HELP Math: Summary of Research Findings

HELP Math Overview

HELP Math is the only proven, supplementary web-based program designed to increase student achievement in mathematics, while simultaneously, improving student's overall English literacy and language abilities. HELP targets the continuum of elementary and middle school students (grades 3-8), who may be at risk of failing grade-level mathematics because they may be missing essential prior knowledge or the relevant vocabulary to understand the content.

HELP Math engages students through interactive multimedia lessons that break down mathematical terms and concepts so that English language learners can understand the academic subject matter. Math content is presented through synchronized audio, visual, text, and interactivity to create a visual connection between words and meaning. Both grade level and prior grade content is always easily accessible. The program is comprehensive, with over 200 hours of state and national standards-aligned math content and comprehensive foundational lessons, and it includes tools to individualize and customize lessons and curriculum.

About the HELP Math Research Study

As part of a multi-million dollar U.S. Department of Education *Ready to Teach* grant, the University of Colorado at Colorado Springs undertook a multi-year, randomized experimental study, which, before attrition, involved more than 1,000 students nationwide. Dr. Lindy Crawford, Associate Dean of the College of Education was the Chief Researcher of the grant. The two figures below show the initial student demographics by ELL condition and state.

Figure 1:

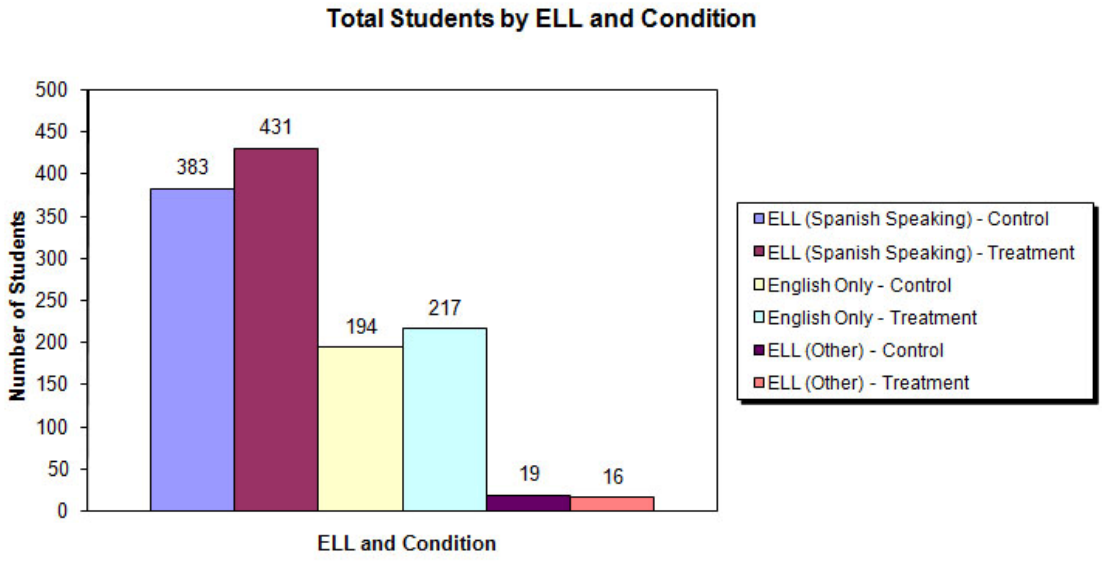
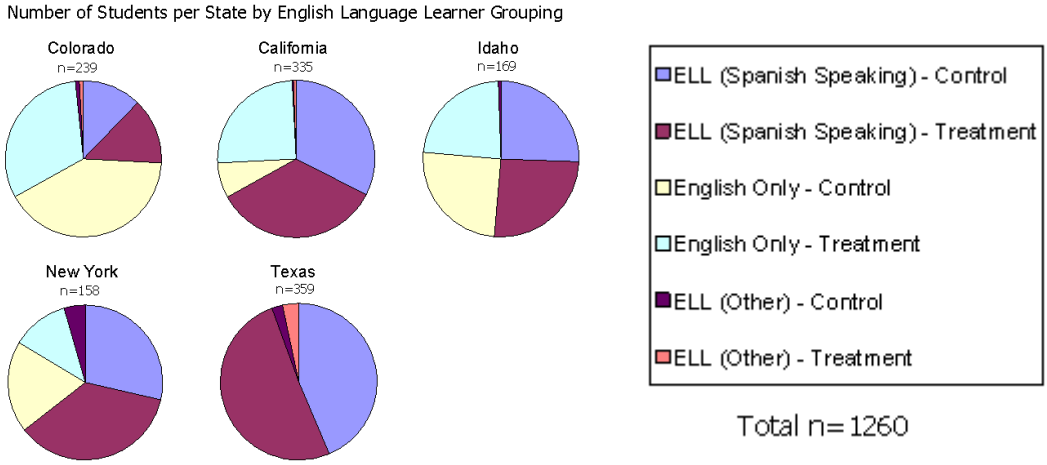


Figure 2:



University of Colorado researchers created a pre/post-test covering: Numbers and Operations, Algebra, Geometry, and Statistics, as well as a Basic Skills module. The reliable and valid tests, targeted for use by middle school, Spanish speaking English language learners, were developed and piloted in the summer preceding the 2007 academic year. Assessment design rigorously adhered to guidelines that aimed to make the test as fair and equitable as possible for all test-takers. Table 1 shows the results of the final item analysis by subtest using item difficulty, point biserial, and a discrimination index. The research team was pleased with the strength of the item statistics and the normalcy of the subtest distributions, especially considering the number of ELLs in the pretest score population.

Table 1

Item Analysis by Subtest

Item Analysis by Subtest				
		Difficulty	**Point Biserial**	**Discrimination Index**
Basic Skills	1	.62	0.39	.65
	2	.70	0.35	.54
	3	.41	0.37	.74
	4	.41	0.44	.83
	5	.45	0.25	.59
	6	.52	0.43	.72
	7	.35	0.22	.61
	8	.42	0.29	.64
Numbers Make Sense	9	.48	0.41	.74
	10	.58	0.4	.69

	11	.37	0.16	.51
	12	.18	0.04	.30
	13	.27	0.11	.49
	14	.31	0.11	.50
	15	.78	0.17	.30
	16	.28	0.11	.50
Algebra	17	.38	0.13	.47
	18	.37	0.14	.57
	19	.30	0.19	.55
	20	.23	0.07	.36
	21	.30	0.33	.75
	22	.61	0.36	.60
	23	.33	0.41	.83
	24	.49	0.36	.72
Geometry	25	.47	0.17	.49
	26	.62	0.29	.55
	27	.44	0.32	.69
	28	.50	0.31	.64
	29	.32	0.27	.69
	30	.43	0.41	.81
	31	.32	0.23	.68
	32	.33	0.3	.75
Statistics	33	.22	0.22	.63
	34	.34	0.31	.69
	35	.38	0.34	.76
	36	.26	0.16	.56
	37	.42	0.18	.48
	38	.24	0.17	.65
	39	.40	0.29	.76
	40		0.07	.44

Implementation of the large scale student study occurred in the fall directly following test development. Students were randomly assigned into a treatment condition (HELP Math) or a comparison condition (one of a few well-established computer-based math interventions selected by the participating teacher). Most students in the control group worked with computer software programs already in use in their schools for supplementary math instruction. During the study, observations and quantitative measures of implementation fidelity occurred across the ten participating schools. The final analysis included 396 ELL students who used the program for approximately 20 hours over 20 weeks. Reasons for the large attrition rate included students who withdrew from school, transferred to other classes within the school or outside of the school, were absent during testing, were not given a posttest due to teacher oversight, or did not participate in the supplementary instruction for the required minimum time.

HELP Intervention Shown to Significantly Increase Student Math Achievement

The treatment group, ELL students using HELP Math, demonstrated significant growth between pre and posttest $t(211) = 6.84$, $p = .000$.

The analysis showed that the HELP Math intervention resulted in greater mean gains than the control group. This finding is even more important when viewed in light of the fact that, during the study, HELP was still in a formative stage of development; foundational lessons (comprehensibly covering grades 3-5) and Statistics/Data Analysis lessons were not completed and therefore not used by study students. Moreover, descriptive statistics revealed that the control group received an average of two more hours of instruction than the HELP Math group.

Table 2

Pre-Post Differences by Condition

Condition	Test	n	Mean	SD	SE
HELP Math	Pretest	212	16.08	5.83	0.400
HELP Math	Posttest	212	18.83	6.66	0.457
Control	Pretest	184	17.11	6.34	0.467
Control	Posttest	184	19.56	8.20	0.604

The study revealed an interaction effect between level of language proficiency and condition $F(2, 394) = 3.91$, $p = .021$. Students at language level 1 (beginning/basic level English proficiency) and language level 2 (limited English proficiency) in the HELP Math intervention group showed higher mean scores than students in the control group, as shown in tables 3 and 4. This result is significant because the HELP Math intervention, with its embedded research-based strategies, instructional scaffolds, and Spanish support, was developed specifically for this population (see Appendix A).

Table 3

Mean Scores Comparison by Condition and Language Level One

Condition	Test	n	Mean	SD	Gain Score
HELP Math	Pretest	48	12.42	5.27	1.85
	Posttest	48	14.27	5.24	
Control	Pretest	34	12.53	4.96	0.44
	Posttest	34	12.97	5.82	

Table 4

Mean Scores Comparison by Condition and Language Level Two

Condition	Test	n	Mean	SD	Gain Score
HELP Math	Pretest	93	16.12	5.62	2.61
	Posttest	93	18.73	6.48	
Control	Pretest	97	16.77	5.96	1.70
	Posttest	97	18.47	7.07	

In addition to student achievement gains, HELP Math shows other significant benefits:

- Calculations of AYP (adequate yearly progress) indicate an increase of 18% in the AYP in math for LEP/ELL students at the participating schools (Lawyer-Brook, 2008).
- All ELL students who used HELP Math showed increases in their state English language proficiency test from the previous year in the research schools in which data were available (Lawyer-Brook, 2008).
- Field-testing led the research team to believe that HELP Math also had potential for students with disabilities, as teachers were reporting its effectiveness with this population. Therefore, in year two of the experimental study, Dr. Crawford's team asked special education teachers to randomly assign students into control and treatment groups. The final database included 69 students with disabilities. Pre-post mathematics scores of Special Ed students showed 15% gains with HELP (Crawford, 2008).
- For three consecutive years, HELP Math was reviewed and "deemed to be of high quality" by the U.S. Department of Education's Government Performance and Results (GPRA) Act (2007, 2008, 2009). The Independent Review Panel of qualified experts, chosen by the US DOE's Office of Innovation and Improvement, gave HELP Math a score of 92.33 out of a possible 100; receiving the highest rating available.
- HELP Math received extremely positive teacher feedback on the program and training (from surveys and focus groups). Quantitative and qualitative information from field studies informed program modifications, with a strong focus on the needs of teachers, the factors involved in successful implementation, and sustainable use of a technology-based math intervention (Crawford et al., 2008).

Appendix A

The key features that distinguish HELP Math from other supplemental programs used by ELLs is its evidence-based pedagogy that is embedded into the digital content; its flexible and sheltered digital learning environment that applies Universal Design for Learning (UDL) principles; and its use of adaptive technology to deliver engaging personalized instruction. HELP support tools may be accessed anytime and phased out when they are no longer needed, including: *Key Terms Dictionary & Hyperlinks* (pictures and audio in English and Spanish); *Bilingual Translations* (content and assessments); *Hints/Need More HELP Buttons* (descriptive, immediate feedback); *Virtual Manipulatives* & *Interactivities* (protractor, number lines, base-10 blocks); and *Social network tools* (teacher-student).

Critically, HELP Math embeds specific instructional strategies directly into the digital math content and specific support tools directly into the digital learning environment to scaffold the learning (see Figure 3). HELP's embedded strategies are designed to remove learning barriers and are instructional practices with demonstrated effectiveness for ELLs, as shown in Table 4 on the next page.

Figure 3: HELP Math Scaffolded Learning Environment

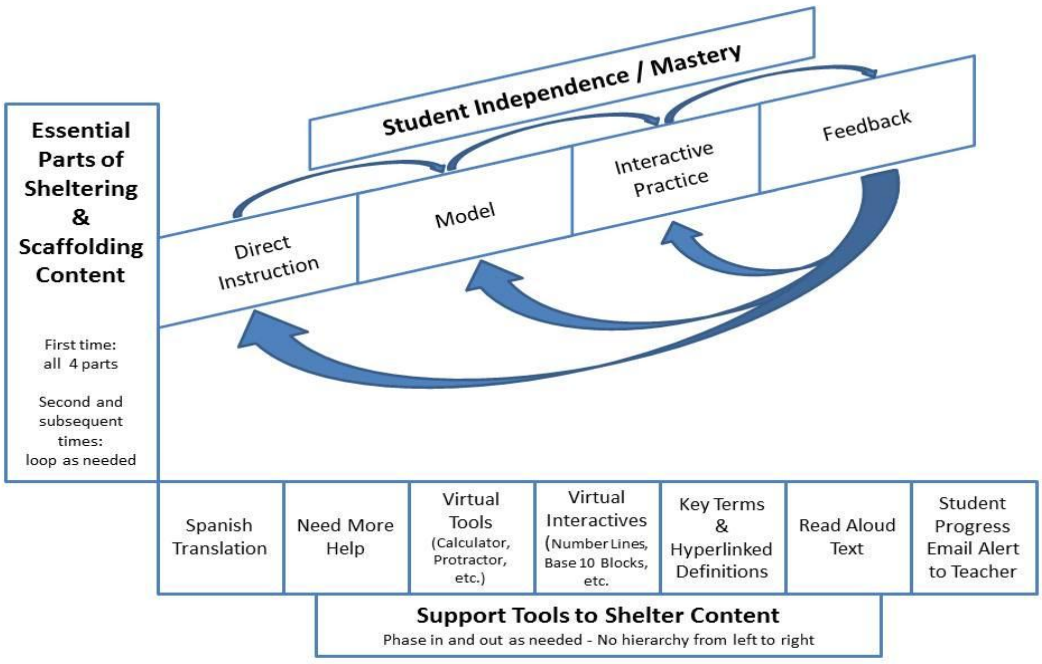


Table 5

Sheltered Instruction Principles & Scaffolding Techniques Underpinning HELP Features

Key Instructional Principle	HELP Methods and Features
Increase content comprehensibility without simplification of the content. (Gersten, Chard, Janaynthi, Baker, Morphy, & Flojo, 2009; Krashen, 1992)	• Provides visual representation. • Synchronizes audio, visual, text, and interactivity (every page) to create a visual connection between words and meaning. For example, corresponding vocabulary, symbols or pictures flash in sync with audio. • Models and demonstrates activities, followed by interactive practice using engaging manipulative tools (e.g., number lines, base ten blocks, hundreds charts, balance scales, geo-boards, spinners, etc.) and interactive math tools (e.g., calculator, protractor, rulers, thermometers, etc.). • Sequences from easy to difficult, with repetition and reinforcement. • Clear explanation of academic instructions. • Virtual teacher/coach has a slow and articulate speaking pace.
Direct, targeted vocabulary development: technical & academic English. (ASCD, 2007; Marzano, 2004; Collier, 1987; Cummins, 1979, 1981)	• Explicitly teaches vocabulary includes a bilingual & pictorial dictionary & contextual hyperlinks (every page). Includes key concept vocabulary (fractions, tessellation), supporting vocabulary (numerator, plane) & academic English (simplify the expression, which of the following, if not X then Y). • Read-aloud throughout. • Language load factored into content design and development. • Integrated content and language objectives for each lesson.
Build background concept knowledge and pre-requisite skills. (Marzano, 2004)	• Computer adaptive and grade level placement tests find each student's level and progresses student through content. • Grade level and prior grade content is seamlessly integrated into a student's personalized curriculum, effectively building a bridge between what students know and need to learn and making explicit links between past learning & new concepts. • Scaffolds the learner by providing the correct academic and/or cognitive support to move student just beyond what they can learn unassisted (e.g., home language translation, key terms dictionary, Need More HELP hints, etc.). • Scaffolds the math content by sequencing problems and

	concepts from easy to more difficult and procedural and problem solving strategies develop from teacher (program) modeled to student-directed. • Provides teachers with comprehensive foundational lessons and tools to individualize & customize lessons and curriculum. • Provides visual & contextual hints and clues and "Need More HELP" buttons.
Review and assess throughout with frequent comprehension checks. (Heward, 2009)	• Provides immediate, constructive, and descriptive feedback consistently. • HELP interactivity with unobtrusive testing and feedback is provided shortly after each instruction and demonstration.
Break down math procedures and concepts into small "learning chucks". (Miller, 1956)	• Systematic and discrete nature of skill presentation. • Demonstrates procedural steps and algorithms associated with problem solving.
Home language support and translations to make content comprehensible. (Franco, 2005)	• Provides Spanish audio and full bilingual translation, which may be turned on or off or phased out as needed. • Optional Spanish-only quizzes.
Increase connections to student lives. (Lock, 1997; Short & Echevarria, 1999)	• Provides "Real World" scenarios, at the start of each lesson. • Language of scenario is situated rather than abstract, with explicit links to current learning objectives.
Increase higher order thinking. (Short & Echevarria, 1999)	• Explicitly teaches problem solving approaches & test-taking skills – how to read, comprehend and answer 'look alike' questions from state standardized math tests. • Integrative NCTM process standards (e.g., communication, representation, approximation, etc.) are woven into each lesson.

For more information, please contact:

Digital Directions International, Dr. Barbara Freeman

Email: helpprogram@comcast.net