*	%
18	*Teachers can help preschoolers learn mathematics.	75	97.4	2	2.6
10	*The teacher should play a central role in preschool mathematics activities.	74	96.2	3	3.9
36	*Teachers should show preschoolers the correct way of doing mathematics.	62	80.6	15	19.5
13	*Preschoolers learn mathematics best through direct teaching of basic skills.	57	74.1	20	26
38	*Before kindergarten, preschool teachers should make sure preschoolers memorize verbal counting numbers.	52	67.6	25	32.5
19	*In preschool, children should learn specific procedures for solving math problems (i.e,. 2+4).	35	45.5	42	54.6
32	*Preschool teachers are responsible for making sure that preschoolers can learn the right answer in mathematics.	35	45.5	42	54.6
6	*Math flashcards are appropriate for preschoolers.	33	42.9	44	57.2
8	Preschoolers learn mathematics without support from teachers.	31	40.3	46	59.8
23	In preschool, children construct their mathematical knowledge without the help of a teacher.	31	40.3	46	59.8
25	*Teachers should help preschool children memorize number facts.	13	16.9	64	83.1
33	*Math work sheets are appropriate for preschool teachers.	10	13	67	87

Note. *indicates this statement is reversed coded while calculating the average score of four domains. *Note. n* = 77.

Table C12

Frequencies and Percentages of Social and Emotional versus Mathematical Development as Primary Goals Subscale for In-service Preschool Teachers

#	Item	Agree		Disagree	
		f	%	*f*	%
1	*Math is an important part of the preschool curriculum.	76	98.7	1	1.3
9	*Math activities are a very important part of the preschool experiences.	76	98.7	1	1.3
7	*Math activities are good opportunities to develop social skills in preschool.	75	97.4	2	2.6
12	*Supporting development in academic subject such as math is the primary goal of preschool education.	67	87.1	10	13.0
16	Social and emotional development is the primary goal of preschool and time spent on math takes away from this goal.	13	16.9	64	83.2
20	Preschool math will weaken preschoolers' self confidence.	6	7.8	71	92.2
26	Preschool children are not socially or emotionally ready for math activities.	5	6.5	72	93.5
28	If a preschool teacher spends time in math activities in the classroom, social and emotional development will be neglected.	4	5.2	73	94.8

Note. *indicates this statement is reversed coded while calculating the average score of four domains. *Note. n* = 77.

Table C13

Frequencies and Percentages of Teacher Comfort in Mathematics Instruction Subscale for In-service Preschool Teachers

#	Item	Agree		Disagree	
		f	%	*f*	%
21	*I can think of many math activities that would be appropriate for preschoolers.	75	97.4	2	2.6
30	*I can create effective math activities for preschoolers.	75	97.4	2	2.6
40	*I know how to support math learning in preschool.	75	97.4	2	2.6
5	*I am knowledgeable enough to teach math in preschool.	74	96.1	3	3.9
27	*Math would be easy for me to incorporate into preschool curricula.	72	93.5	5	6.5
14	I am unsure how to support math development for young children.	10	13	67	87.1
11	Teaching mathematics to preschools is/would be uncomfortable for me.	6	7.8	71	92.2
17	Math is/would be a difficult subject for me to teach in preschool.	5	6.5	72	93.5
24	I don't know enough math to teach it in preschool.	5	6.5	72	93.5
34	I don't know how to teach math to preschoolers.	4	5.2	73	94.8

Note. *indicates this statement is reversed coded while calculating the average score of four domains. *Note. n* = 77.

APPENDIX D

OTHER ADDITIONAL MATERIALS

UNT

A green light to greatness.™

Office of the Vice President of Research and Economic Development

OFFICE OF RESEARCH SERVICES

January 31, 2013

Supervising Investigator: Dr. George Morrison
Student Investigator: In Hong Kim
Department of Teacher Education and Administration
University of North Texas

RE: Human Subjects Application No. 13-056

Dear Dr. Morrison:

In accordance with 45 CFR Part 46 Section 46.101, your study titled "Preschool Mathematics: Pre-service and In-service Preschool Teachers' Knowledge of Children's Mathematical Development and their Beliefs about Mathematics Teaching" has been determined to qualify for an exemption from further review by the UNT Institutional Review Board (IRB).

Enclosed is the consent document with stamped IRB approval. Please copy and **use this form only** for your study subjects.

No changes may be made to your study's procedures or forms without prior written approval from the UNT IRB. Please contact Shelia Bourns, Research Compliance Analyst, ext. 4643, if you wish to make any such changes. Any changes to your procedures or forms after three years will require completion of a new IRB application.

We wish you success with your study.

Sincerely,

Patricia L. Kaminski, Ph.D.
Associate Professor
Chair, Institutional Review Board

PK:sb

UNIVERSITY OF NORTH TEXAS

1155 Union Circle #305250 Denton, Texas 76203-5017
940.565.3940 940.565.4277 fax http://research.unt.edu

University of North Texas Institutional Review Board

Informed Consent Form

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

Title of Study: Preschool Mathematics: Pre-service and In-service Preschool Teachers' knowledge of children's Mathematical Development and their Beliefs about Mathematics Teaching

Student Investigator: In Hong Kim, University of North Texas (UNT) Department of Teacher Education &Administration. **Supervising Investigator:** Dr. George S. Morrison.

Purpose of the Study: You are being asked to participate in a research study which involves pre-service and in-service preschool teachers' knowledge of children's mathematical development and their beliefs about mathematics teaching in preschool classroom. The purpose of this study is to investigate pre-service and in-service preschool teachers' knowledge of children's mathematical development and their teaching beliefs of mathematics, and to determine how experience differentiates the two groups.

Study Procedures: You will be asked to fill out demographic questionnaire and it will take five minutes to complete. Then, you will be asked to complete two surveys which is KMD (Knowledge mathematical development) and Beliefs survey. The surveys will take about fifteen minutes of your time to fill out the surveys.

Foreseeable Risks: No foreseeable risks are involved in this study.

Benefits to the Subjects or Others: This study is not expected to be of any direct benefit to you, but we hope to learn more about preschool children's knowledge of mathematical development. It may contribute to a better understanding for about preschool on children's math learning and development and how to teach the subject more effectively. This research may be beneficial to teachers to promote high quality math programs, as well as have professional development and training of math teaching for preschool children.

Compensation for Participants: Pre-service teachers will receive ball pen set which includes five different colors when they complete survey. In-service preschool teachers will receive a five dollars Star Bucks gift card after they complete the surveys.

Procedures for Maintaining Confidentiality of Research Records: Information obtained will be kept confidential. The data, which includes signed consent forms and coded survey results,

will be kept in a locked filing cabinet in the principal investigator's office at UNT. The researcher will keep the data for three years and then all personally identifiable information will be destroyed. The confidentiality of your individual information will be maintained in any publications or presentations regarding this study.

Questions about the Study: If you have any questions about the study, you may contact In Hong Kim at telephone number or the faculty advisor Dr. George S. Morrison at telephone number 940-565-4476.

Review for the Protection of Participants: This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

Research Participants' Rights:

Your signature below indicates that you have read or have had read to you all of the above and that you confirm all of the following:

- In Hong Kim has explained the study to you and answered all of your questions. You have been told the possible benefits and the potential risks and/or discomforts of the study.
- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- Your decision whether to participate or to withdraw from the study will have no effect on your grade or standing in this course.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You have been told you will receive a copy of this form.

_____
Printed Name of Participant

_____ _____
Signature of Participant Date

APPROVED BY THE UNT IRB
1/31/13 TO 1/30/14

For the Student Investigator or Designee:

I certify that I have reviewed the contents of this form with the subject signing above. I have explained the possible benefits and the potential risks and/or discomforts of the study. It is my opinion that the participant understood the explanation.

_____ _____

Signature of Student Investigator Date

APPROVED BY THE UNT IRB
FROM 1/31/13 TO 1/30/14

Demographic Questionnaire for Pre-Service Teachers

1. Gender

_____ Female _____ Male

2. Age

_____ 18-24 _____ 25-30 _____ 30-35 _____ 36-39

_____ 40-49 _____ 50-59 _____ 60 and above

3. Racial/Ethnic group

_____ African-American Black

_____ Asian/Asian-American/Pacific Islander

_____ Caucasian/White

_____ Hispanic/Latino/Latina

_____ Native American/American Indian/Alaskan Native

_____ Multi-Ethnic (please specify)

_____ Other _____

4. Are you currently enrolled in a university majoring in Early Childhood Study and Development and Family Studies?

_____ Yes _____No

5. What is your classification?

_____Sophomore _____Junior _____Senior

6. Which specific university mathematics courses have you completed (Check all that apply)?

_____College level math _____College Algebra

___Math for Elementary Education Majors I __Math for Elementary Education Majors II

7. Which certification are you seeking (Check all that apply)?

___ Bilingual Generalist EC-6 _____ ESL Generalist EC-6

___Elementary with EC Endorsement _____Generalist EC-6

____Generalist EC-6 with special education EC-12 ____ Special Education/Kindergarten ____

Pre K-4 ____Pre K-6

8. Have you worked with preschool children (Working experience)?

_____Yes _____No

9. What best describes your job title?

____ Lead teacher _____ Assistant teacher

_____ Substitute Teacher _____Volunteer

10. What ages of children do you work with most frequently?

_____Threes _____Fours _____Mixed Threes and Fours

11. How many years have you worked with preschool children?

_____Less than 1 year _____1-2 _____3-5 _____6-10

_____11-15 _____16-20 _____20 years more

12. Have you participated in any professional development that included training about children's mathematical activities within the last three years?

_____ Yes _____ No

Please go on to the next section, Thank you.

Demographic Questionnaire for In-Service Preschool Teachers

1. Gender

_____Female _____Male

2. Age

____18-24 _____25-30 _____30-35 _____36-39 _____40-49

_____50-59 _____60 and above

3. Racial/Ethnic group

_____African-American Black

_____ Asian/Asian-American/Pacific Islander

_____ Caucasian/White

_____ Hispanic/Latino/Latina

_____ Native American/American Indian/Alaskan Native

_____ Multi-Ethnic (please specify)

_____Other _____

4. What is your certification (Check all that apply)?

____ Bilingual Generalist EC-6 _____Elementary with EC Endorsement

____Pre K-4 ____Pre K-6 _____Special Education /Kindergarten

____ESL Generalist EC-6 _____Generalist EC-6

_____ Generalist EC-6 with Special Education EC-12

5. Which school district does your school belong to?

_____ Carrollton ISD _____ Denton ISD _____Denison ISD

_____Frisco ISD _____Sheman ISD _____Lewisville ISD _____McKinney ISD

_____Plano ISD ____Other (Please Specify)_____

6. What is the highest level of education you have completed?

___ Bachelor's Degree __ Master's Degree ____ Doctor's Degree

7. Which specific University mathematics courses have you completed (check all that apply)?

____ College level math _____College Algebra

___Math for Elementary Education Majors I ____ Math for Elementary Education Majors II

8. Have you participated in any professional development that included training about children's mathematical activities within the last three years?

_____ Yes _____ No

9. How many years have you worked with preschool children?

_____1-2years _____3-5 years _____6-10 years _____11-15 years

_____16-20 years _____20 or more years

10. What ages of children do you work with most frequently?

_____Threes _____ Fours _____Mixed threes and fours

11. What best describes your job title (Please Write Down)?

_____

Please go on the next section, Thank you.

ACKNOWLEDGEMENTS

Appreciation is extended to Dr. Linda Michele Platas. The Knowledge of Mathematical Development Survey (KMD) and Beliefs Survey are reproduced with permission from Dr. Linda Michele Platas.

Knowledge of Mathematical Development Survey

For each of the following sets of statements, check the box corresponding to the statement that describes the math skill that a child is likely to learn first. If they are equally easy for a young child, check the box next to "Same." Do not guess if you do not know the answer, instead, check "Do not know".

---

1. ☐ Sam says the counting words in order from 1 to 10 (i.e., "1, 2, 3, 4, 5, 6, …).
   ☐ Sam says the counting words in order from 1 to 13 (i.e., "1, 2, 3, 4, 5, 6, …).
   ☐ Same
   ☐ Do not know

---

2. ☐ Jamie says the counting words in order from 1 to 10 (i.e., "1, 2, 3, 4, 5, 6, 7, 8, 9, 10").
   ☐ Jamie says the counting words in order from 6 to 10 (i.e., "Can you count starting with the number 6? Six…" Answer… "7, 8, 9, 10").
   ☐ Same
   ☐ Do not know

---

3. ☐ Pauli counts a group of seven buttons without touching them.
   ☐ Pauli counts a touchable group of seven buttons.
   ☐ Same
   ☐ Do not know

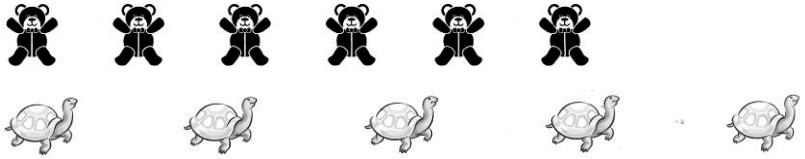
---

4. ☐ Angel matches seven forks in one-to-one correspondence with seven plates.
   ☐ Angel counts a row of seven forks.

   ☐ Same
   ☐ Do not know

---

5. ☐ Ali answers the question, “Are there more teddy bears or more turtles?”



☐ Ali counts a row of eight teddy bears.

☐ Same

☐ Do not know

---

6. ☐ Shea answers the question “Here are two groups of teddy bears. How many all together?” when presented with two groups of two teddy bears.

☐ Shea answers the question: “What is two plus two?”

☐ Same

☐ Do not know

---

7. ☐ Jaiden answers, “How many buttons” after counting a set of six buttons.

☐ Jaiden counts a row of six buttons (i.e., “1, 2, 3, 4, 5, 6”).

☐ Same

☐ Do not know

---

8. ☐ Micah answers the question, “What number comes after five?”

☐ Micah says the counting words in order from 1 to 6 (i.e., “1, 2, 3, 4, 5, 6”).

☐ Same

☐ Do not know

---

9. ☐ Cimarron says the counting words in order from 1 to 10 (i.e., “1, 2, 3, 4, …).

☐ Cimarron counts a row of ten buttons. 

☐ Same

☐ Do not know

---

10. ☐ Cyprus answers the question, “What is five plus one?”

☐ Cyprus answers the question, “What is one plus five?”

☐ Same

☐ Do not know

---

11. ☐ Pilar counts a circle of seven buttons.

☐ Pilar counts a row of seven buttons.

☐ Same

☐ Do not know

---

12. ☐ Kaiden says the counting words in order from 1 to 6 (i.e., “1, 2, 3, 4, 5, 6”).

☐ Kaiden answers the question, “What number comes before six?”

☐ Same

☐ Do not know

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13. ☐ Amari is presented with two groups of buttons, one with five buttons and one with two buttons. When asked “How many altogether?” in the two groups, Amari counts all of the buttons beginning with the group of five buttons (“1, 2, 3, 4, 5, 6, 7”).

☐ Amari is presented with two groups of buttons, one with five buttons and one with two buttons. When asked “How many altogether?” in the two groups, Amari counts on from the first set (“5, 6, 7”). 

☐ Same

☐ Do not know

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14. ☐ Teagan answers the following addition question: “If you have these five cookies and I give you two more, how many cookies will you have altogether?” (all cookies are present).
    ☐ Teagan answers the following subtraction question: “If you have these three cookies and you give me one, how many cookies will you have left?” (all cookies are present)
    ☐ Same
    ☐ Do not know

15. ☐ Kim divides twelve cookies between two puppets equally (“Here are twelve cookies, can you give Elmo and Ernie the same number of cookies?”).
    ☐ Kim divides twelve cookies between three puppets equally (“Here are twelve cookies, can you give Elmo, Ernie, and Bert the same number of cookies?”).
    ☐ Same
    ☐ Do not know

16. ☐ Sage counts a row of seven buttons.
    ☐ Sage produces a group of seven buttons from a larger set (i.e., “Can you take seven buttons out of this box of buttons?).
    ☐ Same
    ☐ Do not know

17. ☐ Justine writes one digit numerals (i.e., can write the number symbol “4”).
    ☐ Justine recognizes one digit numerals (i.e., can point out a “4” in a small group of printed numbers).
    ☐ Same
    ☐ Do not know

18. ☐ In a line of five toy sheep facing the same direction, Indigo answers the question, “Point to the second sheep in line.”

☐ In a line of five toy sheep facing the same direction, Indigo answers the question, “Point to the first sheep in line.”

☐ Same

☐ Do not know

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19. ☐ Peyton counts a group of 8 buttons (not in a row).

☐ Peyton counts a row of 8 buttons.

☐ Same

☐ Do not know

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20. ☐ Daevon recognizes one digit numerals (for instance, can point out a “4” in a group of printed numbers).

☐ Daevon reads single digit number words (for instance, can read the word “four”).

☐ Same

☐ Do not know

Beliefs Survey

Check the box that best describes your agreement/disagreement with the statement (check only one box).

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	
☐	☐	☐	☐	☐	☐	1. Math is an important part of the preschool curriculum.
☐	☐	☐	☐	☐	☐	2. It is better to wait until kindergarten for math activities.
☐	☐	☐	☐	☐	☐	3. Mathematical activities are an inappropriate use of time for preschoolers; because they aren't ready for them.
☐	☐	☐	☐	☐	☐	4. Preschoolers are capable of learning math.
☐	☐	☐	☐	☐	☐	5. I am knowledgeable enough to teach math in preschool.
☐	☐	☐	☐	☐	☐	6. Math flashcards are appropriate for preschoolers.
☐	☐	☐	☐	☐	☐	7. Math activities are good opportunities to develop social skills in preschool.
☐	☐	☐	☐	☐	☐	8. Preschoolers learn mathematics *without* support from teachers.
☐	☐	☐	☐	☐	☐	9. Math activities are a very important part of the preschool experience.
☐	☐	☐	☐	☐	☐	10. The teacher should play a central role in preschool mathematics activities.
☐	☐	☐	☐	☐	☐	11. Teaching mathematics to preschoolers is/would be uncomfortable for me.

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	
☐	☐	☐	☐	☐	☐	12. Supporting development in academic subjects such as math is the *primary* goal of preschool education.
☐	☐	☐	☐	☐	☐	13. Preschoolers learn mathematics *best* through direct teaching of basic skills.
☐	☐	☐	☐	☐	☐	14. I am unsure how to support math development for young children.
☐	☐	☐	☐	☐	☐	15. Most preschoolers are ready for participation in math activities.
☐	☐	☐	☐	☐	☐	16. Social and emotional development is the *primary* goal of preschool and time spent on math takes away from this goal.
☐	☐	☐	☐	☐	☐	17. Math is/would be a difficult subject for me to teach in preschool.
☐	☐	☐	☐	☐	☐	18. Teachers can help preschoolers learn mathematics.
☐	☐	☐	☐	☐	☐	19. In preschool, children should learn *specific* procedures for solving math problems (i.e., 2 + 4).
☐	☐	☐	☐	☐	☐	20. Preschool math will weaken preschoolers' self confidence.
☐	☐	☐	☐	☐	☐	21. I can think of many math activities that would be appropriate for preschoolers.
☐	☐	☐	☐	☐	☐	22. Children are ready for math activities in preschool.
☐	☐	☐	☐	☐	☐	23. In preschool, children construct their mathematical knowledge *without* the help of a teacher.
☐	☐	☐	☐	☐	☐	24. I don't know enough math to teach it in preschool.

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	
☐	☐	☐	☐	☐	☐	25. Teachers should help preschool children memorize number facts (for instance, 2+3).
☐	☐	☐	☐	☐	☐	26. Preschool children are *not* socially or emotionally ready for math activities.
☐	☐	☐	☐	☐	☐	27. Math would be easy for me to incorporate into preschool curricula.
☐	☐	☐	☐	☐	☐	28. If a preschool teacher spends time in math activities in the classroom, social and emotional development will be neglected.
☐	☐	☐	☐	☐	☐	29. Math is confusing to preschoolers.
☐	☐	☐	☐	☐	☐	30. I can create effective math activities for preschoolers.
☐	☐	☐	☐	☐	☐	31. Academic subjects such as mathematics are too advanced for preschoolers.
☐	☐	☐	☐	☐	☐	32. Preschool teachers are responsible for making sure that preschoolers can learn the right answer in mathematics.
☐	☐	☐	☐	☐	☐	33. Math worksheets are appropriate for preschoolers.
☐	☐	☐	☐	☐	☐	34. I don't know how to teach math to preschoolers.
☐	☐	☐	☐	☐	☐	35. Mathematical activities are age-appropriate for preschoolers.
☐	☐	☐	☐	☐	☐	36. Teachers should show preschoolers the correct way of doing mathematics.
☐	☐	☐	☐	☐	☐	37. Very *few* preschoolers are ready for math in preschool.

Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree	
☐	☐	☐	☐	☐	☐	38. Before kindergarten, preschool teachers should make sure preschoolers memorize verbal counting numbers.
☐	☐	☐	☐	☐	☐	39. Math is a worthwhile and necessary subject for preschoolers.
☐	☐	☐	☐	☐	☐	40. I know how to support math learning in preschool.

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