

# **Effective Mathematics Instruction and The Ascend Math Solution**

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### Introduction

The United States continues to lag behind the economically-competitive countries that participated in the Trends in International Mathematics and Science Study (TIMMS) of 2003. Although higher than the international average of 495, the U.S. score of 518 was significantly lower than several of its economic and political counterparts such as Hong Kong (575), Japan (565), Chinese Taipei (564), The Russian Federation (532) and England (531).

Furthermore, the American scores for fourth graders remained unchanged from 1995 when the test had been previously administered. Additionally, during the same time period five out of seven countries leading the U.S. improved; three of them significantly. Eighth graders included in the testing showed some improvement from 1995-1999, but then stagnated and showed no further improvement between 1999 and 2003.

In 2006, the average U.S. score in mathematics literacy on the Program for International Student Assessment among 15 year olds was 474, lower than the Organization for Economic Cooperation and Development (OECD) average score of 498. Moreover, students scoring in the 90<sup>th</sup> percentile scored lower (593) than other comparatively high achieving OECD students (615). The TIMMS and PISA reports show alarming downward trends in American mathematics aptitude and skills.

To remain economically competitive, the United States needs to regain lost ground in mathematics education. To achieve this end, mathematics instruction needs to evolve; to engage students in a way that compels them to learn and enjoy the material they are learning. “Students who are engaged with school are more likely to learn, to find the experience rewarding, to graduate and to pursue higher education” (Marks, 154).

**The Ascend Math Solution** uses state-of-the-art educational technology to build critical math skills. The program develops consistent, individualized course plans for students based on state and NCTM standards. These course plans target student skill gaps and aim to teach exactly what a student needs based on identified strengths and weaknesses. Instructional options are rich and varied, including video tutorials presented by award-winning mathematics instructors, multimedia explorations including technology-based manipulatives, and ample practice. Frequent assessments enable learning paths to be continually updated to reflect students’ current level of mastery. Ascend also includes reporting tools to save time for teachers and facilitate effective communication between teachers, parents and administrators.

This paper explores scientifically-based research that has yielded important insight into effective mathematics instruction in a variety of areas. Research presented was conducted at major universities throughout the United States and appears in peer-reviewed journals. The paper also demonstrates how **The Ascend Math Solution**’s instructional, assessment, and reporting resources align with scientifically-based research to provide a comprehensive solution for improving mathematics proficiency.

### **Mathematics Instructional Considerations**

#### *Foundational Nature of Math*

Mathematics education depends heavily on foundational learning. Nevertheless, math education traditionally follows the “spiral method” where numerous, varied topics are presented in units and students may not explore the same topic for several months or possibly until the next grade level. As a result, students never truly master a concept and therefore lack a foundation for connecting concepts and transferring basic knowledge to more complex math. Without basic, complete mastery, students encounter a compounding effect—falling further and further behind as mathematics tasks progress in complexity (Schmidt, McKnight, & Raizen, 1997; Crawford, Snider 2000).

Karen Smith of the University of Texas and Carol Gellar of Radford University in Virginia compiled effective research-based instructional techniques in their article “Essential Principles of Effective Mathematics Instruction: Methods to Reach All Students.” Their work recognizes the critical importance of having a basic knowledge of key mathematics concepts prior to teaching more advanced concepts. This includes both assessing students’ mastery of foundational concepts and providing remediation in concepts students may not have mastered (Smith, Gellar, 2004).

The Ascend Math Solution provides a critical resource for students not mastering the traditional mathematics curriculum. First, the product assesses student mastery of specific math concepts, providing focused, individualized instruction only in areas of deficiency. Ongoing assessments continually update student learning paths. In addition, Ascend’s reporting mechanism enables teachers to know very quickly exactly where their students’ competencies lie, and where they may need additional instruction. In this way, Ascend shores up the traditional, spiraled mathematics curriculum, providing a solid foundation of mathematical proficiency for students.

#### *Student Self-Confidence in Mathematical Ability*

Philip Griswold of Eastern Montana College conducted a 2 year longitudinal study that focused on student attitudes and their participation in computer aided instruction (CAI). His study raises two points of particular worth. First, students who participated in CAI showed significantly higher academic self-confidence as a result of their participation in the CAI. They perceived themselves as better equipped for their academic tasks.

Second, students considered educationally disadvantaged showed “greater levels of attributing their success internally and of viewing themselves as good readers who do well in school” (Griswold, 1984). These students gained confidence in their own ability to succeed and learn rather than attributing their successes only to external factors such as teachers or tutors. This internalization—seeing oneself as an inherently capable student—is both a powerful motivator and a powerful influencer on academic achievement.

One of **The Ascend Math Solution**'s distinguishing characteristics is its ability to provide students with immediate academic success. Through careful diagnostic assessment, students are provided instruction *at their beginning skill level*, resulting in immediate success. In addition, students are able to continually monitor their own progress throughout the instructional process, enabling them to continue to be motivated by their success.

### ***Student Engagement in Learning***

“Engagement is an important facet of students’ school experience because of its logical relationships to achievement and to optimal human development” (Marks, 2000). Numerous studies consistently demonstrate correlation between engagement and achievement. The more engaged the student, the more readily the student learns and the better he or she performs.

A study conducted by Katerina Bodovski and George Farkas at Pennsylvania State University underscores the critical importance of student engagement in increasing achievement. The results of their study are consistent with previous studies. “Student engagement has a positive effect on mathematics achievement gains at all grade levels tested. Further, engagement has the largest effect on achievement growth for students whose beginning achievement falls in the lowest category” (Bodovski, Farkas 2007).

Additionally, the researchers found “instructional efforts with [students who have the least amount of mathematics knowledge] should focus on innovative attempts to improve their engagement with learning.” Marks encountered similar results in her earlier research and wrote, “Among slow-starting students, those whose engagement was high were capable of showing dramatic achievement growth in subsequent grades” (Marks, 2000).

**The Ascend Math Solution** predicates its approach on the fact that students need to be engaged to learn and achieve. In addition to high-quality video instruction, Ascend includes technology-based manipulatives and interesting and relevant explorations of mathematics concepts to capture and maintain students’ attention. Student learning pathways are highly individualized and continually updated, providing a “customized learning experience” that speaks to individual students’ levels of mastery.

In addition, The Ascend Math Solution was designed to speak to the needs of today’s students—“digital natives” whose everyday experience have led them to expect immediate access to relevant feedback.

### **Effective Intervention/Remediation Approaches**

#### ***The Importance of Diagnostic Assessment***

Teachers recognize the need to understand a student’s knowledge base. Placement tests are regularly used in the classroom to allocate instructional resources and group students based on levels of proficiency. Additionally, “the No Child Left Behind legislation

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carries the implicit assumption that the availability of data will inform and initiate improvements in educational practice” (Wayman, Stringfield, 2006).

Educators are increasingly responsible for providing individualized learning opportunities that ensure students gain valuable math skills necessary for future success. Cognitive diagnosis through assessment provides data that can be used to direct additional instruction to the areas needed most by the individual student (McGlohen, Chang, 2008). Through customized assessments, teachers can teach exactly what a student needs to strengthen mathematics foundation skills and experience consistent gains in mathematics achievement.

The Ascend Math Solution uses a robust diagnostic assessment based on state and NCTM standards to prescribe individual learning paths. Students skip material they have already mastered and focus only on the core areas needed. Continual, ongoing assessments automatically update students’ instructional path, enabling students to connect their foundational knowledge to new concepts.

### *Data-Driven Decision-Making and the Teacher/Student*

Gathering and analyzing student achievement data is necessary (based on No Child Left Behind legislation) and significantly and positively impacts teacher decisions and ultimately students’ learning experience. Research conducted by Jeffrey Wayman and Sam Stringfield of the University of Texas at Austin indicates that teachers are often frustrated by data they deem to be “too old” to be relevant. The study cited teachers terming data more than a few weeks old as “dead data,” and another said, “I need to know what my students are doing now” (Wayman, Stringfield, 2008). They also found that teachers were able to give numerous examples as to how student data allowed them to differentiate instruction to better support and meet students’ needs.

Among the eight criteria for effective mathematics instruction, Smith and Gellar wrote that the instructional plan must include “an error analysis of the student’s work as well as verbal description of the student’s strategy in order to determine the next step in instruction” (Smith, Gellar, 2004). The readily available, real-time data produced by **The Ascend Math Solution** meets both the needs of students and teachers in creating and sustaining a viable, flexible learning environment.

### *The Impact of Accelerated Instruction*

The concept of “accelerated instruction” is traditionally associated with gifted students who respond well when allowed to progress more quickly through school curricula. In 1984, a study by Kulik and Kulik of the University of Michigan examined 21 different reports encompassing 26 different studies that tested the affects of acceleration in academics. Acceleration is defined in their meta-analysis as compressed curriculum, grade skipping, and similar practices that speed up the learning process for capable students (those who score well on standardized tests.) Thirteen of the studies Kulik and Kulik reviewed focused on same-age control groups. Their analysis stated, “The overall

message from the 13 studies therefore seemed unequivocal: acceleration contributes to student achievement” (Kulik, Kulik, 1984).

However, in recent years, a great deal of emphasis has been placed on the use of accelerated instruction for low-performing students. In *Using Online Learning for At-Risk Students and Credit Recovery*, the North American Council for Online Learning states “Some of the early online programs that initially focused on high-achieving students, such as the Kentucky Virtual High School, have expanded offerings, and are finding success with a much broader range of students. As online learning moves past the early adopter phase, the growth of online programs focused on at-risk students or credit recovery has redefined how educational technology can be used to address the needs of all students” (Watson & Gemin 2008). And in the recent Urban Institute report *The Dropout Crisis: Promising Approaches in Prevention and Recovery*, Steinberg and Almeida cite as a key dropout prevention/recovery strategy “Opportunities for youth to catch up and accelerate knowledge and skills” (Steinberg & Almeida 2004).

Teaching children at their level of understanding and proceeding at the pace they set, rather than a pace dictated to them by a generic curriculum, significantly factors into achievement and better performance. **The Ascend Math Solution** supports accelerated instruction—for all students—by prescribing a focused instructional pathway for each student. Students skip material they have mastered and focus only on material they need to learn. Thus, instruction is accelerated beyond the confines of the traditional curriculum—which requires every student to learn math topics in the same order and at the same pace.

### **Technology-Based Instruction and the Student**

Overwhelming evidence gathered over 30 years supports claims that Computer-Aided Instruction (CAI) increases educational achievement across all grade levels and subject areas (Fletcher, et al, 1990). A multimedia approach such as Ascend’s creates a multisensory learning experience that research demonstrates will help all students, including those considered “at-risk,” improve mathematics performance.

For example, in 1998 a study using data from the National Assessment of Educational Progress (NAEP) examined differences in mathematics achievement of fourth- and eighth-graders based on how and how frequently students used technology in their mathematics classroom. The study found that, particularly in eighth grade, the relationship between uses of instructional technology (particularly for higher-order activities as opposed to simple drill-and-practice) was substantially positive (Wenglingsky 1998).

Another study conducted by Fletcher, Hawley and Piele at the University of Oregon determined that students who received CAI “scored significantly higher” than the students learning the same material through traditional instruction (Fletcher, et al, 1990). This achievement held true for grades 3 and 5 across all tests and subtests. Furthermore,

the results of this and similar studies have held true over decades, and technology has continually improved during this time.

Clearly, research offers resounding support for the use of multimedia technology in the classroom. Research conducted by Ascend shows similar positive effects. A pilot study in which Ascend was used for intervention in a Florida middle school showed that 34% of all students advanced two or more grade levels and 43% of 7<sup>th</sup> and 8<sup>th</sup> grade students advanced two or more grade levels during a 5 month intervention period. Pre-test assessments indicated many students were behind several grade levels when they began.

*In Teachers, Computer Tutors, and Teaching: The Artificially Intelligent Tutor as an Agent for Classroom Change*, researchers at the University of Pittsburgh examined what appeared to be a paradox between student claims and student behaviors. Students claimed to prefer a teacher's assistance in learning, but demonstrated a preference for CAI, using a tutoring program. The results of this study indicates students were more motivated to learn, more engaged in instruction, and enjoyed CAI over traditional instruction.

However, as much as the students enjoyed and wanted to use the instructional technology, they still expressed a desire to have a teacher available to offer insight and help when a computer generated response was insufficient (Schofield, et al, 1994).

**The Ascend Math Solution** provides the best of both worlds in terms of student engagement and motivation. First, because students receive immediate—and private—feedback on their work, they are inherently motivated to continue moving through the instructional pathway. Second, detailed explorations, examples, and practice activities are augmented with outstanding video-based instruction delivered by an award-winning mathematics teacher.

### **Technology-Based Instruction and the Teacher**

In addition to significant impact on student learning and motivation, Schofield found that CAI enabled students and teachers to collaborate better. Teachers were able to offer specific, individualized attention, while students had more control over the input they needed from the teacher (Schofield, et al, 1994). **The Ascend Math Solution** provides significant, frequent feedback to students—allowing them to seek additional instructional assistance only when needed. In turn, teachers are freed up to work with individual on specific areas of deficit.

Ascend's individualized instruction enables teachers to meet each student's specific needs rather than taking a "blanket approach" to mathematics instruction. Empowering students to pursue individualized study plans on their own ensures that interaction between teacher and student becomes focused and meaningful. One teacher who has used the program notes, "What I like about Ascend is that it keeps the entire class occupied. All of my students are not raising their hands at the exact same time. Ascend gives me a chance to have one-to-one interaction with the students when they need it at the exact time they need it."

Teachers and administrators also benefit from using Ascend because its automated reporting saves instructors time by eliminating the need to grade or scan papers or compile time-consuming reports. Ascend automatically guides students through individual study plans, provides frequent and ongoing assessment, and automatically reports progress. These tools allow teachers and administrators to access real-time data to measure achievements of an individual, class or the school and communicate this information more effectively with each other and students' parents.

### **Conclusion**

It is clear that American students continue to struggle in mathematics. A “scattershot” curriculum approach, limited instructional resources, and a general sentiment that “math is hard” all contribute to students' low achievement levels. **The Ascend Math Solution** exemplifies instructional and administrative strategies proven by scientifically-based research to improve mathematics outcomes for students. Ascend's focused, individualized instruction—closely and constantly developed and adapted using diagnostic and ongoing assessments—ensures students quickly gain proficiency in basic mathematical concepts. Ascend is highly engaging and motivational, providing high-quality video instruction and engaging mathematical explorations that empower students to direct, assess, and internalize their mathematics proficiency. Teachers and administrators, in turn, have immediate access to achievement data, enabling them to make sound instructional decisions quickly and easily.



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### **About Strategic Education Solutions**

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Strategic Education Solutions provides comprehensive research, development, evaluation, and marketing services to public and private education entities, with expertise in:

- At-Risk Students;
- Dropout Prevention and Recovery;
- Scientifically-Based Research Practices;
- No Child Left Behind Policy and Compliance;
- Technology-Based Education;
- Curriculum and Instruction.

Led by Cynthia Burrow, an education professional with over 15 years of experience, Strategic Education Solutions has completed large-scale research and evaluation projects for state and regional education agencies, and has provided market research and curriculum development support for educational publishers in a variety of content areas.