



## Methods of Assessment of Young Children's Informal Mathematical Experiences

**Written by:** Jonathan Tudge, Ph.D., Department of Human Development and Family Studies, The University of North Carolina at Greensboro

### Introduction

Early in their lives children develop remarkable mathematical competence. Scholars have little understanding about how this occurs, but assume that it develops in the course of children's informal mathematical experiences. Unfortunately, the methods typically used to assess these informal experiences are likely to greatly under-represent them. Scholars, teachers, and parents are unlikely to see involvement in mathematics without close observation, and thus lose opportunities to build on these naturally occurring learning opportunities.

### Key Research Questions

1. How do children develop their mathematical ideas?
2. Children's early experiences are clearly important, but what experiences do young children typically have?
3. What methods are used to assess children's mathematical experiences, and do they provide similar impressions of the extent to which children are involved in early mathematics?
4. To what extent are socio-cultural differences implicated in variations in young children's early mathematical experiences?

These are the key questions that will be addressed in this entry.

### Recent Research Results

Children develop an impressive understanding of various aspects of mathematics (i.e., numbers, operations on numbers, shapes, distance, the passage of time, patterns, etc.) while they are still of preschool age (Baroody, 2004; Baroody, Lai, & Mix, 2006; Ginsburg, Cannon, Eisenband, & Pappas, 2006; Ginsburg, Lee, & Boyd, 2008; Sarama & Clements, 2008). Unfortunately, we know much more about what young children know than how they come to gain that understanding (Hannula, 2005). As eminent theorists such as Jean Piaget and Lev Vygotsky have argued, this understanding must come from the early experiences in which young children engage, either alone or in interaction with siblings, peers, parents, and others. However, the research evidence about the extent of those experiences is highly inconsistent, primarily because of differences in the methods that researchers have used to assess children's involvement

in mathematical experiences (Tudge, Li, & Stanley, 2008). There are four main methods that have been employed for this purpose (see the discussion below).

**Reports on children's mathematics.** A widely used method involves asking parents to report on some aspect of their children's daily experiences and often draws on large samples (Hofferth & Sandburg, 2001; Juster & Stafford, 1985; Timmer, Eccles, & O'Brien, 1985). When asked to report about all of the activities in which their 3- to 5-year-old children were engaged over the previous 24 hours, mathematics is reported as very rarely occurring. In other studies in which parents were asked to report on their preschool-aged children's school-relevant activities (Plewis, Mooney, & Creeser, 1990) or specifically on their mathematical activities (Blevins-Knabe, Austin, Musun, Eddy, & Jones, 2000; Blevins-Knabe & Musun-Miller, 1996; Fluck, Linnell, & Holgate, 2005; Saxe, Guberman, & Gearhart, 1987), they responded that their children had engaged in no, or very little, mathematical activities during the previous week (Fluck et al., 2005; Plewis et al., 1990), about three times per week (Saxe et al., 1987), or twice or three times per week in each of a range of different types of mathematical activities (Blevins-Knabe & Musun-Miller, 1996; Blevins-Knabe et al., 2000). Asking parents about many different types of mathematical activities, as Blevins-Knabe and her colleagues did, clearly prompted them to remember activities that were not considered when they were asked more generally about their children's mathematical experiences.

There are several other reasons for suspecting that parents are likely to under-represent the extent to which their children are involved in mathematical activities. First, young children hardly spend all of their time in their mother's company, and even those children who do not attend any type of child care and whose mothers do not work outside the home spend a significant proportion of their time doing things by themselves or with siblings or friends. Furthermore, stay-at-home mothers may only have a general idea of what their children are doing while they are cooking, cleaning, and so on. Second, sometimes when children are engaged in some mathematical activity it plays a subordinate role to another activity. For example, children may choose two blocks of equal lengths to construct part of a house that they are building, but the mother might pay no attention to the mathematical thinking that is occurring.

Rather than rely on parental reports, more direct methods have been used to discover the extent of young children's mathematical activity. Ramani and Siegler (2008) asked preschoolers themselves to talk about one specific type of mathematical activity (the number of board games they played at home), and found that middle-class children reported more board-game use than did children from poor families. The latter group, however, reported more play with video games. Nonetheless, this method is unlikely to reveal the overall extent to which young children have mathematical experiences.

**Observations of children's activities.** Some scholars have therefore relied on trained observers who follow children, observing their everyday activities. Some of the first systematic observations were conducted by Carew (1980) and Carew, Chan, and Halfer (1976) in both child care and school. However, they simply noted the extent of "intellectual experiences" and did not examine separately the extent to which the children were involved in mathematics. Munn and Schaffer (1993) also conducted systematic observations of 2- and 3-year-olds in Scottish preschools, and reported that

these children engaged in some type of “numeracy event” in about 10% of their observations. Clearly this was far higher than the amount reported by parents. Tudge and Doucet (2004) followed 3-year-old African American and European American children (equally divided by social class) wherever they were (home, child care, etc.) for a total of 18 hours. Tudge and Doucet reported that children were involved in some mathematical activity about once per hour, on average, but that many of the children were never involved in any mathematical activity.

***Auditotaping of children’s activities.*** A third approach obviates the need for any observer. The presence of an observer, after all, may influence the types of activities or interactions in which children are involved. A number of scholars have relied on audiotapes of naturally occurring language in the home (Aubrey, Bottle, & Godfrey, 2003; Tizard & Hughes, 1984) or child-care setting (Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges, 2006). Although this method has the advantage of assessing the use of mathematical language (something likely to be very helpful in later mathematical understanding), the obvious disadvantage is that all non-verbal mathematical experiences are missed.

***Videotaping of children’s activities.*** For this reason Ginsburg and his colleagues (Ginsburg, Lin, Ness, & Seo, 2003; Seo & Ginsburg, 2004) used videotape to film young children from Taiwan and the United States (from both middle-class and poor backgrounds) in preschool settings. They reported that “young children engage in a considerable amount of mathematical activity during their free play” (Seo & Ginsburg, p. 95). Almost all of the U.S. children (from a variety of ethnic and social-class backgrounds) engaged in at least one mathematical activity during the 15 minutes of filming, and on average over 40% of the children were involved in something mathematical during every one-minute segment. Ginsburg et al. (2003) found that the Taiwanese children were even more involved—in around 70% of each one-minute segment of film.

One might argue that preschools are places in which children have more access to materials that lend themselves to mathematics than typically occurs in the home. However, Tudge and his colleagues (Li, Kinney, & Tudge, 2005; Tudge et al., 2008) replicated Ginsburg’s methods using two-hour videotapes of young children’s everyday activities in and around the home and found that African American and European American children from working- and middle-class homes were involved in something mathematical in approximately 36% of the one-minute segments. Using the exact time of engagement revealed that children were engaged in some mathematical activity in almost 20% of the time.

## **Conclusions and Future Directions**

There is thus little doubt that some of our most common data-collection methods can woefully under-represent the extent to which children are involved in mathematics; careful observation reveals a good deal of informal mathematics in the course of children’s everyday activities. This means that parents and early educators have many opportunities to draw children’s attention to the mathematics in what they are doing (Benigno & Ellis, 2008; Ginsburg et al., 2006; Kersh, Casey, & Young, 2008; Tudge,

2008; Vandermaas-Peeler, 2008). As Sarama and Clements (2008) pointed out: "Play does not guarantee mathematical development but it offers rich possibilities" (p. 69). Exploiting such opportunities, or "teachable moments," can be done by parents and early childhood teachers alike, although this does require careful observation of what the child is doing, or trying to do.

Another possibility is to design specific curricula for the teaching of mathematics at the preschool level (e.g., Ginsburg & Amit, 2008; Sophian, 2004). However, to concentrate on the curriculum on the grounds that "exploiting teachable moments on the fly requires deep mathematical knowledge" (Ginsburg & Ertle, 2008, p. 47) may be partly missing the point. Much of young children's interest and ability in reading comes not from any formal curriculum but from parents and early childhood teachers reading with children, pointing out signs, labeling their drawings and so on. Thus in addition to any curricular changes we should try to empower parents and teachers to observe their children and then use their basic mathematical knowledge of number, shape, size, time, and so on to reflect back to the children the things that they have been doing. However, for this to happen, adults must both feel confident about their own mathematical understanding and believe that they can help their children (Vandermaas-Peeler, 2008; Blevins-Knabe et al., 2000).

Parents' (and preschool teachers') confidence in their own mathematical understanding, and their expectations for their children "are strongly shaped by cultural norms that dictate what children of a particular age should know" (Sophian, 2008, p. 41), and there are also clear cultural differences in the ease and relevance of learning numerals and other aspects of mathematics (Benigno & Ellis, 2008; Miller, Smith, Zhu, & Zhang, 1995). Perhaps for these reasons, young Asian children are found to be more involved in mathematics than are non-Asian children in the United States (Guberman, 2004; Sarama & Clements, 2008; Starkey & Klein, 2008), and middle-class children are more involved than are their working-class counterparts (Ginsburg et al., 2003; Ginsburg & Russell, 1981; Saxe et al., 1987; Starkey & Klein, 2008).

Such socio-cultural differences may well exist, but it is clear that these findings are primarily based on parental reports rather than close observation of what the children are doing. It seems unlikely that children's access to objects that afford mathematical opportunities differs by social class or society, but the extent to which parents or early education teachers draw their children's attention to the mathematical aspects of the materials may well vary socio-culturally. Supporting evidence comes both from the clear class variations in parents' use of language (Hart & Risley, 1995, 1999) and in American parents not mentioning the mathematical possibilities even in exhibits about mathematics in museums designed to be of interest to children (Gelman, 2000; Gelman, Massey, & McManus, 1991).

If parents and early childhood educators could be empowered to draw children's attention to the mathematical opportunities inherent in so many of their everyday activities, the children's understanding of mathematical principles would be enhanced. But for this to happen parents and educators, like researchers themselves, need to observe carefully what children are doing.

**Date Posted Online:** 2009-04-30 09:30:04

## References

- Aubrey, C., Bottle, G., & Godfrey, R. (2003). Early mathematics in the home and out-of-home contexts. *International Journal of Early Years Education, 11*(2), 91-103.
- Baroody, A. J. (2004). The developmental bases for early childhood number and operations standards. In D. H. Clements, J. Sarama, & A.-M. Dibiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 173-219). Mahwah, NJ: Lawrence Erlbaum Associates.
- Baroody, A. J., Lai, M., & Mix, K. S. (2006). The development of young children's early number and operation sense and its implications for early childhood education. In B. Spodek & O. N. Saracho (Eds.), *Handbook of research on the education of young children* (2<sup>nd</sup> Ed., pp. 187-221). Mahwah, NJ: Lawrence Erlbaum Associates.
- Benigno, J. P., & Ellis, S. (2008). Do parents count? The socialization of children's numeracy. In O. N. Saracho & B. Spodek (Series Eds.) & O. N. Saracho & B. Spodek (Vol. Eds.) *Contemporary perspectives in early childhood education: Mathematics in early childhood education* (pp. 291-308). Greenwich, CT: Information Age Publishing.
- Blevins-Knabe, B., Austin, A. B., Musun, L., Eddy, A., & Jones, R. M. (2000). Family home care providers' and parents' beliefs and practices concerning mathematics with young children. *Early Child Development and Care, 165*, 41-58.
- Blevins-Knabe, B., & Musun-Miller, L. (1996). Number use at home by children and their parents and its relationship to early mathematical performance. *Early Development and Parenting, 5*, 35-45.
- Carew, J. V. (1980). Experience and the development of intelligence in young children at home and in day care. *Monographs of the Society for Research in Child Development, 45* (6-7, Serial No. 187), 1-89.
- Carew, J. V., Chan, I., & Halfar, C. (1976). *Observing intelligence in young children: Eight case studies*. Englewood Cliffs, NJ: Prentice-Hall.
- Fluck, M., Linnell, M., & Holgart, M. (2005). Does counting count for 3- to 4-year-olds? Parental assumptions about preschool children's understanding of counting and cardinality. *Social Development, 14*, 496-513.
- Gelman, S. A. (2000). The role of essentialism in children's concepts. *Advances in Child Development and Behavior, 27*, 55-98.
- Gelman, R., Massey, C. M., & McManus, M. (1991). Characterizing supporting environments for cognitive development: Lessons from children in a museum. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 226-256). Washington, DC: American Psychological Association.
- Ginsburg, H. P., & Amit, M. (2008). What is teaching mathematics to young children? A theoretical perspective and case study. *Journal of Applied Developmental Psychology, 29*, 274-285.
- Ginsburg, H. P., & Ertle, B. (2008). Knowing the mathematics in early childhood mathematics. In O. N. Saracho & B. Spodek (Eds.), *Contemporary perspectives on mathematics in early childhood education* (pp. 45-66). Greenwich, CT: Information Age Publishing.
- Ginsburg, H. P., Cannon, J., Eisenband, J., & Pappas, S. (2006). Mathematical thinking and learning. In K. McCartney & D. Phillips (Eds.), *Blackwell handbook on early childhood development* (pp. 208-230). Malden, MA: Basil Blackwell.

- Ginsburg, H. P., Lee, J. S., & Boyd, J. S. (2008). Mathematics education for young children: What it is and how to promote it. *Society for Research in Child Development Social Policy Report*, 22, 1-23.
- Ginsburg, H. P., Lin, C., Ness, D., & Seo, K.-H. (2003). Young American and Chinese children's everyday mathematical activity. *Mathematical Thinking and Learning*, 5(4), 235–258.
- Ginsburg, H. P., & Russell, R. L. (1981). Social class and racial influences on early mathematical thinking. *Monographs of the Society for Research in Child Development*, 46(6, Serial No. 193).
- Guberman, S. R. (2004). A comparative study of children's out-of-school activities and arithmetic achievement. *Journal for Research in Mathematics Education*, 35(2), 117-150.
- Hannula, M. M. (2005). *Spontaneous focusing on numerosity in the development of early mathematical skills*. Turku, Finland: University of Turku Press.
- Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore: Brookes.
- Hart, B., & Risley, T. R. (1999). *The social world of children learning to talk*. Baltimore: Brookes.
- Hofferth, S. L., & Sandberg, J. F. (2001). How American children spend their time. *Journal of Marriage and Family*, 63(2), 295–308.
- Juster, F. T., & Stafford, F. P. (1985). *Time, goods, and well-being*. Ann Arbor: Survey Research Center, University of Michigan.
- Kersh, J., Casey, B. M., & Young, J. M. (2008). Research on spatial skills and block building in girls and boys: The relationship to later mathematics learning. In O. N. Saracho & B. Spodek (Series Eds.) & O. N. Saracho & B. Spodek (Vol. Eds.) *Contemporary perspectives in early childhood education: Mathematics in early childhood education* (pp. 233-252). Greenwich, CT: Information Age Publishing.
- 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.
- Li, L., Kinney, T., & Tudge, J. R. H. (2005, February). *Almost never or almost always? Young children's everyday mathematical experiences at childcare and at home*. Presented at the Annual Symposium on Child and Family Development, Athens, GA.
- Miller, K. F., Smith, C. M., Zhu, J., & Zhang, H. (1995). Preschool origins of cross-national differences in mathematical competence: The role of number naming systems. *Psychological Science*, 6(1), 56–60.
- Munn, P., & Schaffer, H. R. (1993). Literacy and numeracy events in social interactive contexts. *International Journal of Early Years Education*, 1(3), 61–80.
- Plewis, I., Mooney, A., & Creeser, R. (1990). Time on educational activities at home and educational progress in infant school. *British Journal of Educational Psychology*, 60(3), 330–337.
- Ramani, G.B., & Siegler, R.S. (2008). Promoting broad and stable improvements in low-income children's numerical knowledge through playing number board games. *Child Development*, 79(2), 375–394.
- Sarama, J., & Clements, D. H. (2008). Mathematics in early childhood. In O. N. Saracho & B. Spodek (Series Eds.) & O. N. Saracho & B. Spodek (Vol. Eds.) *Contemporary*

- perspectives in early childhood education: Mathematics in early childhood education* (pp. 67-94). Greenwich, CT: Information Age Publishing.
- Saxe, G. B., Guberman, S. R., & Gearhart, M. (1987). Social and developmental processes in children's understanding of number. *Monographs of the Society for Research in Child Development*, 52(2, Serial No. 216).
- Seo, K.-H., & Ginsburg, H. P. (2004). What is developmentally appropriate in early childhood mathematics education? Lessons from new research. In D. H. Clements, J. Sarama, & DiBiase, A.-M. (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 91–104). Mahwah, NJ: Erlbaum.
- Starkey, P., & Klein, A. (2008). Sociocultural influences on young children's mathematical knowledge. In O. N. Saracho & B. Spodek (Series Eds.) & O. N. Saracho & B. Spodek (Vol. Eds.) *Contemporary perspectives in early childhood education: Mathematics in early childhood education* (pp. 253-276). Greenwich, CT: Information Age Publishing.
- Sophian, C. (2004). Mathematics for the future: Developing a Head Start curriculum to support mathematics learning. *Early Childhood Research Quarterly*, 19, 59-81.
- Sophian, C. (2008). Rethinking the starting point for mathematics learning. In O. N. Saracho & B. Spodek (Series Eds.) & O. N. Saracho & B. Spodek (Vol. Eds.) *Contemporary perspectives in early childhood education: Mathematics in early childhood education* (pp. 21-44). Greenwich, CT: Information Age Publishing.
- Timmer, S. G., Eccles, J., & O'Brien, K. (1985). How children use time. In F. T. Juster & F. P. Stafford, *Time, goods, and well-being* (pp. 353–382). Ann Arbor: Survey Research Center, University of Michigan.
- Tudge, J. (2008). *The everyday lives of young children: Culture, class, and child rearing in diverse societies*. New York: Cambridge University Press
- Tudge, J., Li, L., Stanley, K. (2008). The impact of method on assessing young children's everyday mathematics experiences. In O. N. Saracho & B. Spodek (Series Eds.) & O. N. Saracho & B. Spodek (Vol. Eds.) *Contemporary perspectives in early childhood education: Mathematics in early childhood education* (pp.187-214). Greenwich, CT: Information Age Publishing.
- Tudge, J. R. H., & Doucet, F. (2004). Early mathematical experiences: Observing young Black and White children's everyday experiences. *Early Childhood Research Quarterly*, 19(1), 21–39.
- Tizard, B., & Hughes, M. (1984). Young children learning: Talking and thinking at home and at school. London: Fontana.
- Vandermaas-Peeler, M. (2008). Parental guidance of numeracy development in early childhood. In O. N. Saracho & B. Spodek (Series Eds.) & O. N. Saracho & B. Spodek (Vol. Eds.) *Contemporary perspectives in early childhood education: Mathematics in early childhood education* (pp. 277-290). Greenwich, CT: Information Age Publishing.

To cite this document:

Tudge, J. (2009). Methods of assessment of young children's informal mathematical experiences. *Encyclopedia of Language and Literacy Development* (pp. 1-7). London, ON: Canadian Language and Literacy Research Network. Retrieved [insert date] from <http://literacyencyclopedia.ca/pdfs/topic.php?topicId=269>