

## Apangea Curriculum Overview

### Overview

ApangeaMath is research-based engaging students directly in problem-solving, using concrete, real-world scenarios, and prompts the student to think abstractly by converting situations into quantities and units. The students work with multiple representations of problems and appeals to students of all abilities and learning styles.

ApangeaMath provides online supplemental math instruction for Grades 3 through Algebra – foundations, pre-algebra and algebra. By offering a unique blend of adaptive instruction that meets students where they are, compelling motivational tools to help students persevere, just-in-time tutoring from live, certified U.S. math teachers to intervene when students need it most,

ApangeaMath is repeatedly proven to dramatically improve learning outcomes for a variety of populations including struggling, ESL and proficient learners. Ultimately, the program's unique instructional design makes math appealing and relevant so students can experience success.

The rest of this description reviews some of the key reasons that ApangeaMath is effective. This includes a research basis, motivation, math focus, the 5-step problem-solving process, the Algebra Instructional Model, and how data drives adaptive instruction.

- **Effectiveness Is Based On and Proven by Research**  
ApangeaMath is based on and proven by research. Based on one of the world's largest bodies of cognitive research developed by the U.S. Air Force to answer the question of how best to teach mathematics problem solving, ApangeaMath is proven effective in supporting independent learners as they build problem-solving skills.
- **Motivation Breeds Effort and Success**  
In order for a program to be successful, students must use it and work hard. ApangeaMath's motivation system provides the incentive for students to persevere.
- **Focus on the Right Math Means Effective Use of Time**  
ApangeaMath provides a coherent, focused pathway through math content.
- **Instruction on a 5-Step Process Provides Problem-Solving Power**  
The 5-step process provides a metacognitive structure that allows students to organize their problem-solving thinking. The instruction built into the process, the Learning Coaches, and the Live Online Teachers focus on both the process and the math content.

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- **Effective Pedagogic Model Provides Access for All Students**  
The Algebra 1 pedagogic model consists of activating prior knowledge, introducing math content in a explicit, interactive way, followed by guided practice and independent practice that gradually releases supportive scaffolding for students.
- **Data Adapts Instruction to Meet Individual Student Needs**  
A combination of a placement test and ongoing formative assessment embedded in every lesson adapts instruction on a lesson-by-lesson basis to meet individual student needs.

**91** % of 8<sup>th</sup> Grade "At-Risk" Students Passed the TAKS After Using Apangea Math. Of These Students, Only 20% Passed the TAKS in 7<sup>th</sup> Grade.

### Effectiveness Based on and Proven by Research

Developed by the US Air Force Research Laboratory, Apangea is the sole provider of Apangea Math, an adaptive online instructional technology that constantly assesses and advances student thinking in a motivating and engaging interface featuring live, certified math teachers.

This scientifically researched cognitive skills program helps to improve student performance with unique embedded real-time formative assessment and high quality, targeted and timely instruction from certified teachers. Tightly aligned to the TEKS, teachers primarily use Apangea Math to supplement and differentiate core instruction (remediation and enrichment) in both middle schools and high schools. Standards most often addressed in Apangea are typically the most problematic for students and their classroom teachers; content that students routinely need the most help understanding and that will have the greatest impact on student success; in whole numbers, fractions, and particular aspects of geometry and measurement—as well as Algebra I.

Groups	Percentage change on concrete reasoning	Percentage change on abstract reasoning
WPS Tutor	31%	20%
Placebo	19%	15%
Control	22%	11%

From 1992 to 2004, the US Air Force engaged in a long-term research effort, the Fundamental Skills Training (FST) project, designed to bring state-of-the-art intelligent tutoring technology to bear on literacy skills problems in mathematics; help school children attain basic literacy skills; and evaluate the effectiveness of the software (now known as ApangeaMath) in enhancing critical thinking skills. To accomplish this goal, the intelligent tutoring system was developed. This system was evaluated in 15 year-long field studies involving 40 schools in 10 states over a 10 year period. Each year these studies have involved 40-50 teachers and nearly 3,000



students. Strong correlations of achievement have been mapped to Apangea and the 5-step cognitive process/ algebraic thinking heuristics research. Students learn to analyze and solve story problems by applying a pedagogy derived from contemporary cognitive science, including principles of active problem solving (Anderson, 1994), elaboration theory (Riegeluth, 1987, 1992), categorization by prototype (Rosch, 1988a-b), mastery learning (Bloom, 1984), and worked examples (Ward & Sweller, 1990).

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The ApangeaMath intelligent tutoring system consists of dozens of independent modules of instruction using multiple representations and a unique tutoring methodology that integrates live teachers and artificial intelligence online. The approach incorporates best practices and techniques found in direct instruction as well as cooperative learning. It corresponds to a scaffolding approach to content acquisition with foundations in arithmetic, pre-algebra and geometry, while moving toward the critical curriculum elements of algebra. The program is underscored by a motivational system built upon the recognition and reinforcement of individual effort.

**Results:** By focusing on the underlying problem solving strategies and adaptively scaffolding the content to meet each learner's needs, ApangeaMath has a track record of significantly accelerating both below grade level learners and on-grade level learners. While no single technology can meet the needs of every potential user, **ApangeaMath is built to meet each learner at their own level.** By working essentially one on one with every user, we engage each student to believe they can 'do math'. We believe that the profile that this builds of the individual user can help teachers better understand and act upon the needs of each student. We also believe that this kind of formative data can shape the thinking of a professional learning community within schools and across the system. Please refer to

[Research and Results](#) (*Multi-Year Large- Scale Field Studies of the Fundamental Skills Training Project's Intelligent Tutoring Systems and The Use of a Cognitive Tutoring System in the Improvement of the Abstract Reasoning Component of Word Problem Solving*) for more information.

<http://tinyurl.com/apangea-research>

### **Motivation Breeds Effort and Success**

Nothing motivates like success. Many US students have experienced little success in math and hear messages reinforcing the idea that math is not for everyone. But, we know that research proves that with effort and support all students can learn math. ApangeaMath has a motivation system and instructional design to move students from disbelief in their abilities to belief. Students' mathititude improves vastly, resulting in increased time doing math. Students work on ApangeaMath during evenings and weekends as well as during school hours.

The instructional system in ApangeaMath provides access to math content for all students, but we realize that in order for students to benefit from that system, they must engage for long enough to begin to experience success. The motivation system provides incentives and encouragement for the students to persevere long enough to believe that their effort counts and to see and feel the success that was eluding them.

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Students earn points for working through the lessons and additional points for correct answers. Along the way real life problem situations and an engaging interface further motivates them to keep working. Feedback from Learning Coaches and Live Online Teachers introduces the message that working hard produces results. Students work to earn points that they can redeem for gift cards or change into donations to charity. And, because investing time in quality math work results in improved math performance, students begin to see success. And that's when success breeding success begins to positively change students' perceptions of themselves as math students.

### Focus on the Right Math Means Effective Use of Time

In 2008, the National Mathematics Advisory Panel released its final report on best practices for the teaching and learning of mathematics. According to The Washington Post, the panel found math education in the United States to be "broken". The panel also stressed the importance of math. According to Larry R. Faulkner, chairman of the panel and former president of the University of Texas at Austin, "Math education isn't just a school subject. It's fundamentally about the chances that real people all across this country will have in life. And it's about the well-being and safety of the nation."

### PANEL RECOMMENDATIONS

Panel Recommendation	ApangeaMath
Schools should focus on key skills that prepare students for Algebra.	ApangeaMath is a skills-based tutoring solution that focuses on the gaps in skills of a particular student. ApangeaMath builds the skills that prepare students for Algebra.
Schools should focus on the Critical Foundations of Algebra, which include skills like the handling of whole numbers and fractions and certain aspects of geometry and measurement.	ApangeaMath provides in-depth instruction and tutoring on all aspects of the Critical Foundations of Algebra.
The curriculum must simultaneously develop conceptual understanding, computational fluency, and problem-solving skills.	ApangeaMath is the only online tutoring solution that integrates conceptual understanding, computational fluency, and problem-solving skills.
Fewer math topics should be covered in a single year. Rather, the curriculum should allow the teachers and students to spend more time on a single topic to ensure that each is learned in enough depth that it need not be revisited in later grades.	ApangeaMath's unique advanced learning pathway tools allow teachers to focus individualized learning pathways and at the same time, expand the amount of time spent on each topic, enabling students to fully learn key topics and develop critical skills.
Teachers' mathematical knowledge is important for students' achievement. The preparation of	All ApangeaMath tutors are certified math teachers.

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elementary and middle school teachers in mathematics should be strengthened.	
Explicit instruction for students who struggle with math is effective in increasing student learning.	For those students who are struggling with a skill, our tutors provide customized, one-on-one lessons in the Concept Zone.

## Instruction on a 5-Step Process Provides Problem-Solving Power

The five steps include Understand, Organize, Build, Solve, and Reflect. This moves the student from understanding the pieces of the problem and the relationships between the pieces through solving the problem using diagrams and equations. In the solve step, students are instructed that the answer to an equation is not the answer to the problem and the importance of understanding how the numeric answer applies to the problem situation. Once the initial problem is solved, the reflect step extends the mathematical thinking to a related problem that depends on connections and relationships inherent in the initial problem.

### Understand

The first problem solving step is **Understand**. In this step, students identify the question they are trying to answer.

The screenshot shows the Apangea Math interface. At the top, there is a navigation bar with buttons for QUIZ, LESSON, WORD PROBLEM, PRACTICE ZONE, and QUIZ. Below this, the current topic is 'Decimals' with a sub-topic 'Adding and Subtracting Decimals'. The interface is divided into five steps: UNDERSTAND, ORGANIZE, BUILD, SOLVE, and REFLECT. The 'UNDERSTAND' step is currently active. The problem text reads: 'You are paid \$30 for babysitting. You spend \$9.90 of your earnings on songs. How much money do you have left?'. Below the problem, there is a prompt: 'Click on the sentence in the problem that describes what you need to find out.' At the bottom of the interface, there is a 'COACH HELP' button and a large empty text area for the student's response.

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CLICK FOR THE REST OF THE 5-STEP PROCESS

<http://tinyurl.com/apangea-5-step-process>

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