

Child Care & Early Education RESEARCH CONNECTIONS

A partnership of the National Center for Children in Poverty, the Inter-university Consortium for Political and Social Research, the Child Care Bureau, and the Office of Planning, Research, and Evaluation

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Early Mathematics A Key Topic Resource List

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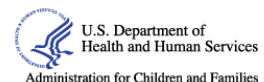
Research Connections conducted a comprehensive search of its collection for resources focused on early mathematics. This Key Topic Resource List includes an overview of the early mathematics literature, as well as a listing of selected resources on the topic.

Search results are grouped into five broad areas:

- Programs and Instruction
- Skills and Knowledge
- Parents and Home Environments
- Standards and Policies
- Program Evaluations and Mathematics Assessment

From the many results, *Research Connections* selected a limited number of resources of various types including reports and papers, executive summaries, and reviews. Selection criteria included topic relevance and relatively recent publication. The full results came from searches on each of the following terms: “early math”, “mathematics”, “numeracy”, and “arithmetic”.

Within each category, resources are organized according to publisher type and publication date. *Research Connections*’ one-sentence description is included for each resource on the following list. For complete citations, which include abstracts and full text for some resources, click on the titles.



Overview:

According to a 2007 Organisation for Economic Co-operation and Development (OECD) report, U.S. students ranked 25th out of 30 developing countries in mathematics literacy testing, an achievement gap that begins as early as preschool and kindergarten. This coupled with the fact that children from lower-income families show lower levels of academic achievement, has renewed researchers', educators', and policy makers' interest in studying mathematics education and how it affects and relates to young children. A new understanding of early brain development has also prompted interest in the development of early mathematics concepts such as: shape, size, pattern, and put together/take apart (addition and subtraction situations).

Focusing on mathematics in early education can lead to more positive outcomes in higher education and beyond. Recent studies have examined many aspects of early mathematics, ranging from the way young children learn and acquire math skills and knowledge, to the methods early education teachers employ to teach math in the classroom. Likewise, the role of parents has been considered, as well as the effectiveness of various early mathematics programs and curricula. The myriad of recent research on early mathematics demonstrates that this topic has become a priority, and researchers are continuing to discover ways to promote positive early math outcomes for young children.

The research on early mathematics includes questions such as the following:

- How is early cognitive development related to mathematical development?
- What strategies are effective in teaching mathematics to young children?
- How best can young children acquire particular math skills and knowledge?
- What different sorts of curricula, programs, and interventions have had positive effects on later acquisition of math skills?
- What role do parents play in early mathematics education?
- What have assessments of young children's mathematics progress found?
- What does existing literature say about early mathematics policies and standards?

Acknowledgements:

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PROGRAMS AND INSTRUCTION

Journals

Saracho, Olivia N.; Spodek, Bernard (2009). [Educating the young mathematician: The twentieth century and beyond.](#) *Early Childhood Education Journal*, 36(4), 305-312.

An historical overview of the movements influencing early years mathematics instruction in western culture between 1900 and 2008

Siegler, Robert S.; Ramani, Geetha B. (2009). [Playing linear number board games--but not circular ones--improves low-income preschoolers' numerical understanding](#) *Journal of Educational Psychology*, 101(3), 545-560

A comparison of the effects of linear or circular board games on the development of children's early numeracy skills, based on a sample of 88 low-income children from 7 Head Start classrooms and 2 child care centers who randomly received either a linear board game, a circular board game, or a numerical activities intervention

Ginsburg, Herb P.; Boyd, Judi; Sun Lee, Joon (2008). [Mathematics education for young children: What it is and how to promote it.](#) *Social Policy Report*, 22(1), 1-23.

An examination of children's abilities, early education curricula, and teacher readiness in the subject of early mathematics, and a presentation of policy recommendations for teacher training, curricula, and research related to the subject

Rudd, Loretta; Lambert, Matthew C.; Zaier, Amani; Satterwhite, Macy. (2008). [Mathematical language in early childhood settings: What really counts?](#) *Early Childhood Education Journal*, 36(1), 75-80

A case study of the use of mathematical language by 11 teachers in interactions with children at a university child care center

Sun Lee, Joon; Ginsburg, Herbert P. (2007). [What is appropriate mathematics education for four-year-olds?: Pre-kindergarten teachers' beliefs.](#) *Journal of Early Childhood Research*, 5(1), 2-31.

An examination of 30 pre-kindergarten teachers' beliefs about early mathematics education, as demonstrated in their evaluations of vignettes describing fictitious teachers' approaches to implementing

Brown, Elizabeth T. (2005). [The influence of teachers' efficacy and beliefs regarding mathematics instruction in the early childhood classroom.](#) *Journal of Early Childhood Teacher Education*, 26(3), 239-257.

A study of correlations among prekindergarten teachers' feelings of self-efficacy, beliefs about the importance of mathematics, and mathematics instructional practices

Casey, Beth; Kersh, Joanne E.; Young, Jessica Mercer. (2004). [Storytelling sagas: An effective medium for teaching early childhood mathematics](#) *Early Childhood Research Quarterly*, 19(1), 167-172

A description of a supplementary mathematics program that teaches mathematics concepts through storytelling; the program was designed to address gaps in preschool and kindergarten curricula

Greenes, Carole; Balfanz, Robert; Ginsburg, Herbert P. (2004). [Big math for little kids](#). Early Childhood Research Quarterly, 19(1), 159-166.

A description of Big Math for Little Kids, a research-based, comprehensive mathematics program for preschool and kindergarten children, designed to develop and expand on prior mathematics knowledge

Griffin, Sharon. (2004). [Building number sense with Number Worlds: A mathematics program for young children](#). Griffin, Sharon, 2004 Early Childhood Research Quarterly, 19(1), 173-180.

A description of Number Worlds, a mathematics program for preschool children designed to help teach conceptual understanding of mathematics at developmentally appropriate levels

Sarama, Julie; Clements, Douglas H. (2004). [Building Blocks for early childhood mathematics](#). Early Childhood Research Quarterly, 19(1), 181-189

A description of Building Blocks, a research-based mathematics program emphasizing the development of a basic mathematics foundation organized into spatial and geometric concepts and numeric and quantitative concepts

Starkey, Prentice; Wakeley, Ann; Klein, Alice. (2004). [Enhancing young children's mathematical knowledge through a pre-kindergarten mathematics intervention](#). Early Childhood Research Quarterly, 19(1), 99-120.

A study which implemented a specialized mathematics intervention in the classrooms of pre-kindergarteners from different socioeconomic backgrounds to improve their math skills

Dobbs, Jennifer; Doctoroff, Greta L.; Fisher, Paige H. (2003). [The "Math is Everywhere" preschool mathematics curriculum](#). Teaching Children Mathematics, 10(1), 20-2.

Brief findings from a study in which Head Start teachers integrated an activity-based mathematics curriculum into the everyday activities of their classrooms.

Sophian, Catherine. (2003). [Learning about "one": Units as a cornerstone for Head Start mathematics](#). Teaching Children Mathematics, 10(4), 210-5.

A description of a new mathematics curriculum focusing on unit measurement, inspired by the ideas of Davydov and implemented in Head Start University Partnership centers

Universities & Research Organizations

Society for Research in Child Development. (2008). [Improving early mathematics education may enhance children's academic success](#). Social Policy Report Brief, 22(1).

A summary of an examination of children's abilities, early education curricula, and teacher readiness in the subject of early mathematics, and a presentation of policy recommendations for teacher training, curricula, and research related to the subject

Other

Anderson, Ann; Anderson, Jim; Thauberger, Carolyn. (2008). [Mathematics learning and teaching in the early years](#). In Contemporary perspectives on mathematics in early childhood education (pp. 95-122). Charlotte, NC: Information Age Publishing.

A review of research and theory on mathematical teaching and learning in populations of children from birth to 8

Ginsberg, Herbert P.; Ertle, Barbrina. (2008). [Knowing the mathematics in early childhood mathematics](#). In Contemporary perspectives on mathematics in early childhood education (pp. 45-66). Charlotte, NC: Information Age Publishing.

An exploration of the role of mathematical knowledge in early education, an overview of children's methods of learning mathematics, an examination of preschool mathematics curriculum materials, and a discussion of the mathematical knowledge required by preschool teachers when implementing a complex mathematics curriculum

National Association for the Education of Young Children. (2002). [Early childhood mathematics: Promoting good beginnings](#). Washington, DC: National Association for the Education of Young Children.

A study on the value of mathematical education and recommendations for educators, instruction methods and curriculum by the National Association for the Education of Young Children (NAEYC) and the National Council for Teachers of Mathematics (NCTM)

SKILLS AND KNOWLEDGE

Government

National Center for Education Statistics. (2008). [Mathematics achievement of language-minority students during the elementary years](#). (NCES 2009-036). Washington, DC: National Center for Education Statistics

An examination of the mathematics achievement of elementary school students in first and fifth grade and its relationship to students' language background

Journals

Curtis, Reagan, Okamoto, Yukari, Weckbacher, Lisa Marie. (2009). [Preschoolers' use of count information to judge relative quantity](#) Early Childhood Research Quarterly, 24(3), 325-336

An examination of preschool effects of the use of children's use of count information to make quantity judgments using a balance-scale task to judge relative quantity with or without count information provided in one study that involved 35 children 3 through 5 years old and a second study that replicates and extends the study with relative quantity in multiple counting contexts with 54 children 3 and 4 years old

Jordan, Nancy C; Locuniak, Maria N.; Kaplan, David; Ramineni, Chaitanya. (2009). [Early math matters: Kindergarten number competence and later mathematics outcomes](#). Developmental Psychology, 45(3), 850-867.

A longitudinal study of the relationship between children's number competence scores in kindergarten through the middle of first grade and their mathematics achievement from the end of first grade through the end of third grade, based on data from 378 kindergarteners and 196 third graders from one public school district in northern Delaware

Bart, William; Yuzawa, Miki; Yuzawa, Masamichi. (2008). [Development of mathematical reasoning among young children: How do children understand area and length?](#) In Contemporary perspectives on mathematics in early childhood education (pp. 157-185). Charlotte, NC: Information Age Publishing.

A review of selected research and theory on the topic of the development of children's conceptions of area and length

Park, Boyoung; Boyd, Barbara Foulks; Chae, Jeong-Lim. (2008). [Young children's block play and mathematical learning.](#) Journal of Research in Childhood Education, 23(2), 157-162.

A qualitative study of the geometric shape knowledge of two boys aged 6 and 7 from low-income families

Laski, Elida V; Siegler, Robert S. (2007). [Is 27 a big number?: Correlational and causal connections among numerical categorization, number line estimation, and numerical magnitude comparison.](#) Child Development, 78(6), 1723-1743.

A study of children's understanding of numerical magnitudes, examining their transition from ordinal estimations to continual measurements on number lines, and the effects on this transition of a method of categorizing numbers by size, using a sample of 40 kindergarteners and 90 children in grades K-2 from public schools in the Pittsburgh area

Zur, Osnat; Gelman, Rochel. (2004). [Young children can add and subtract by predicting and checking.](#) Early Childhood Research Quarterly, 19(1), 121-137.

A study evaluating preschool children's understanding of counting by exposing them to arithmetic-related tasks involving prediction

Other

National Research Council (U.S.), (2009). [Mathematics learning in early childhood: Paths toward excellence and equity](#) Washington, DC: National Academies Press.

A comprehensive review of research on young children's mathematics development, learning, and education

Kersh, Joanne E.; Casey, Beth; Young, Jessica Mercer. (2008). [Research on spatial skills and block building in girls and boys](#) In Contemporary perspectives on mathematics in early childhood education (pp. 233-251). Charlotte, NC: Information Age Publishing

An overview of research on the relationship of block play to the spatial and mathematics skills of young children, with a focus on gender differences

Sarama, Julie; Clements, Douglas H. (2008). [Mathematics in early childhood.](#) In Contemporary perspectives on mathematics in early childhood education (pp. 67-94). Charlotte, NC: Information Age Publishing.

An overview of age appropriate mathematical concepts for preschoolers, including number, arithmetic, geometry, measurement, patterning, algebraic thinking, data, and graphing

Starkey, Prentice; Klein, Alice. (2008). [Sociocultural influences on young children's mathematical knowledge.](#) In Contemporary perspectives on mathematics in early childhood education (pp. 253-276). Charlotte, NC: Information Age Publishing.

An overview of research on socioeconomic and cultural influences on the math skills of young children in Japan, China, and the United States

Ginsburg, Herbert P.; Cannon, Joanna; Eisenband, Janet; Pappas, Sandra. (2006). [Mathematical thinking and learning](#). In D.A. Phillips & K. McCartney (Eds.), *Blackwell handbook of early childhood development*. Malden, MA: Blackwell Publishing.

A discussion of the acquisition of early numeracy skills and mathematical knowledge by young children, with a presentation of a framework for the instruction of such skills

Clements, Douglas H.; Sarama, Julie; Gerber, Susan B. (2005). [Mathematics knowledge of entering preschoolers](#). Paper presented at the annual meeting of the American Educational Research Association, Montreal, Quebec, Canada.

Two studies describing the mathematics knowledge and competencies of low-income preschool children, using a theoretically-based direct child assessment

PARENTS AND HOME ENVIRONMENTS

Journals

Cannon, Joanna; Ginsburg, Herbert P. (2008). ["Doing the math": Maternal beliefs about early mathematics versus language learning](#) *Early Education and Development*, 19(2), 238-260

An examination of maternal approaches to the mathematical learning of their preschoolers, and a study of maternal beliefs about the importance of mathematics versus language learning in the preschool years, based on a sample of 37 New York City area mothers

Hansen, Laurie E. (2005). [ABCs of early mathematics experiences](#). *Teaching Children Mathematics*, 12(4), 208-212.

A discussion of how concepts in mathematics can be introduced through life experiences in preschool classrooms and at home, such as in activities involving nature, money, playing, bathing, and cooking

Tudge, Jonathan R.H.; Doucet, Fabienne. (2004). [Early mathematical experiences: Observing young Black and White children's everyday activities](#) *Early Childhood Research Quarterly*, 19(1), 21-29

An examination of the extent to which young children are engaged in mathematics in the course of their everyday activities, and a look at whether or not such patterns vary by ethnicity or social class

Blevins-Knabe, Belinda; Musun, Linda; Eddy, Annette; Jones, Randall M.; Austin, Ann M. Berghout. (2000). [Family home care providers' and parents' beliefs and practices concerning mathematics with young children](#). *Early Child Development and Care*, 165(), 41-58.

Highlights of findings from three studies on the relationship between the beliefs and practices of parents and home care providers and early childhood environments, and children's development of early numeracy skills

Starkey, Prentice; Klein, Alice. (2000). [Fostering parental support for children's mathematical development: An intervention with Head Start families.](#) *Early Education and Development*, 11(5), 659-680.

An evaluation of an early intervention program for engaging parents in children's early mathematical development, based on a sample of 28 low-income, African-American mothers and their children enrolled in a Head Start center in the San Francisco Bay Area

Other

Benigno, Joann P.; Ellis, Shari. (2008). [Do parents count?: The socialization of children's numeracy.](#) In *Contemporary perspectives on mathematics in early childhood education* (pp. 291-308). Charlotte, NC: Information Age Publishing.

An overview of research on parental socialization of children's emergent numeracy in the home environment, including a discussion of interventions for low-income parents and sociocultural approaches to numeracy

Vandermaas-Peeler, Maureen. (2008). [Parental guidance of numeracy development in early childhood.](#) In *Contemporary perspectives on mathematics in early childhood education* (pp. 277-290). Charlotte, NC: Information Age Publishing

An overview of research on the roles of different types of parent-child interactions in the development of mathematical knowledge in preschool-aged children

STANDARDS AND POLICIES

Government

Missouri Department of Elementary and Secondary Education, Early Childhood Education Section. (2004). [Missouri pre-k mathematics standards.](#) Jefferson City: Missouri Department of Elementary and Secondary Education.

A description of activities and competencies indicating the desired minimum level of understanding of mathematics to be possessed by prekindergarten children entering Missouri schools

Journals

Charlesworth, Rosalind. (2005). [Prekindergarten mathematics: Connecting with national standards.](#) *Early Childhood Education Journal*, 32(4), 229-236.

An overview of the National Council of Teachers of Mathematics (NCTM) standards as they relate to prekindergarten mathematics concept development and instruction

Universities & Research Organizations

Brenneman, Kimberly; Boyd, Judi; Frede, Ellen. (2009). [Math and science in preschool: Policies and practice.](#) (Preschool Policy Brief Issue 19). New Brunswick, NJ: National Institute for Early Education Research

A discussion of preschool children's mathematics and science understanding and what is known about preschool mathematics and science educational practices

Richardson, Kathy. (2000). [Mathematics standards for pre-kindergarten through grade 2](#) (ERIC Digest No. EDO-PS-00-11). Champaign, IL: ERIC Clearinghouse on Elementary and Early Childhood Education

A fact sheet on mathematics standards for pre-kindergarten through grade 2

Other

Saracho, Olivia N.; Spodek, Bernard. (2008). [Research perspectives in early childhood mathematics](#). In *Contemporary perspectives on mathematics in early childhood education* (pp. 309-320). Charlotte, NC: Information Age Publishing.

An overview of selected research and recommendations regarding standards for early mathematics education, the mathematical competence of young children, and the use of technology in mathematics teaching and learning

Clements, Douglas H.; DiBiase, Ann-Marie; Sarama, Julie. (2004). [Engaging young children in mathematics: Standards for early childhood mathematics education](#). Mahwah, NJ: Lawrence Erlbaum Associates.

A compilation of the comments, rationalizations, and conclusions of the Conference on Standards for Pre-School and Kindergarten Mathematics Education, whose purpose was to help develop a framework for math standards, curricula, and pedagogy in early childhood education

National Association for the Education of Young Children. (2003). [State policies that promote early childhood mathematics](#). Washington, DC: National Association for the Education of Young Children.

A study by the National Association for the Education of Young Children (NAEYC) and the National Council of Teachers of Mathematics (NCTM) on state standards of early childhood mathematical education, educational level and professional development recommended for educators, curriculum and testing requirements

PROGRAM EVALUATIONS and MATHEMATICS ASSESSMENTS

Government

United States. National Mathematics Advisory Panel. (2008). [The final report of the National Mathematics Advisory Panel](#) Washington, DC: U.S. Department of Education

An examination of children's math development and learning and the instructional practices and materials, curricula, teacher recruitment, training, and retention practices, and assessment practices to effectively foster children's math education

Journals

Wang, Aubrey H. (2010). [Optimizing early mathematics experiences for children from low-income families: A study on opportunity to learn mathematics](#) *Early Childhood Education Journal*, 37(4), 295-302

An examination of African American and Caucasian students' differential opportunities to learn mathematics and the extent to which those opportunities predict gains in mathematics achievement in kindergarten from a secondary analysis of the Early Childhood Longitudinal Survey of 1,721 first time African American and Caucasian kindergartners in fall 1998 who lived below the poverty line

Baroody, Arthur J.; Eiland, Michael; Thompson, Bradley. (2009). [Fostering at-risk preschoolers' number sense](#). *Early Education and Development*, 20(1), 80-128.
A comparison of the pre- and post-test numeracy skills of children in classrooms using four different numeracy teaching techniques: structured discovery, semistructured discovery, direct instruction, and unstructured practice, based on data collected from 80 at risk children from two public preschools

Kilday, Carolyn R.; Kinzie, Mable B. (2009). [An analysis of instruments that measure the quality of mathematics teaching in early childhood](#). *Early Childhood Education Journal*, 36(4), 365-372.
A review of 9 instruments used to measure the quality of mathematics teaching, 1 in preschool settings and 8 in kindergarten and subsequent grades, and a discussion of their potential uses in early childhood settings

Clements, Douglas H.; Liu, Xiufeng H.; Sarama, Julie. (2008). [Development of a measure of early mathematics achievement using the Rasch model: The Research-Based Early Maths Assessment](#). *Educational Psychology*, 28(4), 457-482
A description of the development, refinement, and testing of the Research-Based Early Maths Assessment (REMA), an instrument for the measurement of math skills in preschoolers using problems of tiered difficulty

Clements, Douglas H.; Sarama, Julie. (2008). [Experimental evaluation of the effects of a research-based preschool mathematics curriculum](#). *American Educational Research Journal*, 45(2), 443-494.
An evaluation of the effects of the Building Blocks preschool mathematics curriculum in a sample of 253 children from low income families

Klein, Alice; Sarama, Julie; Clements, Douglas H.; Starkey, Prentice; Iyer, Roopa. (2008). [Effects of a pre-kindergarten mathematics intervention: A randomized experiment](#). *Journal of Research on Educational Effectiveness*, 1(), 155-178.
An evaluation of the effect of the implementation of the Pre-K Mathematics curriculum and the DLM Express software package on the mathematical knowledge of low-income children in Head Start and public preschool classrooms in greater San Francisco and Buffalo, based on a study of 20 experimental and 20 control-group classrooms

Duncan, Greg; Dowsett, Chantelle J.; Claessens, Amy; Magnuson, Katherine A.; Huston, Aletha C.; Klebanov, Pamela Kato; Pagani, Linda; Feinstein, Leon; Engel, Mimi; Brooks-Gunn, Jeanne; Sexton, Holly; Duckworth, Kathryn; Japel, Christa. (2007). [School readiness and later achievement](#). *Developmental Psychology*, 43(6), 1428-1446
An analysis of findings from six longitudinal studies on the relation between children's academic, attention, and socioemotional skills on school entry and later academic achievement

Fox, Jillian; Diezmann, Carmel M. (2007). [What counts in research? A survey of early years' mathematical research, 2000-2005](#). *Contemporary Issues in Early Childhood*, 8(4), 301-312.
An overview of peer-reviewed literature, published from 2000 through 2005, on math instruction and mathematical concepts found in educational programs for children from birth to 8, including a comparison of the volume literature for infant and toddler, preschool, and school-age math concepts and instruction

Pagani, Linda; Girard, Alain; Jalbert, Julie. (2006). [Does preschool enrichment of precursors to arithmetic influence intuitive knowledge of number in low income children?](#) Early Childhood Education Journal, 34(2), 133-146.

An evaluation of the effectiveness of two different early mathematic enrichment programs on low income preschool children's intuitive knowledge of numbers

Pasnak, Robert; Levit, Kathy; Ferguson, Eleanor O.; Greene, Monica S. (2006). [Applying principles of development to help at-risk preschoolers develop numeracy.](#) The Journal of Psychology, 140(2), 155-173.

An examination of the impact of playing games designed to improve young children's grasp of the oddity and insertion principles using a sample of young, ethnically diverse, Head Start preschool children

VanDerHeyden, Amanda M.; Broussard, Carmen; Cooley, Amanda. (2006). [Further development of measures of early math performance for preschoolers.](#) Journal of School Psychology, 44(6), 533-553.

An examination of the effectiveness of measures designed to predict preschool children's mathematical skills in later years

Arnold, David H.; Dobbs, Jennifer; Doctoroff, Greta L.; Fisher, Paige H. (2003). [Accelerating math development in Head Start classrooms.](#) Journal of Educational Psychology, 94(4), 762-770.

A study of the impact of participating in fun, diverse mathematics-related activities on math skills among Head Start preschool children

Universities & Research Organizations

National Research Council (U.S.). (2009). [Mathematics learning in early childhood: Paths toward excellence and equity.](#) Washington, DC: National Academies Press.

A comprehensive review of research on young children's mathematics development, learning, and education

Ponder, Bentley D. Henry, Gary T.; Rickman, Dana K. (2004). [Evaluation of the pre-k summer readiness pilot program.](#) Atlanta: Georgia State University, Andrew Young School of Policy Studies.

An evaluation of the prekindergarten (Pre-K) summer enrichment pilot program for children in high poverty areas in metro Atlanta

Bridges, Lisa J.; Cochran, Stephanie; Berry, Daniel; Margie, Nancy G.; Calkins, Julia; Zaslow, Martha; Ling, Thomson (2003). [Early childhood education and school readiness: Conceptual models, constructs, and measures: Profiles of early childhood measures.](#) Washington, DC: Child Trends.

A collection of profiles of instruments used to measure different developmental domains in early childhood

Other

Saracho, Olivia N.; Spodek, Bernard (2008). [Contemporary perspectives on mathematics in early childhood education.](#) Charlotte, NC: Information Age Publishing.

A collection of essays on the numeracy of young children and the place of mathematics learning in early childhood education

Tudge, Jonathan R.H.; Li, Linlin; Stanley, Tiffany Kinney. (2008). [The impact of method on assessing young children's everyday mathematical experiences](#). In *Contemporary perspectives on mathematics in early childhood education* (pp. 187-215). Charlotte, NC: Information Age Publishing.

A discussion of select methods used for assessing young children's mathematical experiences in natural settings

To view and sort the full search results from which these resources were selected, you may use the [Recreate Complete Search](#) function. To suggest additions to this Key Topic Resource List, please email us at contact@researchconnections.org.

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