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Creating a Middle School Mathematics Curriculum for English-Language Learners

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Hispanic English-language learners and other students learning English are failing in K–12 mathematics. The field has not responded with mathematics curricula designed for this population, especially at the middle grades. In response to this academic crisis, the Help with English Language Proficiency (HELP) Math program for middle school students was created. HELP Math is a Web-based supplemental curriculum composed of a series of rich interactive lessons that essentialize mathematical vocabulary and academic concepts so that students can better understand the content. As a vehicle for informing the field about designing mathematics curricula specifically for this population of students, the authors track the journey from conceptualization through research and implementation of this supplemental curriculum, with a particular focus on the key challenges and lessons learned.

Keywords: *ELL; math; sheltered instruction; supplemental curriculum*

The No Child Left Behind (NCLB) Act, signed into law January 2002, placed renewed emphasis, urgency, and expectations on all states and school districts to ensure, for the first time, that every child, including those with limited English proficiency, meet the same state academic achievement standards as native English speakers at the same grade level. Moreover, NCLB requires that schools, and school districts, be held accountable for this achievement. School districts receiving Title I federal funds that fail to meet adequate yearly progress goals for two or more consecutive years are considered in need of improvement and underperforming and thus face a range of severe sanctions, such as school closure, firing of teachers, offering of public school choice and transportation, providing of supplemental educational services, and implementation of certain corrective actions (Southern California Consortium on Research in Education, 2005). The pressure to demonstrate adequate yearly progress is particularly acute in schools and districts with relatively high percentages of English-language learners (ELLs), schools that are often linguistically segregated with concentrations of students from low socioeconomic backgrounds (Ma, 2002).

A foundational axiom of NCLB is the belief that every child in the United States deserves a better education than is presently provided. Notwithstanding, as the number of English-language learners continues to grow alongside a shortage of ELL-trained teachers, meeting individual needs presents a substantial, perhaps unprecedented, challenge. One possible solution to this challenge is the provision of differentiated and individualized instruction through use of technology. In this article, we describe the creation of an online supplemental mathematics curriculum designed for middle school ELLs. We recount our efforts at developing a standards-based curriculum that is conceptually sound, research based, and, most important, accessible for students with limited English proficiency. Help with English Language Proficiency (HELP) Math is the first of its kind in applying principles of sheltered instruction in an online environment. Because it provides sheltered instruction, it is appropriate to use with all students

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regardless of their primary language; however, the program is especially responsive to the needs of students who speak Spanish as their primary language because of its "side-by-side" Spanish language support.

In this article, we share the process of designing an online curriculum that incorporates the principles of sheltered instruction, describe the features of this curriculum, and discuss initial findings, including how these data have driven program improvements. We situate our efforts within the context of national and state standards and discuss how these standards have influenced mathematics instruction in the past two decades. Then, before introducing the details of the curriculum, we describe the complexities involved in learning mathematics content while simultaneously overcoming the challenges involved in learning a new language.

Standards-Based Mathematics Curriculum and Instruction

Academic content and achievement standards inform instruction by clearly defining what students should know and be able to do at specified levels of competency at each grade level. For mathematics, it is generally agreed that the standards movement was impelled by the publication *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* (Mathematical Sciences Education Board & Board on Mathematical Sciences, National Research Council, 1989), which found that "current mathematical achievement of U.S. students is nowhere near what is required to sustain our nation's leadership in a globally technological society" (p. 1). In response to this national concern, the National Council of Teachers of Mathematics (NCTM; 1989) developed and published the *Curriculum and Evaluation Standards for School Mathematics*, which was subsequently expanded and replaced by the *Principles and Standards for School Mathematics* (NCTM, 2000). *Principles and Standards for School Mathematics* is still viewed as the most comprehensive set of guidelines for developing mathematical knowledge across each grade level and is often referred to as simply the "Standards." The 2000 NCTM Standards consist of six principles (equity, curriculum, teaching, learning, assessment, and technology), five content standards (number and operations, algebra, geometry, measurement, data analysis and probability), and five process standards (problem solving, reasoning and proof, communication, connections, and representation). The Standards place a critical emphasis on principles and processes and promotes exploratory (discovery) learning through "real-world" issues. Although widely accepted, the Standards are not without debate; much controversy exists about NCTM's approach to the teaching of mathematics, as explored by Schoenfeld (2004).

Most states, and some school districts, with varying resources for providing leadership in mathematics education, have developed their own mathematics standards. Although by and large, these standards have been guided by the 2000 NCTM Standards, state standards have been developed quite independently, resulting in a wide range of mathematics curriculum standards, with discrepancies in the order in which math ideas are presented and emphasized within each grade level (Reys, Dingman, Sutter, & Teuscher, 2005). Content emphasis and content order present two of the greatest challenges to designers and developers of mathematics curriculum frameworks and instructional materials.

In 2006, NCTM introduced the *Curriculum Focal Points for Prekindergarten Through Grade 8 Mathematics*, providing an instructional emphasis by focusing on a small number of significant—fundamental and foundational—mathematical "targets" (topics, ideas, concepts, and skills) that are taught *at* and *across* grade levels. The NCTM explains that "the decision to organize instruction around focal points assumes that the learning of mathematics is cumulative, with work in the later grades building on and deepening what students have learned in the earlier grades, without repetitious and inefficient reteaching" (NCTM, 2006a, para. 2) and that the focal points may serve as "one possible response to the question of how to organize curriculum standards within a coherent, focused curriculum, by showing how to build on important mathematical content and connections identified for each grade level, pre-K–8" (NCTM, 2006b, para. 2).

A singular virtue of national and state standards for mathematics is that they provide a "common backbone" (Freeman, 2006) and can therefore be augmented coherently. In the context of these standards, powerful instructional materials for ELLs and students with special needs may be prepared that align directly to the mathematics standards and thus do not distort or depart from what is required in the traditional classroom. NCLB and standards-based education have had a significant impact on K–12 education and classroom instruction, prompting administrators and teachers to align their curriculum to state mathematics standards and/or the 2000 NCTM Standards. Administrators also are held accountable for ensuring that academic standards are reflected in teachers' instructional methodologies and that these instructional practices result in increased achievement and demonstrated student proficiency on state assessments.

Mathematics and Second-Language Learners

The Language of Mathematics

Although it is said that mathematics is a universal language, it is also a technical language that can be very difficult for students to master and can significantly impede their progress in, and enjoyment of, their mathematical studies. The language of mathematics can be as challenging as a foreign language. One obvious reason for this is that many mathematical terms are brand-new to young learners (e.g., *coefficient*, *hypotenuse*, *tessellation*). Another reason is that many mathematical terms are deceptively familiar (e.g., *value*, *scale*, *chance*, *product*), with the mathematical definitions of these terms being much more specific and complex than their everyday definitions. This can lead to students' thinking they understand these terms and the concepts they represent long before they really do—which, in turn, can lead to misconceptions that students must overcome before they are able to master the concepts.

Mathematics involves two main types of language, the language of words (*hypotenuse*, *scale*) and the language of symbols (> [greater than], variables such as n or x, etc.), symbols that are sometimes different in different countries (e.g., *divide* can be shown as ÷ or /). For many students, the words of math are very challenging, but the symbols of math are equally challenging. Getting comfortable with the words is critical for learning the big ideas of mathematics. Getting comfortable with the symbols is critical for engaging in mathematical problem solving (T. Murphree & L. Murphree, personal communication, March 1, 2007).

Barriers to Learning Math Faced by Second-Language Learners

Thus far we have focused primarily on the many difficulties of understanding the language of mathematics for all learners. The linguistic barriers for second-language learners, however, are formidable, and if you are like many students learning mathematics in a foreign language, there is a good chance you are considering dropping out. In 2002, the reported status dropout rate of Hispanic youth stood at nearly 30%, about four times the dropout rate of their White counterparts (National Center for Education Statistics, 2005a). For those students who do stay in school, well-documented achievement gaps exist among ethnicities, especially in mathematics education. Although the headlines are positive about closing achievement gaps, generally, students from disadvantaged backgrounds (across ethnicities) lag behind, starting as early as kindergarten, persisting and, in many cases, widening after time. Nationwide, 82% of Hispanic fourth-grade students are below proficient in mathematics (56% of whom are below basic), increasing to 88% of Hispanic eighth-grade students (50% of whom are below basic) (National Center for Education Statistics, 2005b). These figures are even more striking when one considers that the scores of ELLs at the beginning-proficiency level are typically not included in the scores from the National Assessment of Educational Progress (National Center for Education Statistics, 2003). These sobering statistics are understandable when one imagines the day-to-day challenges faced by students who are not fluent in the language of instruction.

Imagine that you are living in Brazil; for the purposes of this scenario, assume that you (the reader) speak a little Portuguese and that you are able to order food in a cafe through a combination of muttering a word sounding somewhat like the food you are ordering while pointing at a picture of the food you wish to eat. You go from the cafe to your night class, where you are taking a course in real-world mathematics.

The teacher begins the lesson by saying, "*Hoje, ilustraremos o conceito de notação científica a partir do conceito de 'mole.' Moles são uma coleção de átomos (ou moléculas) cuja massa total é o número de gramas numericamente igual ao peso atômico do átomo. Esses são números muito grandes, em notação científica, igual a* 6.02×10^{23} *onde 6.02 é o coeficiente, com base 10 elevada à potência 23* [Today, we will illustrate the concept of scientific notation by thinking about "moles." Moles are a collection of atoms (or molecules) whose total mass is the number of grams numerically equal to the atomic weight of the atom. These are very large numbers, in scientific notation, equal to 6.02×10^{23} whereby 6.02 is the coefficient, with an exponent 23 raised from a base of 10]."

Remember, you know a little Portuguese; your initial relief that this class is going to be about small furry animals (*moles*) quickly gives rise to increasing panic when you are suddenly bombarded with words like *mass*, *coefficient*, *exponent*, and so forth, terminology that is being illuminated using concepts such as atoms and molecules ("Didn't you hear those terms in science class?"). To add to your confusion, the math content is being presented using specific academic language ("illustrate the concept," "raised from a base"). By this point in the lesson, you are probably completely lost, perhaps staring into space and smiling, wondering if math is really for you.

Second-language acquisition is influenced by many factors, including but not limited to the student's socioeconomic-cultural environment, literacy in the native language, attitudes toward the first and second languages, and perceptions of others' attitudes toward the first and second languages (e.g., related to relative status; August & Hakuta, 1997). Given the persistent underachievement of many ELLs, the intersection of language development and literacy acquisition (Klingner & Artiles, 2006)—including literacy acquisition in content areas such as math—is of particular significance and cannot be ignored. If a student cannot understand what is being said in math class, then it is difficult to move beyond the language to master math content and skills, no matter how gifted the student may actually be.

Challenges Faced by Teachers of English-Language Learners

To understand mathematics, a student needs to be able to read, solve problems, and communicate using technical language in a specialized context. To properly discuss and explain mathematics content, a teacher is required to use technical language. A lack of proficiency in the language of mathematics leads to frustration on the part of teachers of ELL students as well as by mainstream mathematics teachers faced with more and more students with limited English proficiency in their mathematics classroom. The frustration felt by ELL teachers is because of increasing pressure to teach content areas such as math. ELL teachers are typically not trained in mathematics and frequently have difficulty with, and fear of, the subject (Zaslavsky, 1994). On the other hand, mainstream mathematics teachers are typically not trained in ELL and do not have the language skills to help ELLs. This is particularly acute in the elementary (Grades K–4) and middle school grades (Grades 5–8). According to the National Center for Educational Statistics, in the 1999–2000 school year, at least two thirds of math teachers at Grades 5 to 8 and three quarters of the middle-grade English as a Second Language or bilingual teachers did not report holding a major certification in the subject taught (Seastrom, Gruber, Henke, McGrath, & Cohen, 2002). Financially, it is not possible to have a bilingual teacher or paraprofessional in every classroom. The problem is further exacerbated at home; for instance, Spanish-speaking parents find it difficult, if not impossible, to help their children even if they understand math (most having learned it in Spanish).

Using data from a Course Crafters survey, Ragan (2006) showed that (a) nearly 70% of the teachers surveyed have students in their classes whose first language is not English, (b) 90% of all teachers surveyed say their ELLs need extra help to learn the content and skills required in their grade level, and (3) teachers consider all four subject areas—reading, math, science, and social studies—significantly more difficult for ELLs than for native English speakers. According to the U.S. Department of Education, only 20% of U.S. teachers feel well prepared to meet the needs of such students (Lewis et al., 1999).

These challenges are not going away. Between 1979 and 2004, the number of school-age children (ages 5–17) who spoke a language other than English at home increased from 3.8 million to 9.9 million, or from 9% to 19% of all children in this age group (National Center for Education Statistics, 2006). Among students in the more than 110,000 U.S. schools (public, charter, private), there are more than 5 million ELL students. About 80% of ELLs are Latino; by 2010, ELLs will make up approximately 25% of total student population; and by 2030, ELLs will make up 40% (Ragan, 2006). In the 2004–2005 school year, this represented about 10.5% of the total K–12 public school enrollment, with a 56% increase from the 1994–1995 ELL population (National Clearinghouse for English Language Acquisition, 2006).

Academic English and the Need for Sheltered Instruction

"Academic English" is defined as "the ability to read, write, and engage in substantive conversations about math, science, history, and other school subjects" (American Educational Research Association, 2004, p. 2). Academic English relies on a wide understanding of words, concepts, language structures, and interpretation strategies. It includes vocabulary used beyond social conversations and includes vocabulary required to communicate effectively and comprehend materials in academic content area classes (American Educational Research Association, 2004). According to a nationally recognized ELL specialist, academic English is the language of the classroom and of text, tests, standardized assessments, and college and job interviews (L. Franco, personal communication, April 28, 2006). Franco maintains that many people confuse academic language with "content" language, that is, language particular to a field of academic content. She contends that content language (*hypotenuse*, *scale)* is just a part of academic language. Academic language can be single words, phrases (groups of words without a conjugated verb, such as "which of the following"), or grammatical constructions, such as cause-and-effect language ("if . . . then" or "if . . . always . . . then . . . always") or whole clauses (groups of words that include conjugated verbs).

An appreciation for the distinction between social language (basic interpersonal communications) and cognitive academic language (Cummins, 1979) is essential to understanding why teachers need to take a special approach toward the teaching of mathematics to ELLs. Effective instructional technologies have been developed to address the challenges associated with teaching English-language learners in fully inclusive classrooms. One effective instructional methodology is the use of sheltered instruction or sheltered subject matter teaching (Krashen, 1992). Sheltered or scaffolded teaching strategies in support of a student's development have their roots in Vygotsky's (1978) *zone of proximal development*. "The zone of proximal development is the distance between what children can do by themselves and the next learning that they can be helped to achieve with competent assistance" (Raymond, 2000, p. 176). The scaffold or support enables students to metaphorically step or reach to the next level, just beyond that which they would have been able to achieve on their own.

Sheltered instruction is delivered in English; thus, teachers need to modify the delivery of their lessons to ensure that the content is easy to grasp. Key sheltered instruction strategies include but are not limited to the following: (a) Increase comprehensibility, the idea is to promote (not inhibit) achievement and cross culture understanding; (b) Scaffold (shelter the instruction), providing visual and contextual clues, demonstrations, and slowing the speaking space; (c) Target vocabulary development, emphasizing math content language as well as academic English; (d) Build on student background knowledge; (e) Increase connections to students' lives and concerns, recognizing that language acquisition takes place in natural settings; (f) Promote student-to-student interaction and dialogue; (g) Increase higher order thinking skills, ensuring the work is cognitively challenging; (h) Review and assess.

A research-based measurement tool designed to measure the quality of instruction delivered in multilingual contexts is the sheltered instruction observation protocol (SIOP), created by the Center for Research on Education, Diversity, and Excellence (Short & Echevarria, 1999). SIOP is a model that helps teachers incorporate best-practice sheltered instruction strategies into their lessons and to effectively deliver sheltered lessons to ELLs in their classroom. Fundamentally, the SIOP method is about more than simply incorporating a smattering of instructional strategies into a teacher's lesson plan; SIOP embraces the understanding that "without systematic language development, students never develop the requisite academic literacy skills needed for achieving success in mainstream classes, for meeting content standards, or for passing standardized assessments" (Echevarria, Short, & Powers, 2006, p. 199).

At the core of the SIOP model is an acute understanding that ELLs have particular language acquisition and development needs (Echevarria, Vogt, & Short, 2000). Specifically, there is a recognition that (a) "age-appropriate English language knowledge is a prerequisite for attaining content standards" (Echevarria et al., 2006, p. 197), (b) an important distinction exists between social-conversational and academic-content English (Cummins, 1979) and that it takes a longer time to acquire content language (e.g., math) than to acquire social language skills, (c) it is "difficult for ELLs without strong oral and written English skills" to demonstrate competency in content areas (e.g., math reasoning) in the classroom and on standardized assessments (Slavin & Cheung, 2003, as cited by Echevarria et al., 2006, p. 197), and (d) there are tacit cultural assumptions and implicit cultural rules and expectations of the classroom.

Expanding Sheltered Instruction Techniques Into an Online Environment

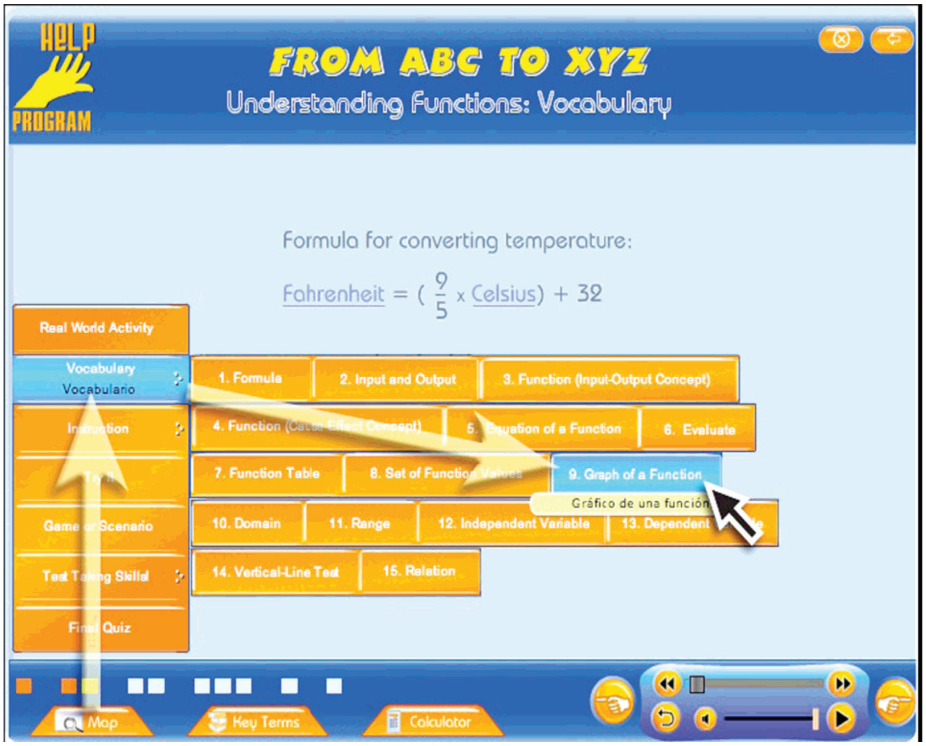
In 2002, as a response to the requirements of NCLB, the academic standards movement, and standardized assessments, and as a result of the continuing high academic failure and dropout rates among ELLs, Digital Directions International (DDI), a socially responsible educational technology company, set out to leverage the growing national cyberinfrastructure to deliver sheltered instruction mathematics content online. As a result, the HELP Math program was created. It has since been field-tested in the classroom with the extensive input of students, teachers, and administrators. We share HELP Math's conceptual underpinnings, lesson design, online delivery systems, and other programmatic features as a model for how one team of individuals worked together to bring sheltered instruction techniques, used typically in a traditional classroom setting, into an online environment.

Design of the Curriculum

HELP Math is a Web-based supplemental curriculum composed of a series of rich interactive modules that essentialize mathematical vocabulary and concepts so that students can easily understand and retain the content. HELP Math builds on the research of the SIOP model of classroom-based instruction for ELLs—takes this successful educational pedagogy and adapts it, capturing the principles of sheltered instruction through interactive, computer-based multimedia. The program incorporates specific techniques of sheltered instruction, such as visuals, repetition, synchronicity, and building on prior knowledge, to make mathematics instruction comprehensible to the ELL student while simultaneously developing English language proficiency.

The program comprehensively aligns to national and selected state mathematics standards for middle school and emphasizes the *Curriculum Focal Points* (NCTM, 2006). In particular, HELP Math content aligns to the 10 NCTM standards (Grades 6–8); the lesson content aligns

Figure 1
Lesson Map and Vocabulary Feature

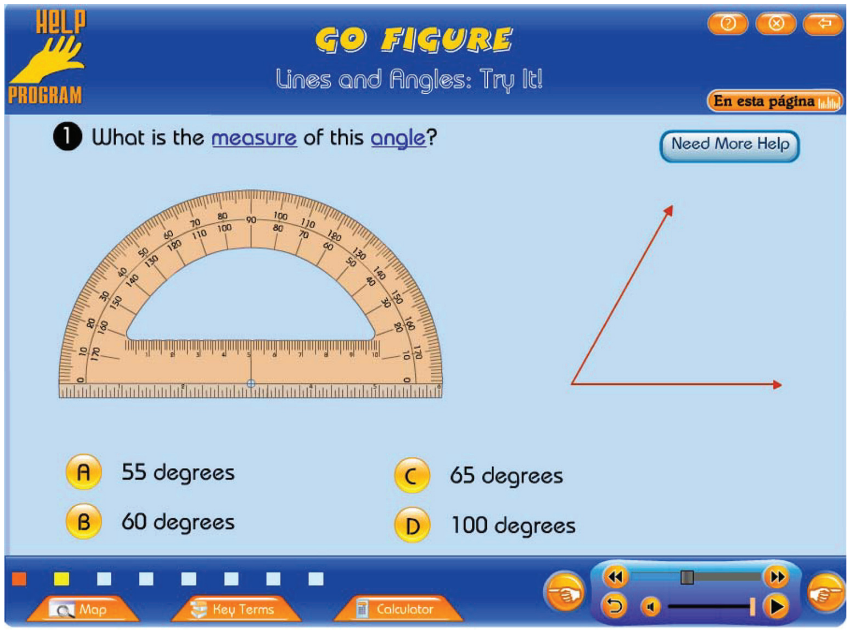


directly to the five mathematics content standards, and the five process standards are distributed throughout each lesson (NCTM, 2000). As shown by the "map" in the lower left of Figure 1, each lesson is structured in the same way, with seven sections organized around explicit content and vocabulary objectives. Teachers using HELP Math report benefits associated with the consistent delivery of sheltered instruction content (Lawyer-Brook, 2007). Given that the content is Web based, students can navigate and explore the content in a nonlinear fashion and engage in the learning process, that is, interact in multiple ways with the content. As we have learned by observing students interacting with the program, it is not uncommon for a student to start a HELP Math lesson by playing the game; however, discovering that she does not have the skills to play the game, she visits the vocabulary or instructional sections to retrieve the necessary information. Such students are both learning math and taking control of their own learning experience (Dewey, 1916; Vygotsky, 1978).

As a standards-based, supplemental program, HELP Math enables teachers to individualize and differentiate instruction for ELLs and other students struggling to learn mathematics in elementary and middle school classrooms. The program is designed to remove the linguistic and cultural barriers (e.g., numbers are written with periods instead of commas in Spanish) from the learning of mathematics content and mathematics skills by *scaffolding* the learning (i.e., providing necessary support for a student to succeed slightly beyond his or her comfort zone; Vygotsky, 1978, Walker, n.d.). Math concepts are scaffolded by using rich multimedia (i.e., a student can simultaneously see, hear, and manipulate the content) and providing interactive constructive feedback loops that provide the student multiple opportunities to develop and practice their skills, with support and extra help available as needed. Although it is difficult to capture a multimodal program in a static screen shot, we have provided Figure 2 as a frame of reference. In the portion of the lesson captured in Figure 2, a student manipulates the protractor by clicking and dragging it onto the angle shown. If the student needs more help, he or she can click on the "Need More Help" button in the upper right corner. Directly above the Need More Help button is the link to Spanish audio. And if the student needs vocabulary support, he or she can click on the hyperlinked (underlined) words. This screen shot illustrates some of the multimedia features available in the program.

The explicit objective of HELP Math is to make the learning of math accessible to all students (especially

Figure 2
Example of Multimedia Program Supports

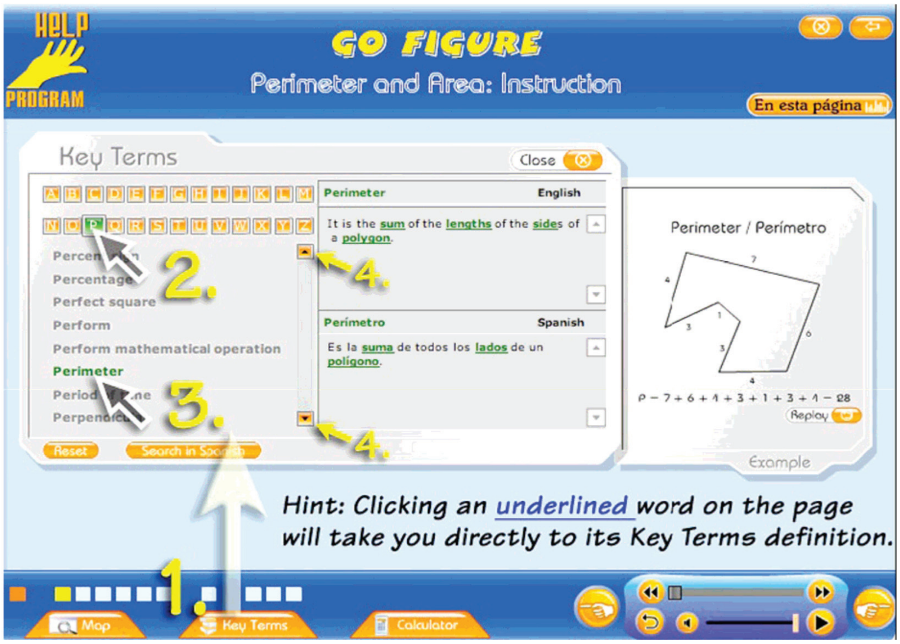


those lacking the prerequisite background knowledge) and to build students' confidence in their ability to understand math. The program does so by breaking down mathematical concepts into small, comprehensible "learning chunks," emphasizing content and academic vocabulary, and explicitly teaching problem-solving and test-taking skills related to standardized mathematics assessments.

The program focuses on mathematical language yet also emphasizes symbolic language. Most essential, HELP emphasizes vocabulary. In emphasizing vocabulary, HELP Math is really illuminating math concepts. Direct vocabulary instruction (repeated, contextual, and varied exposures to words) has a proven effect on student comprehension (Marzano, 2004). Students who receive systematic vocabulary instruction score 33% better than students who do not receive similar instruction on measures of academic reading and reading comprehension (Marzano, 2004). Although HELP Math content is taught in English, native-language support is always available within the context of the lesson through (a) hyperlinks within the instruction for contextual definitions and (b) an extensive key terms glossary providing math content definitions as well as general academic language (*equation*, *solve*, etc.) and phrases (*which of the following*, *perform the operation*, etc.). See Figure 3 for an illustration of these built-in features. Currently, second language support is provided only in Spanish, where the demand is the greatest. There are, however, plans to extend the program into different languages.

The program's functionality and design draw heavily on research from the SIOP model; U.S. Department of Education's Office of English Language Acquisition and National Clearinghouse for English Language Acquisition; National Council of Teachers of English; Center for Research on Education, Diversity, and Excellence; and the Northwest Regional Educational Laboratory. As summarized in Table 1, each section of the HELP program contains key research-based principles for ELL mathematical literacy development. These key research-based principles for ELL mathematical literacy could be integrated into any mathematics curriculum used with English-language learners. The principles are not bound by the delivery system but instead have been found to increase achievement for ELLs when properly applied. For example, Abedi and Dietel (2004) report that modifying the language of test questions can increase ELLs performance by up to 20%; this finding supports math curricula that avoid jargon and complex sentence patterns. Simplified language has also demonstrated positive results but cannot be confused with a simplification of mathematical concepts to be taught. Emphasis on vocabulary building in mathematics is also a well-researched principle (see, e.g., Carter & Dean, 2006; Harmon, Hedrick, & Wood, 2005). We must create curricula with these features at the core if we are to help increase the achievement of English-language learners.

Figure 3
Example of Native-Language Vocabulary Support



Initial Results From Pilot Tests

During 2005, the Colorado Department of Education funded a pilot investigation into the effects of DDI's HELP Math program when used as a supplement to core instruction. Beta tests with 154 students (after attrition) across three Colorado school districts (metropolitan to semirural) and nine middle school classrooms suggested that the math ELL software was successful in developing both math knowledge and English proficiency of ELLs in middle school. Data from a standards-based 30-item pretest and posttest demonstrated large gains made by sixth- and seventh-grade English-language learners who completed HELP Math lessons. Students in the HELP treatment group showed an average improvement of 73% as compared to students in the control group, who demonstrated an average of 8% growth. Results highlighted the effectiveness of the program when used by students whose English language skills were advanced (average increases of 79% on posttest) as opposed to students who were at the intermediate levels of English proficiency (39%) or at a nonproficient level (54%) (Tran, 2005).

Descriptive feedback from students and teachers through the use of focus groups and exit surveys also revealed positive results. Students reported that they liked the program and felt better about their potential to learn math. When asked how they felt about the program, students responded with statements such as "less stupid," "less lost," "more relaxed," and more willing to "figure out what the teacher (computer) was saying." Evidence garnered during the teacher exit survey confirmed this finding suggesting that HELP Math was an important motivator and positive contributor to increasing students' perceived ability to succeed in a mainstream math class. When asked to rate how useful the program was to teachers in their attempts to individualize instruction, teachers rated the program an 8 on a 10-point scale. Similarly, teachers rated HELP Math an 8 on a 10-point scale in terms of its level of student engagement. Teachers also found that HELP Math modules captured and held their students' attention. It was reported that on average, a student could spend about 30 minutes actively engaged in the program.

Feedback From Field Tests

HELP Math is currently being field-tested across four states, and qualitative feedback from these field tests continues to inform program modifications (with a strong focus on teacher support materials). It was recognized from the inception of the program that potential drawbacks existed in using a computer-based model of sheltered instruction. Most significant among these was the lack of student-to-student interaction and dialogue and of teacher-to-class communication as well as the difficulty of developing writing skills in ELLs. During

Table 1
Key Sheltered Instruction Strategies

Key ELL Sheltered Instruction Strategies	How It Is Implemented in HELP
Increase comprehensibility	Student simultaneously sees, hears, and manipulates the content; connects words and meaning by using nonverbal clues; and synchronizes audio and text
Scaffold or shelter the instruction	Supports such as "Need More Help," slower speaking pace, translations, and constructive feedback loops available throughout the lesson
Target vocabulary development	Program explicitly teaches vocabulary (content and academic English) with math content and language development objectives incorporated into each lesson; supports text with visual and contextual clues; and provides hyperlinks and key terms dictionary with English and Spanish definitions and pictures
Build on student background knowledge	Program breaks down the concepts into small "learning chunks," providing support for each concept and showing connections between what students already know and what they are learning
Increase connections to students' lives	Program provides real-world scenarios and modeling
Promote student-to-student interaction and dialogue	Program provides accompanying teacher guides and case studies for effective classroom integration
Increase higher order thinking skills	Program uses simplified English to explain math concepts but never simplifies the concepts themselves; concepts are always grade-level appropriate
Review and assess	Program integrates assessment into the learning process, including nongraded, unobtrusive assessment and interactive feedback loops, which provide students constructive feedback and an opportunity to learn from their mistakes

Note: ELL = English-language learner; HELP = Help with English Language Proficiency.

the formative evaluation, the project team came to understand the significance of students working in groups and is currently developing HELP Math lesson plans that provide strategies for how teachers can use HELP Math modules for small-group and whole-class instruction. In addition, the project team learned that resources, technology, and capabilities vary enormously not only from state to state but also from district to district, from school to school, and in some instances, from classroom to classroom. For example, capacity differs in terms of number and access to computers (labs, classrooms, libraries), size of the broadband pipe, technology competency (some schools or districts have dedicated technicians, others do not), and teachers' level of comfort using technology and implementing it with students.

A further difficulty in implementing an online program is how schools and teachers schedule student and teacher time. For example, some schools provide intervention and supplemental instructional services during the school day by providing a double math period or requiring mathematics remediation during computer lab or an elective period; others provide supplemental instructional services primarily in after-school, weekend, or summer school programs. A key lesson is not to rely solely on the strength and quality of the online curriculum but to spend time and resources planning the implementation: collaborating with administrators and technicians to ensure the technology is working, meeting with teachers to schedule time for regular use of the supplemental curriculum, and training teachers so they feel confident in implementing the program.

One of our most important findings to date, as reported quantitatively during pilot testing and garnered qualitatively through field testing, is that although HELP Math is very successful with ELLs with higher levels of English proficiency (still below grade level), it appears to be less effective with new language learners. Although other cultural (nonlinguistic) group risk factors (e.g., low socioeconomic status, limited parental education, low-achieving schools, etc.) contribute to difficulties faced by new language learners, we know that providing support for language and literacy development in the home language provides a foundation for success in English (Snow, Burns, & Griffin, 1998). Extra home-language support has, therefore, been built into new HELP modules to address this challenge; for example, we have included a button on each HELP instructional page that, when the student clicks on it, summarizes the content in his or her native language. Initial feedback from teachers on this additional functionality is extremely encouraging, so much so that in the newer elementary school modules, bilingual support is provided on every page of the program. Yet nothing in curriculum development is without debate. Formative evaluations showed that although about 85% of teachers really like this feature and encourage their students to use it, others are opposed to any form of bilingual instruction or support. Therefore, within the accompanying HELP teacher administration tool, teachers have the flexibility to switch this functionality off. Further study will illuminate whether this increased level of instructional sheltering will result in greater achievement gains for a broader student population.

Finally, the formative data collected through the initial pilot study and the current field tests have provided a significant amount of information on diverse topics, including those related to development of an online curriculum as well as the challenges involved in effectively implementing an online curriculum in a middle school setting. Along the lines of curriculum development, decisions have had to be made (or modified) related to the type of interactivity needed, the desired amount of native language, and the impact of foreign instruction on content learning. Challenges related to effective implementation include the immense technology diversity at the schools, the effect of teacher implementation styles, the amount of teacher support required, and the barriers to conducting experimental research in school settings.

Using Sheltered Instruction Across Student Populations

It is becoming increasingly clear from teacher feedback that sheltered instruction is more than just a tool to teach English-language learners but is a best-practice method of teaching academic content; as such, both ELL and non-ELL students are benefiting from the HELP Math program with its embedded sheltered instruction strategies. Unexpectedly, teachers using the program during the field tests have also reported its success with students receiving special education. Teachers acknowledge the effectiveness of certain features of the program when working with students who struggle with reading and mathematics, including (a) consistency of lesson design within each of the mathematics modules, (b) vocabulary support available to students within the narrative presented to them (as hyperlinked words) and in an online dictionary of mathematical terms, (c) immediate corrective feedback when errors are made, (d) multiple opportunities for student practice, and (e) a focus on concept development. The last two features, multiple practice opportunities and a focus on concept development, were also found to be effective in the study conducted by Ketterlin-Geller, Chard, and Fien (see this issue).

The HELP Math program was initially created as a grade-level instructional supplement to help middle school ELL students achieve in math. What we have learned during our initial observations and data collection is that many economically disadvantaged students and migrants enter U.S. schools without the language, academic literacy skills, or background knowledge to enable grade-level learning in content areas such as math. Such students require content that is less challenging as well as higher levels of language support to fill in serious gaps in their basic reading and mathematics comprehension. This is particularly critical in math, because according to the National Council of Teachers of Mathematics (2006a), mathematics learning is cumulative. The project team believes that new HELP Math modules, which are currently being developed for Grades 3 to 5, can be used by middle school students and will thus go part of the way toward addressing these gaps.

Conclusion

Middle school is a pivotal point in a student's career. One method of successfully engaging middle school students with varied needs is curriculum differentiation and individualization. Online curricula can be highly individualized, allowing students to move through content at their own pace, providing them with reteaching as often as they need it, and supplying them with as much or as little vocabulary support as they desire. We must provide students with limited English proficiency the same number of learning opportunities as we provide to their English-proficient counterparts; academic achievement depends on sufficient opportunities to learn. Poor academic achievement manifests itself in high levels of student dropouts and, frequently, subsequent economic and societal disadvantage, making improving educational attainment for English-language learners a societal imperative.

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