WHITE PAPER

Increasing Elementary Math Proficiency for English Language Learners

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Executive Summary

When compared to overall student enrollment, English language learners (ELLs) are the fastest-growing K-12 segment in the United States today and this trend shows no signs of slowing down. The exponential growth in ELL enrollment is changing the dynamics of today's elementary school classrooms even in states that had not seen large numbers of ELLs in the past. A growing number of ELLs are being educated in mainstream classrooms by teachers without the training or resources needed to effectively instruct them. Against this backdrop, most ELLs are not meeting academic proficiency standards; especially alarming is their growing achievement gap in mathematics.

The numbers and needs of ELLs in the K-12 mainstream classroom are growing, and with them come new challenges for educators. ELLs come to the elementary classroom with varying levels of English language proficiency, varying levels of math proficiency, and a high need for individualized support. Also, because ELLs often lack sufficient academic math language in English, traditional assessment tests offer an incomplete view of their understanding of math concepts. With schools under immense pressure to raise the academic proficiency of ELLs, it has become clear that differentiated elementary math programs are needed to support teachers and address the challenges facing ELLs so they can achieve math proficiency.

One way of differentiating instruction is through adaptive math learning programs, which can help ELLs at every level of English language proficiency develop conceptual understanding and procedural fluency. A non-language based solution that is highly visual and accessible to students at any level of English proficiency is especially critical. A program that offers differentiated instruction based on a fine-grained assessment of each student's comprehension level will ensure ELLs are working at an appropriate level of difficulty for their individual level of proficiency and understanding. A curriculum that promotes independent learning in an engaging and rewarding environment will encourage ELLs to persist, practice, and explore new concepts. Comprehensive progress monitoring and reporting for educators will ensure teachers have detailed information on ELL comprehension and progress to inform instruction and intervention strategies.

The use of adaptive and differentiated elementary math programs is especially beneficial to teachers working with ELLs in mainstream classrooms, when used for individualized, independent learning. This is particularly true for states and districts with high enrollment of ELLs and quickly growing ELL enrollments. Utilizing an effective, adaptive elementary math program to supplement classroom instruction can support ELLs and their teachers as they work toward closing the math achievement gap.

The growing English language learner student population

English language learners, or ELLs, is the term commonly used to describe the approximately five million students currently enrolled in U.S. public schools (pre-K through grade 12) who are learning English as a second language (ESL).

ELLs in the U.S. come from over 400 different language backgrounds, although the vast majority — approximately 80 percent — are Spanish speakers. Among elementary-age ELLs, 76 percent were born in the United States. However, about 80 percent of parents of ELLs were born outside the U.S.[1]

ELLs understand, speak, read, and write English at varying levels of proficiency, as measured on English language proficiency tests. They also come to the classroom with many different cultural, socioeconomic, and educational backgrounds.

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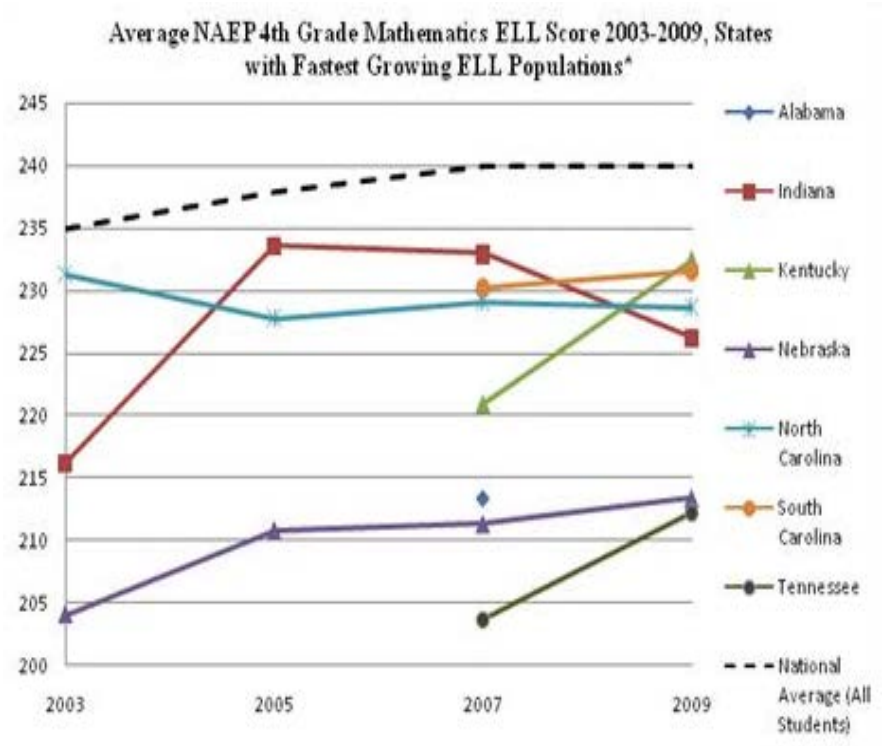

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Nationally, the ELL school population is increasing faster than any other segment of the student population, and it is expected to continue growing rapidly in the years ahead.[2] In fact, at the current rate, ELLs will account for one of every four U.S. students by 2025.[3]

ELL enrollment has grown more than 53 percent over the last ten years, while total school enrollment increased only 8.45 percent during that same period. Some states (including North Carolina, Nevada, and Virginia) have seen ELL enrollment growth upwards of 250 percent.[4]

About two-thirds of ELLs are concentrated in five states: California, Texas, Florida, New York, and Illinois. But over the past 15 years, ELL growth has been most rapid in states that had very few or no ELLs in the past, such as North Carolina, South Carolina, Georgia, Indiana, Oregon, Washington, Tennessee, and Kansas.[5]

Challenges in ELL instruction

The exponential growth in ELL enrollment presents a number of challenges, in particular because in many states and districts with new and growing ELL populations there are no special programs or trained ESL teachers to help ELLs and the classroom teachers who are now serving them.

Complicating matters are two other developments:

1. Beginning in 1998 with California (the state with the largest ELL enrollment), several states have eliminated bilingual education and mandated instruction only in English for ELLs. The most recent national data from a 2001–02 school survey shows that a majority of ELLs — approximately 60 percent — receive what is essentially all-English instruction.
2. Since the passage of *No Child Left Behind* (2002), ELLs are required to achieve at the same high levels of academic achievement as their native English-speaking peers, regardless of each individual student's English proficiency or literacy level.[6]

Due to this convergence of federal law and state-level policy, the pressure on school districts to raise the academic achievement of ELLs is substantial and falls almost totally on the shoulders of mainstream classroom teachers, many of whom have little experience or training with ELLs.

The achievement gap in math

On average, ELLs' academic achievement tends to be lower than the achievement levels of all students. The achievement gap is especially striking in the area of mathematics. On the 2007 National Assessment of Educational Progress (NAEP), fourth-grade ELLs scored 25 points below non-ELLs in math. The gaps among eight-graders were even larger — 37 points in math. And in both elementary and middle grades, ELLs are much less likely than white students to score at or above the proficient level in mathematics.

- ELLs in the six states with largest ELL enrollments (Arizona, California, Florida, Illinois, New York, and Texas) scored below the national average on the NAEP 4th grade mathematics test from the years 2003 to 2009.[7]
- Except for Arizona and California, average NAEP 4th grade mathematics ELL scores in the six states with largest ELL enrollments improved from 2003 to 2009. In Arizona and California, the average NAEP 4th grade mathematics scores for ELLs decreased from 2003 to 2009.
- Although the average NAEP 4th grade mathematics ELL scores in Texas have improved from almost 220 to almost 230 from 2003 to 2009, ELLs in Texas still scored lower than the national average in 2009.
- ELLs in the seven states with the fastest growing ELL enrollments (Alabama, Indiana, Kentucky, Nebraska, North Carolina, South Carolina, and Tennessee), scored below the national average on the NAEP 4th grade mathematics test between 2003 and 2009.[8]
- Data was not available for all states from 2003 to 2009. For example, in Alabama, data was only available during 2007. In that year, ELLs in Alabama on average scored almost 20 points lower than the national average on the NAEP 4th grade mathematics test.
- In 2009 in Kentucky, where ELLs' average NAEP 4th grade mathematics were the highest of any of the other states with quickly growing ELL enrollments, ELLs' average scores were still noticeably below the national average.

It was once commonly believed that math in English should be easier for ELLs because it's less language-dependent than other subjects. This belief is still held in many school systems today where it is routinely recommended that bilingual students be placed in math as their first mainstream subject. However, a respectable body of knowledge has been developed about what kinds of language cause difficulty for ELLs. This research, which includes language that is specific to math, plus a lot of academic language that is common across all academic subjects, makes it obvious that that math is not nonverbal.[9]

Why is mathematics difficult for ELLs?

When learning mathematics in a new language and culture, some of the challenges ELL students encounter include:

- **Undeveloped second language reading comprehension skills.** Second language readers (ELLs) read more slowly and understand less than native language readers. Math achievement is affected because students don't understand textbooks and can't process word problems.

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Technology of this kind can improve comprehension and support ELLs at all levels of English proficiency.

- **Limited mathematics vocabulary.** The vocabulary of mathematics is very specialized and abstract. Everyday language takes on different meanings, and two or more mathematical terms are often combined to form a new concept.[10]
- **Difficulty in understanding the complex syntax of mathematics.** Many structures that are frequently used in math are difficult for ELLs, including comparatives, passives, and words that reference other words. Not only do ELLs need to understand the specific register of mathematics, they also need the ability to present arguments within the context of mathematics, resulting in many conceptually dense terms. All of this complicates learning mathematics for ELLs.[11]
- **Prevalence of word problems.** In order to solve a word problem, ELLs must be able to understand the language in the problem, interpret that language so they can identify the math relations and understand what the problem is asking, and convert the language and the math relations to abstract symbols. All of this is made more difficult by the fact that word problems are artificial situations described using the mathematical language of problem solving, and often lack the extended context that helps reading comprehension. This makes it difficult to use reading skills learned in other contexts to help understand the problem.
- **Background knowledge.** ELLs from certain parts of the world may have gaps in their education due to wars or other disasters, or they may have attended schools with limited resources and poorly trained teachers. As a result, they may lack the basic math foundation needed to build math achievement later on.
- **Cultural differences.** The mathematics ELLs have studied in their native countries may vary significantly from practices in the U.S. For example, in different countries, symbols may play different roles;[12] other countries may use only the metric system, thus making fractions difficult to grasp.[13] Some countries emphasize rote learning over problem-solving skills.[14]

Addressing the challenge: Ensuring ELLs achieve math proficiency

School districts across the country are eager for tools that will help educators address the challenges ELLs face. These materials must go beyond translations of student materials or daily "tips" in the teacher's edition in order to make grade-level content accessible to the majority of ELLs, close the achievement gap, and allow this growing population of students to achieve academic success.

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math proficiency and a high need for individualized support. And because ELLs often have an incomplete grasp of academic math language, traditional assessment tests don't provide a complete view of their understanding of math concepts. Often, ELLs know more math than they can demonstrate on traditional assessment instruments. In addition to standard assessments, their comprehension and learning should be evaluated based on observations of their performance on specific hands- on activities.

Adaptive technology programs that incorporate the best practices in ELL research and instructional design can support educators in increasing math achievement and proficiency among ELL elementary students by addressing the main challenges surrounding ELLs today. These challenges include:

- **Placement in mainstream classrooms.** More and more ELLs are enrolled in mainstream classrooms with teachers who are not trained to support the language and learning needs of second language learners. In addition, faster transitioning of ELLs into the mainstream classroom and the spread of English-only legislation puts additional pressure on mainstream teachers to serve and support ELLs at low levels of English language proficiency. Adaptive math programs use technology to support teachers and differentiate instruction while supporting the diverse needs of ELLs in the mainstream classroom. Technology of this kind can improve comprehension and support ELLs at all levels of English proficiency. The end result is an effective method for teaching both language and content without the use of a student's native language.
- **Exponential growth.** Rapidly growing ELL enrollments in areas that have less capability and fewer resources to serve ELLs means more ELLs are educated without extra language and content support services. To address this issue, elementary math programs that help ELLs achieve math proficiency and include teacher support are needed to help districts build an ELL knowledge base and empower teachers to help students achieve.
- **Doing more with less.** In today's budget-cutting environment, teachers, schools and districts are being asked to do more with less. Cost effective, adaptive learning technology programs can play a critical role in achieving this goal helping EVERY student benefit from individualized instruction and achieve math proficiency at a low cost per student.

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Adapting instruction based on an ELL's demonstrated proficiency in mathematics . . .

- **Federal legislation.** *No Child Left Behind* placed significant pressure on districts and schools to ensure that all students succeed, including ELLs. Schools are under immense pressure to raise both the language proficiency and the academic proficiency of ELLs as measured by standardized tests. Elementary math programs that help ELLs learn math content while also teaching the language of math would make these at-risk students successful on both the math and English language proficiency tests they are required to take under federal law.
- **Disparate circumstances.** ELLs enter the U.S. school system at any grade and any time during the year. Some students come with limited or no prior formal schooling, and with limited understanding or knowledge of grade-level math skills. Technology-based elementary math programs that assess and then adapt to the skill level of students will more successfully support learning and raise academic achievement of ELLs, regardless of academic backgrounds.

Best practices in ELL elementary math instruction

Adaptive math learning programs can help ELLs at every level of English language proficiency develop conceptual understanding and procedural fluency in the foundational math that is essential to future success in mathematics. A non-language based solution that's accessible to students at any level of English proficiency is critical. Adapting instruction based on an ELL's demonstrated proficiency in mathematics and providing extra help and more challenging activities for ELLs as necessary is critical as this ensures students are working at an appropriate level where they can be successful.

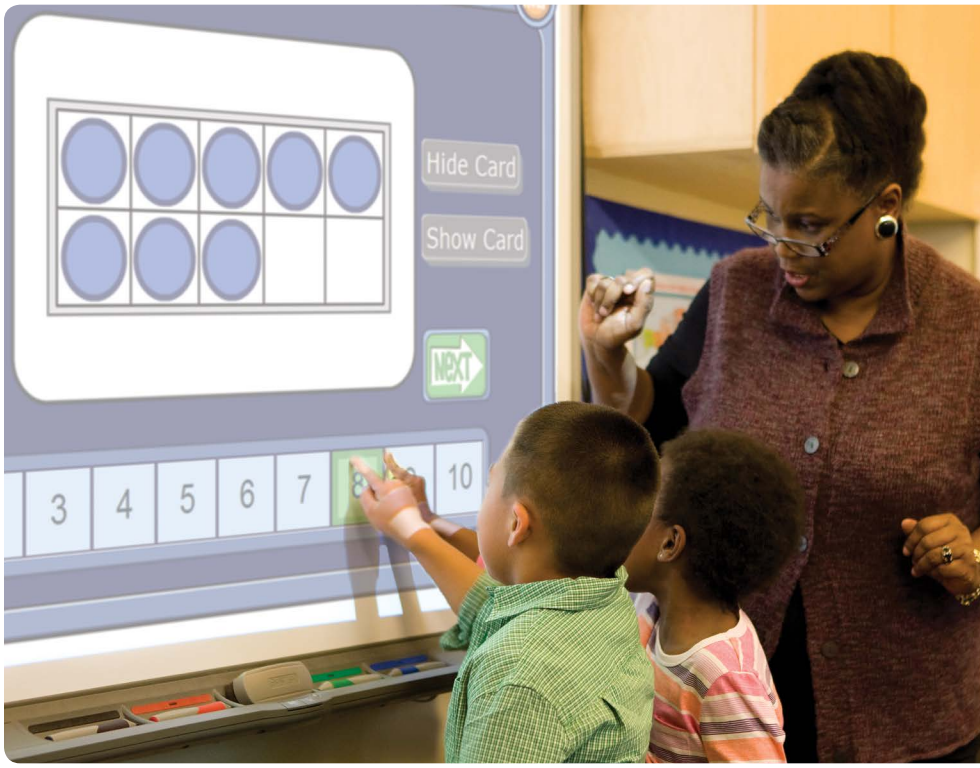
Adaptive technology programs that provide differentiated instruction are ideal for use by ELLs in the mainstream classroom where they can be used as a supplement to traditional math instruction, and can also be deployed for individualized, independent instruction. This is particularly applicable for states and districts with high enrollment of ELLs and quickly growing ELL enrollments.

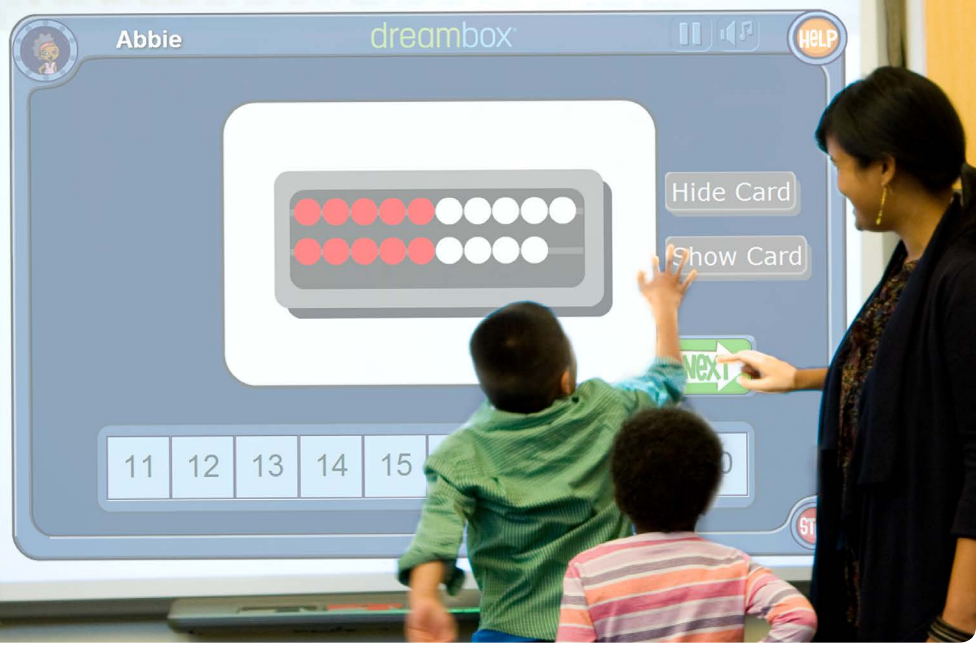
The following features of an adaptive math learning program are specifically recommended for ELLs:

- **Highly visual, hands-on activities and use of visual math manipulatives.** It is crucial for ELLs to be able to explore and learn mathematical concepts in a manner that is less language-dependent than most other materials and methods for teaching math concepts. Visual math manipulatives help students with limited English proficiency develop deep understandings of concepts and skills through multiple modalities, promoting problem solving and critical thinking.

- **Continuous and dynamic performance assessment.** ELLs often know more than what they can demonstrate on traditional reading- and writing-based assessments. For this reason, it is more effective to evaluate their learning based on observations of their performance on daily classroom tasks. This method uses rubrics that include specific criteria for acceptable performance to make the task evaluation more accurate and reliable. When a teacher with a large number of students is unable to do this on a one-to-one basis, adaptive learning programs that integrate assessment and instruction are able to track response time of students, types of mistakes, efficiency of student strategies, and level of comprehension. This information is critical to ensuring students are working at the right level and informing instructional plans.
- **Adaptive, individualized instruction based on student response, level of comprehension, strategies and right and wrong answers.** An effective program should adapt, individualize, and support learning for ELLs at varying levels of math proficiency. Adaptive curriculum differentiates the amount of scaffolding for students in every activity, providing ELLs extra help when they need it, but also challenging students who are excelling. Students can learn and practice on their own, at their own pace. Students should be offered problem-specific hints and scaffolding, the ability to stop an activity if they choose, and re-explanation of instructions — in every activity.

Ongoing progress reporting of student comprehension and proficiency on specific concepts can help teachers tailor instructional plans…





Engaging activities, lessons and rewards for time, effort and academic achievement

- **Comprehensive progress monitoring and reporting.** Many teachers are working with ELLs in large and diverse mainstream classrooms. Ongoing progress reporting of student comprehension and proficiency on specific concepts can help teachers tailor instructional plans and ensure that ELLs don't fall through the cracks. This is especially important for ELLs, who often require additional individualized academic intervention and support. An effective program should track individual student progress and provide reports detailing how well students are learning the essential math concepts and skills.
- **Engaging activities, lessons and rewards for time, effort and academic achievement.** Incentives and rewards for both achievement and time spent are essential for students to persist in an activity. They are especially important for ELLs, who often lag behind their native English-speaking peers and need additional learning time to catch up. Programs that integrate gaming and rewards to motivate ELLs to persist, continue learning and practicing, and explore math concepts in a supportive and rewarding environment, will increase ELL engagement and achievement in mathematics.

About the Authors

Lise Ragan is the founder and CEO of Course Crafters, Inc. the preeminent developer of curriculum and instructional materials for English language Learners (ELLs) and resources and professional development for their teachers since 1993. Lise is a former teacher of ELLs. She does consulting, training, and professional development in the ELL field with both school districts publishers.

Dr. Suzanne Irujo has been a teacher and teacher educator in the fields of English as a second language, bilingual education, and foreign language education for over 30 years. Her public school experience includes elementary bilingual education and English as a second language (ESL), and high school ESL and Spanish. Suzanne is Professor Emerita at Boston University, where she taught and trained teachers in their graduate ESL/bilingual program. She is the author of numerous scholarly articles and educational materials, including several articles on ELLs and mathematics.

Alex Ragan founded and was editor-in-chief of *The ELL Outlook,* an e-newsletter resource for ELL educators, from 2001 to 2008. From 2005 to 2009, Alex was editorial director at Course Crafters, where he directed instructional design and content development of all materials, including The Academic Language Notebooks: The Language of Math (Course Crafters/Perfection Learning), on which he and Suzanne Irujo are authors. He holds a Master of Education degree, Specialized (Ed.M.) from the Harvard Graduate School of Education.

More information can be found at **www.coursecrafters.com**.

About DreamBox Learning

DreamBox Learning Math is changing the way students engage with and understand math. Through our innovative technology we deliver a phenomenal level of individualized math instruction. Dynamic adaptations, based not just on answers but on strategies, keep all learners, from struggling to advanced, in their optimal learning zone.

DreamBox Learning's rigorous math curriculum is aligned with Common Core State Standards and builds conceptual understanding and fluency. Our integrated instruction and assessment, together with detailed reporting, give teachers and administrators actionable data on comprehension, proficiency, and academic progress. Just as important, we offer a highly engaging experience that teaches in a way that motivates today's kids.

Founded in 2006 in Bellevue, Washington, DreamBox Learning's award-winning products target students in kindergarten through fifth grade and deliver more than 600 core lessons with unlimited variations. More information can be found at **www.dreambox.com**.

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Bellevue, Washington, and launched its first online learning product in January 2009. DreamBox Learning Math has won more than 35 top education and technology industry awards and is in use in all 50 U.S. states and throughout Canada. The DreamBox Learning Math platform offers a groundbreaking combination of Intelligent Adaptive Learning™ technology, a rigorous mathematics curriculum, and a highly motivating learning environment. DreamBox Learning Math captures every decision a student makes while working in the program and adjusts the student's learning path appropriately, providing millions of individualized learning paths, each one tailored to a student's unique needs. DreamBox supports teachers and their practice in every type of learning environment, offline or online. For more information about DreamBox Learning Math and the DreamBox Math for iPad app, please visit: dreambox.com.

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