Closing the Math Achievement Gap Through Targeted Interventions

by Barbara Freeman and Lindy Crawford

Numeracy in a Digital Society

The problem of learning mathematics in a non-native language is situated within a wider discourse concerned with equality and social justice in K-12 education. English language learners (ELLs) are persistently underachieving in mathematics. For example, according to the Nation's Report Card, 85% of Hispanic eighth-grade students are performing below Proficient in math (45% of whom are below Basic). By 12th grade, 92% of Hispanic students are failing to reach proficiency in math, representing more than a 20% gap with their white peers—a gap that has persisted and has shown no significant change since 1992 (National Center for Education Statistics, 2007).

In a digital society, being numerate is as critically important as being literate. Steen (2001) maintained that in the same way that the printing press changed the general public's need to be literate, the computer and the Internet have increased the requirement for people to be numerate. In a technological era, numbers (in discourse, tables, graphs) are used to describe and measure events that affect most aspects of life, such as personal finance, public policy issues, taxes, and so forth. Given the copious amount of information instantaneously available through the Internet, students need to be able to discern valid information from misinformation and have the ability to visualize, interpret, and transform abstract data into meaningful contextual knowledge (Gardenfors, 2007). Students and adults who are neither numerate nor mathematically literate may be limited in their ability to effectively evaluate alternatives, problem-solve and communicate complex ideas. Hence, they may struggle to find gainful employment or fully participate in civic life.

Although it is widely accepted that mathematics is a universal language, students are taught the subject through the use of language and must quickly overcome daunting language barriers to keep up with what is being taught in class (Freeman & Crawford, 2009). To understand content and develop mathematical skills and reasoning—long before comprehension can occur at a symbolic level—students need to be able to read, solve problems, take tests, and communicate using technical (e.g., addend, factor) and academic language (e.g., represent X with Y). Learning math in a non-native language—and the pedagogical challenges it presents—is particularly difficult for students who are not academically literate in their native language and may not have inherited the economic means or cultural capital (Bourdieu, 1986) that other, more advantaged students may have received. Gardenfors (2007) noted that some students may not yet have the breadth of "experiential background" to bring to bear to understand theoretical patterns (essential in mathematics)—which, to a large extent, "depends on an intricate alliance between experience and theoretical knowledge."

Additional and Specific Instructional Support

ELL students require additional and specific support (e.g., language, prerequisite skills) if the mathematics achievement gap is to be closed. Equal access to resources is, of course, essential to improve the opportunities of ELLs, yet it is not enough if it is not also accompanied by targeted support that takes into account individuals' or groups' special needs. The value of a resource cannot be viewed in isolation from the individual's capability to use that resource (Sen, 1992). For example, providing equal access to books without Braille represents a false opportunity for a blind person to read and achieve. Braille will not automatically make blind students literate; however, it will provide them with a genuine opportunity to read and learn. Likewise, teaching students grade-level math in a non-native language without extra supports in both the native, and the non-native language, or teaching students math in their native language without also providing tools to acquire prerequisite skills, does not provide genuine opportunity for ELLs to become numerate.

Specific instructional interventions and resources (classroom-based and digital) are available to help ELLs learn math. One effective instructional methodology for teaching subject content to non-native learners is sheltered instruction (Freeman & Freeman, 1988). Sheltered or scaffolded teaching strategies in support of a student's development have their roots in the zone of proximal development (Vygotsky, 1978). The scaffold or support enables students to metaphorically step or reach to the next level, one just beyond what they would have been able to achieve on their own. The Sheltered Instruction Observation Protocol (SIOP) model is a tool designed to measure the quality of classroom instruction delivered using sheltered instruction strategies (Short & Echevarria, 1999). SIOP helps teachers to incorporate sheltered instructional strategies—such as visuals, repetition, and reliance on prior knowledge—into their lessons to make content (e.g., math, science) comprehensible to ELLs while simultaneously developing the learner's overall English language abilities.

Like SIOP, HELP Math, a digital mathematics intervention, uses sheltered instructional strategies to teach

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math content and develop language concurrently in meaningful contexts. What differentiates HELP is that it scaffolds ELLs' ability to learn math by embedding research-based techniques directly into the instructional content, including, for example, vocabulary development, bilingual support, and immediate corrective feedback. HELP employs audio, video, text, and interactivity synchronized to create a visual connection between words, symbols, and meaning (e.g., corresponding vocabulary, symbols, or pictures flash in sync with audio) (Freeman & Crawford, 2009). To achieve higher levels of understanding, HELP Math emphasizeskey foundational milestones (e.g., fractions, decimals, ratios, and pivotal concepts in geometry and measurement). Figure 1 shows a sample screen from a Grade 6 lesson in which students are working on a division problem. Students interact with a number line to help them visualize the operation.

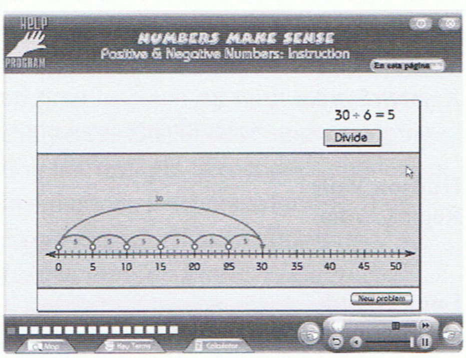

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Figure 1. Software providing visual support.

Through built-in diagnostic-prescriptive assessments, the HELP intervention is able to identify a student's prior concept knowledge and skill gaps, and design an individualized custom curriculum based on each student's unique requirements. For example, if students are not ready to master division skills, they may be presented with foundational lessons before progressing to division. Figure 2 shows development of the concepts of the number line and rational numbers, as a prerequisite to learning division.

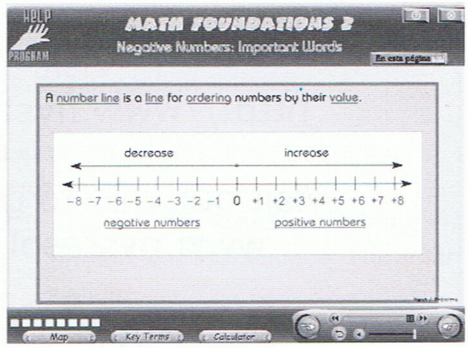

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Figure 2. Number line foundations.

Conclusion

As the complexity and economic dominance of the knowledge economy accelerate, and as technology is increasingly integrated in a digital world, freedom to choose one's path and well-being (Sen, 1999) are predicated on academic knowledge, literacy (including content literacy), and numeracy. Speaking of the "enduring educational achievement gap," Suarez-Orozco and Sattin (2007) said, the "new economy is increasingly unforgiving to those without skills and credentials for functioning in the knowledge-intensive sector of the opportunity structure." It is hence vital that English language learners receive the additional and specific support and scaffolding that they require, so that they are afforded real opportunities to achieve. Thus, as ELL students mature, they will not be excluded from the extraordinary prospects the world has to offer.

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Equal Goals, Unequal Treatment (*continued from page 15*)

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