

## RESEARCH ARTICLE

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### Teachers' Beliefs Count: Teacher Beliefs and Practice in Early Childhood Mathematics Education (ECME)

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Teachers are the key to success in Early Childhood Mathematics Education (ECME) and as such, there is a great need to focus on the teacher's mind...what teachers think about learning, their curriculum and the mathematics in it (Ginsburg, Lee and Boyd, 2008; Cross, Woods and Schweingruber, 2009). Early childhood teachers were surveyed on their beliefs and practices related to ECME. The findings suggest that early childhood teachers may not hold as negative a view of mathematics and ECME as previously has been supposed. Moreover, more instruction time seems to be devoted to ECME than previously reported. However, the findings also strengthen the contention that literacy-based activities dominate academic instructional time in the early childhood classroom. In line with the literature, the teachers expressed a narrow view of EMCE, with numeracy and arithmetic skill development as the most important focus of ECME; this narrow view is counter to recent recommendations by leading researchers and professional organizations.

A substantial body of developmental research today supports that from infancy, young children engage in diverse mathematical thinking; literally, they are born to be mathematicians (Gallistel and Gelman, 2005; Geist, 2009; Gelman, 2006; Xu, Spelke and Goddard, 2005). This has created a shift in paradigm: from formal mathematics education for young children in the last century being considered "developmentally inappropriate" and delayed until elementary school (Balfanz, 1999; Geary, 1996; Ginsburg, 2009) to a new emphasis today on the importance of early child mathematics education (ECME) as critical for laying a foundation for future mathematics and academic success (Cross, Woods and Schweingruber, 2009; Duncan et al., 2007; Samara and Clements, 2009). Concomitant with the rise in research highlighting children's early mathematical competencies has been the growth of guidelines and standards of practice for preschool-level mathematics.

Despite wide variability, forty-nine states now have some form of standards for early mathematics education (Cross et al., 2009). Most pre-school level mathematics guidelines in the U.S. are based on a few major sources (Clements, Sarama and DiBiase, 2004; NAEYC, 2002/2010; NCTM, 2000; NCTM 2006; Cross et al., 2009). These professional and research-

based sources all outline early intentional learning in five major “core knowledge” areas: number and operations, geometry, measurement, algebraic thinking, and data analysis. This expansion to five critical core mathematical knowledge areas constitutes a broadening of the scope of previous practice from a narrowed focus of *early mathematics = numeracy* to encompass concepts critical for decision making in daily life that have often been excluded in the past (McCrone and Dossey, 2007). Even with this expanded view of pre-school mathematical content, number is still emphasized as the critical foundational area, followed closely by geometry and measurement. In addition to the five core knowledge areas, pre-school level guidelines today move away from the didactic and rote instructional methods of the past. They outline critical thinking and behavior processes to be addressed in ECME, including: problem solving, reasoning and proof, communication, connections and representations (NCTM, 2000) and organizing information, patterning and composing (Clements, Sarama and DiBiase, 2004). These ECME processes provide the means by which teaching and learning can occur, as well as focusing on domains of cognitive development.

Due to recent research findings, mathematics education for young children has become a primary focus in the early childhood field in the U.S., for researchers and policy makers alike. With this focus, the question now is how ECME is being translated in the early childhood classroom. Lee and Ginsburg (2007a) contend that a critical step towards finding an answer is to investigate teacher’s beliefs concerning the teaching and learning of mathematics; teachers are the key to success in ECME and thus there is a great need to focus on the teacher’s mind...what teachers think about learning, their curriculum and the mathematics in it (Ginsburg, Lee and Boyd, 2008 and Cross, Woods and Schweingruber, 2009). To begin to provide insight into early childhood teachers’ beliefs and practices of ECME, this article outline results from a survey of twenty-eight New York City early childhood teachers.

## LITERATURE REVIEW

### Teachers and Beliefs

Beliefs have been posited as being more influential than knowledge in determining perceptions and judgments which effect teachers’ behavior in the classroom (Pajares, 1992). A large body of research supports that teacher practice is filtered through the lens of personal beliefs about what is appropriate learning for children and what is appropriate ways to teach them; early childhood teacher beliefs align with their classroom practice (for reviews, see Brown, 2005; Cross et al, 2009; Vartuli, 1999). Specifically, teacher belief systems have been shown to be a major determinant of teacher decision making and curriculum implementation, along with influencing the classroom climate and affecting the nature of teacher-child interactions (Lara-Cinisomo et al., 2009; McMullen, 1997), all of which are connected to learning outcomes. The majority of research on early childhood teachers’ beliefs has focused on general classroom practice (developmentally appropriate practice) and school readiness (school entry, testing and retention), while beliefs about particular subjects, including mathematics, have remained largely unexplored (Brown, 2005; Lee and Ginsburg, 2007a).

Despite the lack of substantial research, there has long been a connection made between teacher beliefs and mathematics education; Thompson (1984) states: “There is strong reason to believe that in mathematics, teachers’ conceptions (their beliefs, views, and preferences) about

the subject matter and its teaching play an important role in affecting their effectiveness as the primary mediators between the subject and the learners” (p. 105). Teachers have strong beliefs about mathematics and mathematics education (Cross et al., 2009). However, much of the past (and even current) literature devoted specifically to teachers’ beliefs about ECME is based on case studies of individual teachers and anecdotal evidence. The few recent studies dedicated to early childhood teachers’ belief about mathematics suggest that early childhood teachers seem to hold beliefs of fear and hate towards mathematics and do not consider it as important for inclusion in the classroom (Lee and Ginsburg, 2007a/b; Stipek, 2008). Via a review of anecdotal evidence and the few empirical studies available, Ginsburg, Lee and Boyd (2008) conclude that in general, early childhood teachers do not place high value on and do not devote much time to teaching mathematics, with the qualification that the greater the school’s poverty level and the greater the number of minority students enrolled, the more teachers seem to express beliefs that emphasize the importance of academic subjects such as mathematics and literacy.

## Teachers and ECME

Instead of focusing on ECME, the literature suggests early childhood teachers devote their time and effort to other areas of instruction. Copley (2004) states that early childhood teachers generally feel mathematics is difficult to teach and are most comfortable teaching language and reading skills. In a similar vein, Lee and Ginsburg (2009) contend that many teachers claim that language and literacy are the most important academic topics to be taught in early childhood. This is supported by empirical evidence showing that 8% of instruction time is devoted to mathematics-based activities (such as counting, time, shapes and sorting), whereas 21% of early childhood classroom time is spent on literacy-based activities (Early et al., 2005). This is problematic, as mathematics ability at the beginning of kindergarten has now been shown to be a strong predictor of later general academic success, stronger even than early reading ability (Duncan et al., 2007). Further, early childhood teachers have reported beliefs that social-emotional and physical development are more important to young children’s development than instruction in academic areas (Cross et al., 2009); some research indicates that early childhood teachers focus first on social-emotional development, then literacy development and last on mathematics (Ginsburg, Lee and Boyd 2008).

Moreover, teacher’s belief on the nature of ECME seems to be very narrow in scope. Rather than the development of conceptual understanding through real-world problem solving in the broad areas of number and operations, geometry, measurement, algebraic thinking and data analysis that is advocated by the leading developmental researchers, NCTM and NAEYC today (Cross et al., 2009; NAEYC, 2002/2010; NCTM, 2006), current ECME teaching practice has been shown to focus on the learning of discrete skills and factual knowledge (NCEDL, 2005; Early et al., 2005). Even those early childhood teachers who have stated that they do value and practice mathematics instruction may be operating within a limited view of ECME... holding beliefs and providing direct mathematics instruction limited to counting and simple arithmetic activities (Copley, 2004; Ginsburg, 2009; Starkey et al., 2004).

## METHOD

### Participants

Twenty-eight Early Childhood teachers participated in a survey of their beliefs about the role of mathematics in the early childhood classroom. Specifically, it addressed the teachers' feelings' about mathematics and mathematics education and sought information on ECME in their teaching practice. Fourteen respondents worked in private schools, five worked in public schools and nine taught for Head Start. Twenty-seven of the teachers worked in New York City, one just outside the city. Three participants worked with 0-2 year-old children, six worked with 3 year-olds, eight worked with 3 and 4 year-olds, nine worked with four-year olds and two taught kindergarten. Two of the teachers were students finishing ECE programs, five had associate degrees in ECE, 11 held a bachelors degree in ECE and nine had Masters degrees in ECE (educational information for one participant is missing).

### Data Collection

All respondents were solicited from a city-wide conference on Early Childhood Education in New York City. Two hundred ninety professionals attended the conference. Ninety-five attendees were excluded from the study because they were not practicing early childhood teachers, leaving a possible pool of 195. Of these, 150 who were available during the lunch breaks were invited to fill out a ten-question survey on ECME. Twenty-eight surveys were collected (a response rate of approximately 19%). The survey included seven multiple choice questions, a rating question, a checklist and a fill-in-the-blank question. In addition, there were three text boxes for teachers to enter any additional responses.

## RESULTS AND DISCUSSIONS

The first survey questions addressed teachers' attitudes towards mathematics and towards teaching mathematics. Forty-three percent expressed positive feelings towards the subject of mathematics, 36% expressed neutral feelings towards the subject matter and 21% expressed negative feelings. In regards to feelings about the teaching of ECME, 50% of the participants indicated they loved/found it exciting, 46% indicated a neutral attitude and none indicated they hated/thought ECME was hard/scary [note: one participant's information is missing]. Between the two questions, two of the six participants who had expressed negative feelings about the subject of mathematics indicated positive feelings towards teaching it and the other four who were negative about mathematics expressed a neutral attitude toward teaching it. These results runs counter to Lee and Ginsburg (2007a/b) findings of overwhelming negative attitudes towards mathematics by early childhood teachers. Although the majority of attitudes towards mathematics and teaching EMCE was not as negative as one might have expected, a large portion of participants responded with neutral attitudes. This is noteworthy, as young children tend to internalize their teachers' enthusiasm for a subject— or lack thereof (Jackson and Leffingwell 1999); neutral attitudes may result in teachers unconsciously modeling a lack of

conviction in the importance of mathematics (Hachey, 2009) or devoting more instructional time to areas they feel more positive towards.

In terms of devoting time to instructional practice, 19 participants (68%) indicated that they spend the most time per week engaged in formal language/literacy activities. In fact, one teacher wrote “I am most comfortable with language/literacy”, a similar sentiment to what was reported by Copely (2004). Four participants responded that they spent the most time on developing life skills, three participants indicated art/music activities and one participant indicated mathematics was the greatest weekly focus (no participant responded spending the most instructional time on either science or social studies). This finding supports the literature that states that teachers emphasize language/literacy instruction over other academic subjects in the early childhood classroom. However, it also indicates that language/literacy seems to take precedence over social development, counter to what has been suggested by other research (Cross et al, 2009; Ginsburg, Lee and Boyd 2008).

Although language/literacy was shown to be the main emphasis, the respondents indicated they devoted higher amounts of weekly instructional time to ECME than previously has been cited. The majority of teachers (79%) indicate they spend 11-50% of their week engaging in formal mathematics activities with students. This is higher than the 8% reported by Early et al. (2005) and the 6% reported by NCEDL (2005). In addition to formal ECME, 86% (24 respondents) indicated that they actively seek out opportunities to exploit informal mathematics children may do in the classroom. This is not surprising, as early childhood education has a strong tradition of teachers' utilizing observation for the purpose of determining how best to support children's learning (Cross et al., 2009). This rise in reported ECME practice may be a reflection of changing teacher beliefs/practices in response to the ECME nationally policy movement that has been happening in recent years.

Although the results suggest that more ECME is taking place, they also indicate that as the literature suggests, teachers still have a narrow view of ECME. Teachers were asked to rank from most to least important ECME “big ideas” that encapsulate the broad range of topics advocated by NAEYC, 2002/2010 and NCTM, 2006. Rankings were collapsed into categories of most important (ranked 1<sup>st</sup>, 2<sup>nd</sup> or 3<sup>rd</sup>), neutral (ranked 4<sup>th</sup>, 5<sup>th</sup> or 6<sup>th</sup>) and least important (ranked 7<sup>th</sup>, 8<sup>th</sup> or 9<sup>th</sup>) and frequencies were calculated. Teachers ranked the three most important topics as Counting, Patterns and Arithmetic, in that order. The three least important instructional topics were Data Analysis, Algebraic Thinking and Measurement (also in order). General Reasoning, Spatial Reasoning and Geometry fell in the middle range, judged as neither very important nor very unimportant. These rankings were supported by a follow-up question asking the teachers explicitly the focus of the majority of their ECME activities and which ECME activities teachers do not cover at all. The majority of the teachers reported counting as the focus of their learning activities, followed by arithmetic. Consistent with the earlier ranking, the least focused on learning activities were reported as Data Analysis and Algebraic Thinking. One teacher wrote: “No algebraic insight because they are so young and learning their numbers first is priority”. Although supportive of previous research that finds that teachers hold narrow beliefs that equate ECME to arithmetic or numeracy (Copely, 2004; Ginsburg, 2009; Starkey et al., 2004), these findings are problematic for the advancement of the field. Research shows that young children are capable of learning broad areas of mathematics, and therefore, should be instructed in a wider and more complex range of mathematical activities (Ginsburg, Lee and Boyd, 2008; Lee and Ginsburg, 2009). Additionally, Cross et al. (2009) outlines Geometry and Measurement as core content areas for ECME, however, these areas were not deemed as

important by the teachers. Thus, the findings of this survey support the contention made by many researchers that there is still a distinct contrast between current teacher beliefs and practice and ECME guidelines and recommendations and further, that early childhood teachers need to expand their conception of appropriate EMCE content.

In addition to being narrow in scope in terms of content area, the findings also indicate that teachers may hold beliefs of the pedagogy of ECME that is didactic in nature (focused on mastering skills and/or procedures). Seventy percent of the teachers surveyed indicated that teaching basic skills and procedures and providing student opportunities to practice them was the focus of their EMCE activities, in comparison to the 30% of the teachers who indicated their instruction time focused on students helping students to invent, use and discuss their own mathematical strategies. One teacher wrote: "Math is mostly about procedure and routine, when done right from the start, I think it yields more positive results". This focus on skill and procedure is likely related to the reliance on counting and arithmetic activities which teachers stated dominated their instruction and their ranking of the area of "Reasoning" as a low priority for ECME. This finding coincides with previous research (Ball, 1995; NCEDL, 2005), which suggests that teachers less often exposed children to instruction that is conversational and interactive. However, this didactic method runs counter to current pedagogical principles advocated by the leading research, which specifically emphasize teachers focusing on the mathematization of children's experiences by capitalizing on children's intuitive mathematics and giving language to what is first understood by children on an informal level (Cross et al, 2009; Ginsburg, Lee and Boyd, 2008).

This suggestion that teachers focus ECME mainly on teacher-led skill instruction is not clear cut, however, as an inconsistent finding was seen within the teachers' expressed beliefs. As noted earlier, 70% of the participants indicated that they felt most important is learning activities that teach student skills versus allowing children to invent /use their own strategies. However, in a later question, 86% of the participants indicated that most important for teaching mathematics to students is that children explore math activities on their own/during free play versus during teacher led activities to build up specific math skills. In line with responses to the later question, Lee and Ginsberg (2007b) report that teachers tend to believe that young children should engage in mathematics learning that is game and fun-based, with the emphasis on not being highly demanding or "pushing" young children before they are "ready". One teacher wrote: "I use manipulatives, books and games... these seem to be the most fun for children". One explanation for inconsistency in responses between the questions can be explained in that the teachers are expressing the belief that children can learn mathematics during play but at the same time, still need explicit instruction on mathematical skills (Lee and Ginsburg, 2009). This dichotomy of beliefs may be indicative of conflicting internal reactions by early childhood teachers to the debate about the benefits of incidental versus intentional teaching of ECME (Cross et al, 2009; Ginsburg, Lee and Boyd, 2008). Evidence for this struggle is seen in what one teacher wrote: "It is important to allow them their own way to understanding or grasping a concept, however, they are first taught their basic skills".

Finally, participants were asked to identify materials/activities that they consistently use for ECME. One hundred percent of the participants reported using manipulatives and blocks and 96% reported using books and counting activities. Eighty-eight percent reported using songs and art for EMCE and 85% indicated that they use games and drama. Fifty-four percent of the teachers reported using computers (many who did not indicated they did not have one in the classroom) and blackboards. The least used material was dittos, with 46% indicating that they

use them for ECME. These findings confirm previous research which suggests that EMCE often is integrated and co-occurs with other academic content, in particular art and literacy (Clements and Sarama, 2007a; Early, 2005). It also shows similarly seen reliance on games, music and manipulatives for EMCE but suggests higher amounts of computer and ditto use than previously has been reported (Cross et al., 2009; Sarama and DiBiase, 2004). The finding of higher reported ditto use is troubling, since it runs counter to the conceptual, real-world mathematical problem solving advocated by leading researchers. Congruent with findings from Seo and Ginsburg (2004) and Early (2005), the teachers' responses suggest they integrate ECME with activities assumed to heighten children's engagement, relying heavily on manipulatives and blocks to teach mathematical ideas.

## LIMITATIONS

This survey of early childhood teachers consisted of a sample of one group of teachers among many. Therefore, characteristics of this particular group (for instance, that they are all teachers in the New York City area and that they all self-selected to attend professional development) may limit the applicability of these findings to the broader population of practicing early childhood teachers. However, a strength of this investigation is that it did include teachers from various types of settings (Public, Private and Head Start), so it is unlikely that the findings are connected to a particular approach or method of Early Childhood Education.

The teachers who participated in the survey indicated less negative views of mathematics and mathematics instruction and greater percentages of instructional time devoted to ECME than has been previously supported. From this, one could conclude that changes in beliefs and practice are occurring from what has happened in the past. However, another reason for the results of this survey may be related to the high teacher preparation level of the participants; 74% of the participants had a bachelor degree or higher. This percentage is higher than the national average and more teacher preparation has been linked to increased knowledge and comfort with EMCE (Cross et al., 2009; Pianta et al., 2005). In addition, almost 1/3 of the participants self-identified as Head Start Teachers. This may have impacted the findings, as teachers who work with lower-income students have been shown to be more concerned with academic subjects such as mathematics (Ginsburg, Lee and Boyd, 2008). This suggests the need for a replication of this survey with a larger sample, including more participants with less early childhood teacher preparation to better reflect the general early childhood teacher population.

## CONCLUSION

Teacher beliefs about ECME are a critical factor influencing early childhood teacher practice and as such, deserve attention. Results from the teachers surveyed suggest that early childhood teachers may not hold as negative a view of mathematics and ECME as has been previously supposed. In addition, more classroom time seems to be devoted to ECME than previously reported. However, the findings also support the contention teachers have stronger beliefs in the importance of literacy and that literacy-based activities dominate academic instructional time. In line with the literature, teachers expressed a narrow view of EMCE, with numeracy and arithmetic skill as the most important focus of ECME. Overall, this presents the hope that

ECME is gaining more attention in the early childhood classroom. However, this hope is tempered by the still narrow view of ECME teachers still seem to hold. ECME will only reach its fullest potential when teacher beliefs and practices expand to more equitable instruction time and include the rich and broad mathematical problem solving that current guidelines advocate and, moreover, that young children are capable of doing.

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