The National Council of Supervisors of Mathematics Improving Student Achievement Series No. 6/Fall 2009

Research-Informed Answers for Mathematics Education Leaders

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

Improving Student Achievement in Mathematics by Addressing the Needs of English Language Learners

"Amplify and Enrich — rather than simplify the language of the classroom, to give students more opportunities to learn the concepts involved."

Aida Walqui, The Teacher Quality Initiative

Our Position

It is the position of the National Council of Supervisors of Mathematics that in order to improve the mathematics achievement of English Language Learners (ELLs), educators must acknowledge that all ELLs can learn rigorous mathematics and that the current achievement gap can be closed when teachers, administrators, and policy makers:

- Realize that mathematics is neither value free nor culture free, but instead is a product of human activity. Thus race, class, culture, and language play key roles in its teaching and learning.
- Understand that language is not only a tool for communicating, but also a tool for thinking. Every mathematics teacher is a language teacher — particularly the academic language used to formulate and communicate mathematics learning (Lager, 2006).
- Realize that regular and active classroom participation — in the form of discussing, explaining, writing, and presenting — is crucial to ELLs' success in mathematics, and ELLs can produce explanations, presentations, and engage in discussions as they are learning English.
- Recognize that ELLs, like English-speaking students, require consistent access to high-cognitive demand tasks in mathematics.
- Learn to see the evidence of ELLs' mathematical thinking, hear how ELLs use language to communicate about mathematics, understand the competence that ELLs bring, build on this competence, and provide access to opportunities for advancing their learning.
- Value the home language of each ELL student and find ways to promote its use whenever possible.
- Provide and participate in ongoing professional development to help mathematics teachers shape instructional practices to foster success of ELLs in mathematics, including the development of language-rich classrooms for the benefit of all students.
- Establish district and school-wide structures that promote collaboration among teachers of mathematics, specialists in English as a second language, bilingual teachers and Language Arts teachers, in order to meld skills and knowledge in the service of ELLs' learning of mathematics.

The NCSM Improving Student Achievement Series is a set of position papers designed to provide research-based practices for school and district mathematics education leaders.

Research that Supports Our Position

In the past three decades, the percent of U.S. children living in households where the native language is not English more than doubled from 9% to 19% (Firestone et al., 2006). The total number of students labeled as "Limited English Proficiency" is 9.6% of the student population, or 4.5 million students (Planty et al., 2008). Many of these children are taught mathematics in English which, assessment data suggest, adds a considerable learning hurdle for them.

On the 2007 NAEP 8th-grade mathematics test, ELLs scored 37 points below non-ELLs (Lee et al., 2007). In state-level testing, data are equally troubling. For

example, in Massachusetts, while 40% of all 8th-graders score at Proficient and Above in the state mathematics assessment, only 13% of ELL 8th-graders score at this level (Rennie Center for Education Research & Policy, 2007). ELLs who perform poorly are at heightened risk of being inappropriately diagnosed as learning disabled. (August et al., 2005). Furthermore, because of current testing demands and Annual Yearly Progress goals, many schools are tempted to address ELL needs by separating language work from mathematics work, with "short-term, expedient coping strategies" (Firestone et al., 2006, p. 54). Often, this lack of integration of language and content development contributes to the lack of active engagement by ELLs in mathematics classrooms (Brenner, 1998).

How teachers approach integrating language and content has an important bearing on whether ELLs are mathematically successful (Brenner, 1998; Secada & De La Cruz, 1996; Thornburg & Karp, 1992). Further confounding ELLs' access to learning and showing their competency may be the lack of basic opportunities to learn, since "ethnic minority students have less exposure to content and their instruction tends to cover less content relative to non-minority students" (Herman & Abedi, 2004, p. 5; Masini, 2001; Gándara & Contreras, 2009). However, one of the strengths ELLs bring to school is their "cultural capital." Teachers can use this capital to stimulate their students' learning of mathematics, or teachers can ignore it and, by doing so, actively deplete their students' motivation to learn (Averill, Anderson, Easton, Te Maro, Smith & Hynds, 2009; Tate, 1997).

The literature underscores the importance of *integrating* content and academic language development in classroom instruction (August et al., 2005; Calderon, 2007; Garrison et al., 2006; Snow, 2007). Sustained vocabulary work with ELLs is essential, particularly with academic vocabulary — words referring to thinking and communicating (e.g., *analysis, deny*); words common across subjects, but with different meanings depending on subject (e.g., *base, element*); words that have common meanings that differ from discipline-specific meanings (e.g., *prove, property*). Beyond developing academic vocabulary, ELLs need to participate regularly, both orally and in writing, by "explaining solution processes, describing conjectures, proving conclusions and presenting arguments" (Moschkovich, 1999, p. 11).

Thus, classroom participation by ELLs is essential. Linguists and cognitive specialists recognize that language enables students to bring order and meaning into their classroom experiences and should be practiced by second-language students "not only as a communicative tool but also as a cognitive tool for interacting with the teacher, with one another, and with content knowledge itself" (Lyster, 2007, p. 22). Research underscores the importance of teachers providing regular opportunities for all students but especially for ELLs to engage in mathematical tasks of high *cognitive demand,* a recommendation emphasized in the QUASAR Project (Henningsen & Stein, 1997; Silver & Stein, 1996) and supported by cognitive science research (Bransford, Brown, & Cocking, 2000; Siegler, 2003).

Research supports the creation of learning environments that use *multimodal mathematical communication* — speaking, writing, diagramming, gesturing, etc., to reinforce the learning of mathematical representation, language, and the norms of mathematical communication (Chval & Khisty, 2001; Goldenberg, 1991; Khisty & Chval, 2002; Moschkovich, 2002). Like other academic disciplines, mathematics has its own "register" — i.e., its own ways of employing language to construct knowledge. Features of the mathematics register include technical vocabulary (e.g., "hypotenuse"), dense noun phrases such as "the volume of a rectangular prism with sides 8, 10, and 12 cm" (e.g., from Schleppegrell, 2007, p. 143), precision in definition, and particular norms for convincing arguments. All students, but especially ELLs, need guidance in their navigation with the mathematics register. For example, often in the mathematics register, the same word may be used for a *process* and for a *thing* or *result*. "Reflection" is one such example: it can refer to the process of reflecting or to the result of reflecting.

An important conclusion from research is that all students, including ELLs, need access to teaching that promotes conceptual development. Hiebert & Grouws (2007) describe this teaching as having two central features: one is that teachers and students attend explicitly to concepts, and the other is that students wrestle with important mathematics.

How NCSM Members Can Implement Our Position

NCSM members must act to create and sustain the conditions and structures that will enable all ELLs to fully participate in our classrooms and successfully learn mathematics. Moreover, NCSM members must act to alert mathematics teachers, coaches, and administrators that it is time to move away from incidental to systematic approaches and the use of language pedagogy in the mathematics classroom, and must collaborate with them to realize that change.

More specifically, NCSM members must:

1. Acquire knowledge in the literature regarding ELLs learning mathematics and in the local relevance of that literature, including:

- Exploring the literature to identify the various ways in which opportunities for ELLs to learn mathematics can be improved.
- Targeting the opportunity gap for ELLs and becoming knowledgeable of research-informed best practices to eradicate that gap. (See References.)

2. Establish, participate in, and sustain professional learning communities of mathematics and ESL teachers, specialists, coaches, and administrators to work collaboratively to ensure all English Language Learners are successful in mathematics by ensuring that:
   - Teachers have the skills and knowledge required to analyze students' mathematical productions — e.g., their written work, their presentations using words, gestures, diagrams, and the mathematical arguments they make with fellow students — to determine where mathematical thinking appears basically sound, and to determine where improvements in mathematical communication might improve the mathematical thinking.
   - Teachers have opportunities to reflect on their own language use and production while doing mathematics, if they move beyond math vocabulary development strategies and help ELLs understand the complexities of the mathematical register. Teachers should have the lesson-planning skills and techniques that support ELLs, including how to scaffold lessons appropriately and how to balance different corrective interventions, so that ELLs and non-ELLs develop shared understandings during lessons.
   - ESL specialists and teachers of mathematics meet regularly to analyze ELLs' participation and production in mathematics lessons, and to plan accordingly.
3. Advocate in the broader community for high expectations and the belief that an ELL's culture and first language are a resource — not a deficit — for learning in the mathematics classroom specifically:
   - Promote and participate in research studies aimed at eradicating the mathematics achievement gap for ELLs.
   - Ensure that policies and programs are enacted to close the opportunity gap to ensure meaningful mathematics learning for English Language Learners.

One of a series of position papers of the
National Council of Supervisors of Mathematics
www.mathedleadership.org

National Council of Supervisors of Mathematics

Mission Statement

The National Council of Supervisors of Mathematics (NCSM) is a mathematics leadership organization for educational leaders that provides professional learning opportunities necessary to support and sustain improved student achievement.

Vision Statement

NCSM envisions a professional and diverse learning community of educational leaders that ensures every student in every classroom has access to effective mathematics teachers, relevant curricula, culturally responsive pedagogy, and current technology.

To achieve our NCSM vision, we will:

N: Network and collaborate with stakeholders in education, business, and government communities to ensure the growth and development of mathematics education leaders

C: Communicate to mathematics leaders current and relevant research; and provide up-to-date information on issues, trends, programs, policies, best practices and technology in mathematics education

S: Support and sustain improved student achievement through the development of leadership skills and relationships among current and future mathematics leaders

M: Motivate mathematics leaders to maintain a life-long commitment to provide equity and access for all learners

Revised July, 2007

References

August, D., M. Carlo, C. Dressler & C. Snow. 2005. The critical role of vocabulary development for English language learners. *Learning Disabilities Research & Practice* 20, no. 1:50–57.

Averill, R., D. Anderson, H. Easton, P. Te Maro, D. Smith & A. Hynds. 2009. Culturally responsive teaching of mathematics: Three models from Linked Studies. *Journal for Research in Mathematics Education* 40, no. 2:157–186.

Bransford, J., A. Brown & R. Cocking. 2000. *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press.

Brenner, M. E. 1998. Development of mathematical communication in problem solving groups by language minority students. *Bilingual Research Journal* 22, nos. 2–4:103–128.

Calderon, M. 2007. *Teaching reading to English language learners, grades 6–12: A framework for improving achievement in the content areas.* Thousand Oaks, CA: Corwin Press.

Chval, K. & L. Khisty. April 2001. Writing in mathematics with Latino students. Paper presented at the Annual Meeting of the American Educational Research Association, Seattle, WA.

Firestone, W. A., M. C. Martinez & T. Polovsky. June 2006. Teaching mathematics and science to English language learners: The experience of four New Jersey elementary schools. New Jersey Math Science Partnership. http://hub.mspnet.org/index.cfm/13070.

Gándara & Contreras. 2008. The Latino education crisis: The consequences of failed social policies. Cambridge, MA: Harvard University Press.

Garrison, L., O. Amaral & G. Ponce. 2006. UnLATCHing mathematics instruction for English learners. *NCSM Journal of Mathematics Education Leadership* 9, no. 1:14–24.

Goldenberg, C. 1991. Instructional conversations and their classroom application. http://www.ncela.gwu.edu/pubs/ncrcdsll/epr2/.

Henningsen, M. & M. K. Stein. 1997. Mathematical tasks and student cognition: Classroom-based factors that support and inhibit high-level mathematical thinking and reasoning. *Journal for Research in Mathematics Education* 28 no. 5:524–549.

Herman, J. L. & J. Abedi. 2004. Issues in assessing English language learners' opportunity to learn mathematics. *CSE Report 633*. Los Angeles: Center for the Study of Evaluation, University of California at Los Angeles.

Hiebert, J. & D. Grouws. 2007. The effects of classroom mathematics teaching on students' learning. In *Second handbook of research on mathematics teaching and learning,* ed. F. Lester, 371–404. Reston, VA: NCTM.

Khisty, L. L. & K. Chval. 2002. Pedagogic discourse and equity in mathematics: When teachers' talk matters. *Mathematics Education Research Journal* 14, no. 3:154–168.

Lager, C. 2006. Types of mathematics-language reading interactions that unnecessarily hinder algebra learning and assessment. *Reading Psychology* 27:165–204.

Lee, J., W. Grigg & G. Dion. 2007. *The Nation's Report Card: Mathematics 2007* (NCES 2007-494). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, D.C.

Lyster, R. 2007. Learning and teaching languages through content: A counterbalanced approach. Amsterdam/Philadelphia: John Benjamins.

Planty, Michael, William Hussar, Thomas Snyder, Stephen Provasnik, Grace Kena, Rachel Dinkes, Angelina KewalRamani & Jana Kemp. 2008. *The Condition of Education 2008* (NCES 2008-031). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, D.C.

Masini, B. R. April 2001. Race differences in exposure to algebra and geometry among U.S.A. eighth-grade students. Paper presented at the Annual Meeting of the American Educational Research Association, Seattle, WA.

Moschkovich, J. 2002. A situated and sociocultural perspective on bilingual mathematics learners. *Mathematical Thinking & Learning* 4:189–212.

Moschkovich, J. 1999. Supporting the participation of English language learners in mathematical discussions. *For the learning of mathematics* 19, no. 1:11–19.

Rennie Center for Education Research & Policy. (2007). Seeking effective policies and practices for English language learners. Cambridge, MA: Rennie Center for Education Research & Policy.

Schleppegrell, M. J. 2007. The linguistic challenges of mathematics teaching and learning: A research review. *Reading & Writing Quarterly* 23:139–159.

Secada, W. G. & Y. De La Cruz. 1996. Teaching mathematics for understanding to bilingual students. In *Children of la frontera: Binational efforts to serve Mexican migrant and immigrant students*, ed. J. L. Flores, ERIC Clearinghouse on Rural Education and Small Schools.

Siegler, R. S. 2003. Implications of cognitive science research for mathematics education. In *A research companion to principles and standards for school mathematics,* ed. J. Kilpatrick, W. B. Martin & D. E. Schifter, 219–233. Reston, VA: NCTM.

Silver, E. A. & M. K. Stein. 1996. The QUASAR project: The "revolution of the possible" in mathematics instructional reform in urban middle schools. *Urban Education* 30:476–522.

Snow, C. 2007. Learning all-purpose academic words. Webinar presentation on September 6, 2007. Accessed at http://www.schoolsmovingup.net/cs/wested/view/rs/7662.

Tate, W. F. 1997. Race-ethnicity, SES, gender, and language proficiency trends in mathematics achievement: An update. *Journal for Research in Mathematics Education* 28:652–680.

Thornburg, D. G. & K. S. Karp. April 1992. Resituating mathematics and science instruction for language different students. Poster presented at the meeting of the American Educational Association, San Francisco.