Journal of Vincentian Social Action

Volume 4 | Issue 3 Article 7

Barriers to Quality Early Mathematics Teaching and Learning

BILGE CEREZCI
St. John's University, cerezcib@stjohns.edu

BARRIERS TO QUALITY EARLY MATHEMATICS TEACHING AND LEARNING

Bilge Cerezci

The distinguished mathematics educator Bob Moses proclaimed that during the 1950s and 1960s literacy was seen as the key civil right. Today, he argues mathematics in the 21st century is what reading was in the 20th century (Moses & Cobb, 2001). We no longer have the luxury of thinking of mathematics as the right of a privileged few, so often referred as "math" people. Innumeracy should be as unacceptable for society as illiteracy.

The National Commission on Mathematics and Science Teaching (NCMST) explained that there are at least four major reasons that highlights the significance of gaining mathematics competence: (1) the constantly changing demands of the interdependent global economy require and value extensive knowledge of mathematics; (2) American citizens need to have mathematics skills and knowledge in order to compete in that changing economy; (3) knowledge in mathematics is closely related to the nation's security and future; and (4) "the deeper, intrinsic value of mathematical and scientific knowledge shapes and defines our common life, history, and culture" (2000, p.7). The National Council of Teachers of Mathematics (NCTM) builds on the claim of mathematics' importance by connecting it to individual growth and social success and states, "in this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. A lack of mathematical competence keeps the doors closed" (National Council of Teachers of Mathematics, 2000, p. 5). Lacking sufficient mathematical knowledge and skills portends significant socioeconomic and quality of life challenges for current and future generations. In order for our society to develop citizens who are knowledgeable and globally competitive in this knowledge economy, it is essential to provide all with quality mathematical experiences.

In order for our society to develop citizens who are knowledgeable and globally competitive in this knowledge economy, it is essential to provide all with quality mathematical experiences.

MATHEMATICS ACHIEVEMENT IN THE U.S.

Unfortunately, many students in the U.S. fail to master the foundational mathematical understanding in early elementary years and beyond (Romberg & Kaput, 1999). In fact, "Since the 1970s, a series of assessments of U.S. students' performances has revealed an overall level of mathematical proficiency well below what is desired and needed" (National Association for the Education of Young Children and National Council of Teachers of Mathematics, 2002, p. 1).

Commonly referred to as the "Nation's Report Card," National Assessment of Educational Progress (National Assessment of Educational Progress, 2013) has become the most prominent appraisal of the American students' knowledge in different subject of American students. The most recent report, 2017 National Assessment of Educational Progress Report (NAEP), suggested that only 40 % of a nationally representative sample of American students in 4th grade scored at or above a proficient level in mathematics achievement, and of those, 60 % scored below proficient level. American children not only

perform poorly on their own national mathematics tests, but they also lag behind their international peers mathematically. In the most recent Program for International Student Assessment (PISA) administered by the Organization for Economic Cooperation and Development (OECD, 2015), the average math score of American 15-year-olds was 470, 94 points lower than the top performing country (Singapore), and 20 points lower than the OECD's average, positioning Americans 35th out of 72 participating countries (OECD, 2015). The results of another international research study, the Trends in International Mathematics and Science Study (TIMSS), indicated that 8th grade students in the U.S. were outperformed in math proficiency by their peers in Singapore, the Republic of Korea, China, Japan, Kazakhstan, the Russian Federation, Canada, and Ireland (Provasnik, Malley, Stephens, Landeros, Perkins, & Tang, 2016). Recent national and international mathematics test results provide continuing documentation of the need to increase the focus on improving student achievement in mathematics.

Mounting evidence indicates that the poor mathematics performance demonstrated by American students starts from the time of school entrance and the dependence of later school performance on the quality of early math experience (Aunola, Leskinen, Lerkkanen, & Nurmi 2004; Carr, Peters, & Young-Loveridge, 1995; Chicago Department of Family and Support Services, 2014; Duncan et. al., 2007). For example, in a recent assessment of school readiness, by the Chicago Department of Children and Family Services, among 7,354 kindergarten-age children attending Head Start programs in Chicago, 2,059 of them, or nearly one third, performed below the standard for school readiness in kindergarten mathematics based on the Teaching Standards GOLD Assessment System (Chicago Department of Family and Support Services, 2014). Furthermore, research also emphasizes the cumulative effects of poor mathematics achievement by suggesting that if a student falls behind mathematically during the critical years of early schooling, it becomes increasingly unlikely that the student will catch up as she or he moves up the grade levels (Aunola, Leskinen, Lerkkanen, & Nurmi 2004; Bodovski & Farkas, 2007; Flanagan, McPhee, & Mulligan, 2009).

The level of mathematics skills young children develop prior to school entry is particularly critical for students who come from low-income and minority groups (Pearman, 2017; Starkey, Klein, & Wakeley, 2004). Unfortunately, research suggests that preschool children who are born into poverty are more likely to begin school with less knowledge in areas such as number sense, spatial sense and geometry, and measurement compared to their more advantaged peers (U.S. Department of Education, National Center for Education Statistics, 2006), a pattern that tend to accelerate as these children progress through elementary grades (Bodovski & Farkas, 2007; Clements, Sarama, & Gerber, 2005, April; Starkey, Klein, & Wakeley, 2004; Manfra, Dinehart, & Sembiante, 2014; U.S. Department of Education, National Center for Education Statistics, 2006; Pearman, 2017; Saxe, Guberman, & Gearheart, 1987). This spread in achievement differences across students might not be necessarily problematic. All students vary in their academic strengths and areas of growth. Those that slowly progress in one area may excel in another faster than others or vice versa. Yet, literature indicates that developing skills in such areas in mathematics starting in the early years provides a strong foundation for future mathematical learning, and therefore such a trend observed among students warrants closer inspection (Clements & Sarama, 2009; Ginsburg, Lee, & Boyd, 2008; Mix, 2001).

THE ROLE OF EARLY CHILDHOOD TEACHERS

Even though young children are natural mathematicians (National Research Council, 2009) and capable of developing some complex mathematical ideas (e.g., addition) and strategies (e.g., sorting by multiple attributes to analyze data), it is also true that they do not become skilled in mathematics without intentional and high quality instruction (Baroody, 2001; Baroody & Dowker, 2003; Clements, 2001; Epstein, 2003; Richardson & Salkeld, 1995). For example, in an effort to assess the quality of mathematics teaching

in U.S. classrooms and document how variations in quality of teaching might produce different student outcomes, Rivkin and colleagues (2005) collected and analyzed the math test scores of approximately one-half million students in grades 3 through 7 at over 3000 schools in Texas (Rivkin, Hanushek, & Kain, 2005). The final report on this study suggested that students whose teachers were identified as effective, gained 1.5 grade equivalents while students whose teachers were less effective only made a gain of 0.5 grade equivalents during the same academic year. In another study, Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges (2006) observed and audiotaped math speeches of a total of 26 head teachers and 198 children from 13 preschools and day-care centers in Chicago. Results of the study revealed that mathematizing children's daily experiences and explaining them in explicit math language was significantly associated with students' math knowledge growth. Specifically, preschoolers who were exposed to more math language in their classrooms showed greater growth in mathematics compared to their peers who were exposed to lower levels of such language. Doabler and Fien investigated the extent to which explicit instruction in early mathematics instruction is critical for improving kindergarten students' mathematics achievement and found a similar result to those of Klibanoff (Doabler & Fien, 2013). In this study, a total of 379 observations were conducted in 129 kindergarten classrooms, involving approximately 2,700 students from 46 schools. Results indicated that providing explicit mathematics instruction was significantly correlated with student students' math achievement.

When put together, these studies' results underscore the notion that the teachers and the nature of instruction in early mathematics matters and can have significant impact on mathematics learning. Teachers can make a difference for their students who need quality teaching and learning experiences in mathematics. They can to do so by making mathematics equitably accessible to all and by empowering all students to succeed.

CURRENT ISSUES IN EARLY MATHEMATICS EDUCATION

Although research highlights the importance of early math skills and their positive implications for later success and importance of providing quality mathematics teaching and learning experiences, mathematics is often seldom done in early childhood settings. Observational studies of early childhood and early elementary revealed several reasons to why this is the case (Clements & Sarama, 2011; Engel, Claessens, & Finch, 2013). One line of research revealed that educators often do not allocate enough time for guided math learning experiences (Chung, 1994; Rudd, Lambert, Satterwhite, & Zaier, 2008). For example, Chung (1994) conducted a study to document the amount of time kindergarten teachers spent on teaching mathematics on a daily basis. Based on the observations gathered from 30 public school kindergarten teachers, Chung concluded that observed teachers spent about one fourth of their classroom time on teaching mathematics that was usually integrated with other learning activities, and that mathematics was seldom taught as a separate subject.

In another study, Rudd and colleagues observed 11 teachers who worked with children ranging in age from birth to five years. Researchers gathered 40 hours of observations in which they noted no incidence that could be identified as intentionally planned mathematics activities (Rudd, Lambert, Satterwhite, & Zaier, 2008). Similar trends have also been observed in early elementary grades where teachers delivered mathematics instruction only 3 hours more per week compared to their preschool counterparts (Bargagliotti, Guarino, & Mason, 2009).

Literature has also indicated that most early childhood teachers underestimate what young children know and what they can learn in mathematics (Brown, 2005; Clements & Sarama, 2009; Graham, Nash, & Paul, 1997; Lee, 2004; Tudge & Doucet, 2004; Van den Heuvel-Panhuizen, 1990). For example, in one study, Van den Heuvel-Panhuizen (1990) asked

groups of preschool teachers and school staff who worked with preschoolers to estimate their preschoolers' mathematical competencies when they entered kindergarten the following year. Results of the study revealed that teachers and staff highly underestimated the math competencies of these young children. Particularly, when more than 80% of these kindergarteners were able to count out nine marbles, the adults' estimates only ranged between 20% and 50%. Further, while more than 40% of these students were able to subtract 8 from 10 without using any manipulatives, adults estimated less than 10% of them would be capable of completing this task (Van den Heuvel-Panhuizen, 1990). This sort of underestimation often compromises what early childhood teachers teach and how they teach it (Brown, 2005; Graham, Nash, & Paul, 1997; Lee, 2004; Tudge & Doucet, 2004). Stated by Lee and Ginsburg, "Teachers often limit their focus to one-to-one correspondence, simple counting and numbers, and perhaps naming and sorting simple shapes, even when children are capable of learning far more complex content" (2009, p. 39). While acquiring the basic skills in mathematics is important in early years, teachers need to help children build upon and extend them to deeper and broader mathematical concepts (Clements, 2004; Sarama & Clements, 2010).

Unfortunately, in the field of early education, most of the teachers do not possess the mathematical knowledge that is necessary to provide quality mathematics teaching and learning opportunities to young children (Ball, 1990; Ma, 1999; Hill, Schilling, & Ball, 2004) and often do not feel confident in teaching them mathematics (Bursal & Pazkanos, 2006; Copley, 2004; Wilkins, 2008). Teachers cannot teach what they do not know. Further discussing how teachers' content knowledge can affect the quality of their instructional practices, Brophy (1991) states:

> Where (teacher's) knowledge is more explicit, better connected and more integrated, they will tend to teach the subject more dynamically, represent it more varied ways, and encourage and respond fully to student comments and questions. Where their knowledge is limited, they will tend to depend on the text content, de-emphasize interactive discourse in favor of seatwork assignments, and in general, portray the subject as a collection of static, factual knowledge. (Brophy, 1991, p. 352)

Lack of confidence and competence early childhood teachers experience can also be traced to the method courses teachers have taken during their college years. Although the education system highly depends on the work and knowledge of early childhood teachers to help young children learn math concepts and develop math understanding, the same system does not put enough effort into equipping teachers with the necessary mathematics knowledge base and skills that they require to undertake the task. Research indicates that most of the early childhood programs in higher education do not offer courses specifically devoted to mathematics teaching and learning in early childhood classrooms (Armstrong, Ginet, & Warisi, 2012, January; Ginsburg, Lee, & Boyd, 2008; National Research Council, 2009). Even when they do, it usually does not exceed more than one course, which is not enough to equip prospective teachers with necessary domain specific knowledge in mathematics that they need in order to provide quality mathematics education for preschool and kindergarten children (Copple, 2004; Ginsburg, Lee, & Boyd, 2008; Ginsburg, Jang, Preston, VanEsselstyn, & Appel, 2004).

…teacher experience plays an important role in determining student achievement, particularly in the first years of teaching.

Finally yet importantly, literature also reveals that teacher experience plays an important role in determining student achievement, particularly in the first years of teaching. It turns out that high-achieving students tend to get the best teachers,

leaving others to less experienced instructors (Kalogrides, Loeb, & Beteille, 2011). Assigning lower-achieving students to inexperienced teachers could have significant impact on equal access to quality learning. Minority and poor students are often assigned to less-experienced teachers more often than their white and non-poor counterparts are, a pattern that is likely to reinforce the relationships between race and achievement and poverty and achievement (Kalogrides, Loeb, & Beteille, 2011).

CONCLUSION

The goal of minimizing the barriers to access to quality mathematics education has been a part of the national agenda since the early 1980s. Three decades later, it is hard to say we have made any progress as many American students still struggle to be proficient in mathematics. Given the facts that low mathematics achievement among the U.S. students has its roots in early years, the role of teachers in early childhood settings becomes even more essential in terms of providing a robust mathematics experience through intentional and high quality mathematics teaching. Early childhood teachers must self-reflect on their own attitudes, beliefs and knowledge in teaching and learning mathematics in order to identify areas of strength and growth. This is essential and needed in order to provide early mathematics education to all that promotes rich, rigorous, and relevant mathematical experiences for our nation's children. Even though young children engage in a substantial amount of mathematical activities and discoveries on a daily basis, evidence indicates that young children, especially those who are more disadvantaged compared to their peers, need intentional mathematics instruction to connect their intuitive mathematics discoveries and knowledge into generalizable and more sophisticated mathematics knowledge (Bahr & de Garcia, 2010; Starkey, Klein, & DeFlorio, 2014; Rouse, Brooks-Gunn, & McLanahan, 2005). Through high quality and accessible mathematics education, preschool and kindergarten children can develop robust mathematics knowledge, which will potentially have long-term positive implications for their academic performance in mathematics and other subject areas (Sanders & Rivers, 1996; Weiss & Pasley, 2004). Every student has a right to become equipped to play an active role in the society using mathematics as a resource. The research findings mentioned above point to the need for greater attention to early mathematics teaching practices and instruction as they can improve early mathematics education and yield long-term improvements in the skills and lives of future generations.

REFERENCES

Armstrong, A., Ginet, L., & Warisi, S. (2012, January). *Exploring early math teaching and learning in community college ECE programs*. Poster session presented at the annual meeting of the Illinois Education Research Council, Tinley Park, IL.

Aunola, K., Leskinen, E., Lerkkanen, M. K., & Nurmi, J. E. (2004). Developmentaldynamics of math performance from preschool to grade 2. *Journal of Educational Psychology, 96*(4), 699-713. https://doi.org/10.1037/0022-0663.96.4.699

Bahr, D. L., & De Garcia, L. A. (2010). *Elementary mathematics is anything but elementary.* Belmont: Wadsworth, Cengage Learning.

Ball, D. L. (1990). The mathematical understandings that prospective teachers bring to teacher education. *The Elementary School Journal, 90*(4), 449-466. https://doi.org/10.1086/461626

Bargagliotti, A. E., Guarino, C. M., & Mason, W. M. (2009). *Mathematics instruction in kindergarten and first grade in the United States at the start of the 21st century.* California Center for Population Research, University of California, Los Angeles.

Baroody, A. J. (2001). Early number instruction. *Teaching Children Mathematics, 8*(3), 154-158.

Baroody, A. J., & Dowker, A. (2003). *The development of arithmetic concepts and skills: Constructing adaptive expertise.* Mahwah, NJ: Erlbaum. https://doi.org/10.5860/choice.41-1688

Bodovski, K., & Farkas, G. (2007). Mathematics growth in early elementary school: The roles of beginning knowledge, student engagement and instruction. *The Elementary School Journal, 108*(2), 115-130. https://doi.org/10.1086/525550

Brophy, J. E. (1991). Conclusion to advances in research on teaching, Vol. II: Teachers' knowledge of subject matter as it relates to teaching practice. In J. E. Brophy (Ed.), *Advances in research on teaching: Vol. 2 Teachers' subject matter knowledge and classroom instruction* (pp. 347-362). Greenwich, CT: JIA Press.

Brown, E. T. (2005). The influence of teachers' efficacy and beliefs regarding mathematics instruction in the early childhood classroom. *Journal of Early Childhood Teacher Education, 26,* 239-257. https://doi.org/10.1080/10901020500369811

Bursal, M. & Paznokas, L. (2006). Mathematics anxiety and preservice elementary teachers' confidence to teach mathematics and science. *School Science and Mathematics, 106*(4), 173-180. https://doi.org/10.1111/j.1949-8594.2006.tb18073.x

Carr, M., Peters, S. & Young-Loveridge, J. (1994). Early childhood mathematics – A framework. In J. Neyland (Ed.), *Mathematics education – A handbook for teacher, Vol. 1* (pp. 262-269). Wellington: Wellington College of Education.

Chicago Department of Family and Support Services. (2014). *Head start/early head start annual report 2012-13*. Retrieved from http://csdgroup.files.cyscopa.com/Uploads/DFSS%202014%20Annual%20Report%20FINAL%20FINAL.pdf

Chung, K. E. (1994). *Young children's acquisition of mathematical knowledge and mathematics education in kindergarten* (Unpublished doctoral dissertation). Iowa State University, Iowa. https://doi.org/10.31274/rtd-180813-9958

Clements, D. H. (2001). Mathematics in the preschool. *Teaching Children Mathematics, 7,* 270-275.

Clements, D. H. (2004). Preface. In D. H. Clements, J. Sarama & A. M. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. ix-xv). Mahwah: Lawrence Erlbaum. https://doi.org/10.4324/9781410609236

Clements, D. H. & Sarama, J. (2009). *Learning and teaching early math: The learning trajectories approach*. New York, NY: Routledge. https://doi.org/10.4324/9780203883389

Clements, D. H., & Sarama, J. (2011). Early childhood mathematics intervention. *Science, 333*(6045), 968-970. https://doi.org/10.1126/science.1204537

Clements, D. H., Sarama, J., & Gerber, S. (2005, April). *Mathematics knowledge of entering preschoolers*. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, Canada.

Copley, J. V. (2004). The early childhood collaborative: A professional development model to communicate and implement the standards. In D. H. Clements, J. Sarama & A. M., DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 401-414). Mahwah: Lawrence Erlbaum.

Copple, C. E. (2004). Mathematics curriculum in the early childhood context. In D. H. Clements, J. Sarama & A. M. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp.83-90). Mahwah: Lawrence Erlbaum.

Doabler, C. T., & Fien, H. (2013). Explicit mathematics instruction: What teachers can do for teaching students with mathematics difficulties. *Intervention in School and Clinic, 48,* 276–285. https://doi.org/10.1177/1053451212473151

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P.,… Japel, C. (2007). School readiness and later achievement. Developmental Psychology, 43, 1428–1446. https://doi.org/10.1037/0012-1649.43.6.1428

Engel, M., Claessens, A., & Finch, M. (2013). *Teaching students what they already know? The misalignment between mathematics instructional content and student knowledge in kindergarten.* Paper presented at the American Educational Research Association Annual Meeting, New Orleans, LA. https://doi.org/10.3102/0162373712461850

Epstein, A. S. (2003). How planning and reflection develop young children's thinking skills. *Young Children, 58*(4), 28–36.

Flanagan, K. D., McPhee, C., & Mulligan, G. (2009). *The children born in 2001 at kindergarten entry: First findings from the kindergarten data collections of the early childhood longitudinal study, birth cohort (ECLS-B).* Washington, DC: National Center for Education Statistics.

Ginsburg, H. P., Jang, S., Preston, M., Appel, A., & VanEsselstyn, D. (2004). Learning to think about early childhood mathematics education: A course. In C. Greenes & J. Tsankova (Eds.), *Challenging young children mathematically* (pp. 40-56). Boston, MA: Houghton Mifflin.

Ginsburg, H., Lee, J., & Boyd, J. (2008). Mathematics education for young children: What it is and how to promote it. *Society for Research in Child Development, Social Policy Report, 22,* 3-22. https://doi.org/10.1002/j.2379-3988.2008.tb00054.x

Graham, T. A., Nash, C., & Paul, K. (1997). Young children's exposure to mathematics: The child care context. *Early Childhood Education Journal, 25*(1), 31-38.

Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing measures of teachers' mathematics knowledge for teaching. *Elementary School Journal, 105,* 11-30. https://doi.org/10.1086/428763

Kalogrides, D., Loeb, S. & and Beteille, T. (2011). Power play? Teacher characteristics and class assignments, in *Annual Meetings of the Association for Education Finance and Policy.* Seattle, WA. Kane. https://caldercenter.org/sites/default/files/CALDERWorkPaper_59.pdf

Klibanoff, R. S., Levine, S. C., Huttenlocher, J., Vasilyeva, M., & Hedges, L. V. (2006). Preschool children's mathematical knowledge: The effect of teacher "math talk". *Developmental Psychology, 42*(1), 59-69. https://doi.org/10.1037/0012-1649.42.1.59

Lee, J. S. (2004). Correlations between kindergarten teachers' attitudes toward mathematics and teaching practice. *Journal of Early Childhood TeacherEducation, 25*(2), 173-184. https://doi.org/10.1080/10901020502502l0

Lee, J. S. & Ginsburg, H. (2009). Early childhood teachers' misconceptions about mathematics education for young children in the United States. *Australasian Journal of Early Childhood, 34*(4), 37-45. https://doi.org/10.1177/183693910903400406

Ma, L. (1999). *Knowing and teaching elementary mathematics*. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Manfra, L., Dinehart, L. H., & Sembiante, S. F. (2014). Associations between counting ability in preschool and mathematic performance in first grade among a sample of ethnically diverse, low-income children. J*ournal of Research in Childhood Education, 28,* 101–114. https://doi.org/10.1080/02568543.2013.850129

Mix, K. S. (2001). The construction of number concepts. *Cognitive Development, 17,* 1345-1363. https://doi.org/10.1016/s0885-2014(02)00123-5

Moses, R. P., & Cobb, C. E., Jr. (2001). *Radical equations: civil rights from Mississippi to the Algebra Project.* Boston: Beacon Press.

National Assessment of Educational Progress. (2013). *The nation's report card: Mathematics and reading 2013*. Retrieved from http://www.nces.ed.gov/nationsreportcard/subject/publications/main2013/pdf/2014451.pdf

National Association for the Education of Young Children and National Council of Teachers of Mathematics. (2002). *Early childhood mathematics: Promoting good beginnings*. Retrieved from https://www.naeyc.org/sites/default/files/globally-shared/downloads/PDFs/resources/position-statements/psmath.pdf

National Commission on Mathematics & Science Teaching for the 21st Century. (NCMST) (2000). Before it's too late: A report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.

National Research Council. (2009). *Mathematics in early childhood: Learning paths toward excellence and equity.* Washington, DC: National Academy Press.

Organization for Economic Cooperation and Development (OECD) (2015). *Education at a Glance 2015: Highlights,* OECD Publishing. https://doi.org/10.1787/76d4bc29-en

Pearman, F. A. (2017). The effect of neighborhood poverty on math achievement: Evidence from a value-added design. *Education and Urban Society, 51*(2), 289-307. https://doi.org/10.1177/0013124517715066

Provasnik, S., Malley, L., Stephens, M., Landeros, K., Perkins, R., & Tang, J. H. (2016). *Highlights From TIMSS and TIMSS advanced 2015: Mathematics and science achievement of U.S. students in grades 4 and 8 and in advanced courses at the end of high school in an international context.* Washington, DC: National Center for Education Statistics Report No. NCES 2017-002.

Richardson, K., & Salkeld, L. (1995). Transforming mathematics curriculum. In S. Bredekamp & T. Rosegrant (Eds.), *Reaching potentials: Transforming early childhood curriculum and assessment, Vol. 2* (pp. 23-42). Washington, DC: National Association for the Education of Young Children.

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica, 73*(2), 417–458. https://doi.org/10.1111/j.1468-0262.2005.00584.x

Romberg, T., & Kaput, J. (1999). Mathematics worth teaching, mathematics worth understanding. In E. Fennema, & T. Romberg (Eds.), *Mathematics classrooms that promote understanding* (pp. 3-18). Mahwah, NJ: Lawrence Erlbaum Associates.

Rouse, C., Brooks-Gunn, J., & McLanahan, S. (2005). Introduction to school readiness: Closing racial and ethnic gaps. *Future of Children, 15,* 5-13. https://doi.org/10.1353/foc.2005.0010

Rudd, L. C., Lambert, M. C., Satterwhite, M., & Zaier, A. (2008). Mathematical language in early childhood settings: What really counts? *Early Childhood Education Journal, 36,* 75-80. https://doi.org/10.1007/s10643-008-0246-3

Sanders, W. L., & Rivers, J. C. (1996). *Cumulative and residual effects of teachers on future student academic achievement*. Knoxville, TN: University of Tennessee Value-Added Research and Assessment Center.

Sarama, J., & Clements, D. H. (2010). The mathematical lives of young children. In V. Washington & J. D. Andrew (Eds.), Children of 2020: *Creating a better tomorrow* (pp. 81-84). Washington, DC: Council for Professional Recognition.

Saxe, G. B., Guberman, S. R., & Gearhart, M. (1987). Social processes in early number development. *Monographs of the Society for Research in Child Development, 52*(2). https://doi.org/10.2307/1166071

Starkey, P., Klein, A., & DeFlorio, L. (2014). Promoting math readiness through a sustainable prekindergarten mathematics intervention. In M. Boivin & K. L. Bierman (Eds.), *Promoting school readiness and early learning. Implications of developmental research for practice* (pp. 187-210). New York, NY: The Guilford Press. https://doi.org/10.1016/j.ecresq.2004.01.002

Starkey, P., Klein, A., & Wakeley, A. (2004). Enhancing young children's mathematical knowledge through a pre-kindergarten mathematics intervention. *Early Childhood Research Quarterly, 19*(1), 99-120.

Tudge, J., & Doucet, F. (2004). Early mathematical experiences: Observing young Black and White children's everyday experiences. *Early Childhood Research Quarterly, 19,* 21–39. https://doi.org/10.1016/j.ecresq.2004.01.007

U.S. Department of Education, National Center for Education Statistics. (2006). *The Condition of Education 2006* (NCES 2006-071). Washington, DC: U.S. Government Printing Office.

Van den Heuvel-Panhuizen, M. (1990). Realistic arithmetic/mathematic instruction and tests. In K. Gravemeijer, M. Van den Heuvel, & L. Streefland (Eds.), *Contexts, free productions, tests and geometry in realistic mathematics education* (pp. 53-78). Utrecht: Freudenthal-Institut.

Weiss, I. R. & Pasley, J. D. (2004). What is high-quality instruction? *Educational Leadership, 61*(5).

Wilkins, J. L. M. (2008). The relationship among elementary teachers' content knowledge, attitudes, beliefs, and practices. *Journal of Mathematics Teacher Education, 11*(2), 139-164. https://doi.org/10.1007/s10857-007-9068-2

ABOUT THE AUTHOR

Bilge Cerezci began her career as an educator in Turkey. After earning a bachelor of science degree in early childhood education from Bosphorus University in Istanbul, she nurtured the development of young minds as a teacher in Turkish preschools. Cerezci moved to Chicago in 2007 to pursue graduate studies at the Erikson Institute and completed her master's degree in child development with an infancy specialization in 2009. She was awarded her PhD in applied Human Development from Loyola University Chicago and the Erikson Institute in 2017. During her doctoral studies, Cerezci worked for the Erikson Institute's Early Math Collaborative, which was launched in 2007 to enhance the quality of early math education by helping preschool and early elementary school teachers incorporate effective early math instruction into their classrooms. Her work for the Early Math Collaborative focused on the refinement of a new tool designed to measure the quality of mathematics instruction in preschools and elementary schools. She has also served as an adjunct faculty member in the Child Development Department of the City Colleges of Chicago and the Teacher Education Department at Loyola University. Dr. Cerezci now resides in New York City, where she shares her knowledge and insights with the next generation of educators as an assistant professor in the Curriculum and Instruction Department at St. John's University.