How to Accelerate Math Achievement with Adaptive Learning Technology

WITH ADAPTIVE LEARNING TECHNOLOGY

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LEARNING

Introduction

All children can become proficient mathematical thinkers when they learn in an environment that is engaging, individualized, and responsive to their developing mathematical ideas and strategies. Yet effectively teaching math to a broad range of learners has become a problem of scale that may be solved with the addition of adaptive learning technologies to the classroom. **Adaptive learning technologies extend the capacity of the teacher to individualize instruction and enhance learning.** Effective technologies have a high degree of adaptation, are based on a rigorous curriculum, and empower students to be self-directed learners. They provide students with appropriate, immediate feedback and teachers with real-time, actionable data to improve classroom management and productivity.

The result is an effective, engaging, and highly individualized learning environment for every student that helps teachers differentiate instruction so that all learners excel in math.

One Classroom, One Teacher, Many Learners

Millions of children enter school each year with the potential to learn math and to understand mathematical concepts. Yet far too many students fail to achieve a basic level of proficiency and even fewer develop a positive attitude toward learning and using math. Current research shows that early preparation in mathematics is the biggest predictor of later school achievement, even more so than early literacy, attention ability, and social-emotional issues.[1]

School administrators and teachers recognize that differentiating or individualizing instruction engages students and helps them reach or even exceed performance expectations. However, designing a daily curriculum for every student based on their individual learning style and readiness requires a high degree of specialization and deep insight into each student's progress and comprehension. Teachers and schools don't have the time or resources to truly differentiate instruction for all students.

WHY IS IT SO HARD FOR ALL STUDENTS TO EXCEL AND ENJOY MATH?

- As class sizes increase, teachers have less time to observe students as they work individually.

- A single group of 15 to 30 students may have a range of abilities and preparedness — from English language learners and students working below grade level to accelerated learners ready to zoom ahead.

- There is no single model of instruction that works for all students, and the number of instructional strategies any single instructor can know and use is limited.

- The promise of data-driven decision making to individualize instruction is hampered by the lag between assessment, reporting, analysis, and action.

Shrinking budgets combined with higher expectations and more rigorous standards put increasing pressure on schools and teachers to do more with less. Adaptive learning technologies build on great teaching in the classroom by providing students with an individualized learning environment that is engaging and responsive to their developing mathematical ideas and strategies.

All children can become proficient mathematical thinkers when they learn in an environment that is **engaging, individualized, and responsive** to their developing mathematical ideas and strategies.

1. Duncan, G., et al. (2007). "School Readiness and Later Achievement." *Developmental Psychology,* 43, 1428– 1446, ccf.tc.columbia.edu/pdf/school_readiness_study.pdf.

Effective Adaptive Learning Technologies

The National Institute of Standards and Technology (NIST) Advanced Technology Program defines adaptive learning systems as "systems that readily adapt the learning experience to the skills and needs of the learner." A vast range of technology tools with varying degrees of effectiveness may fall under this general umbrella. To determine which technologies will enhance instruction and deeply engage all students in mathematical concepts, decision makers for curriculum and instruction should consider the following:

- **Degree of adaptation.** Does the technology offer a few paths with student-directed pacing or does it offer millions of learning paths with fine-grained adaptation?

- **Rigor of the curriculum.** Does the technology only focus on practice or does it offer a rich environment for developing conceptual understanding, computational fluency, and problem solving?

- **Level of engagement.** Does the technology appeal to a narrow range of students or does it empower all students with choices and personalized challenges that help them take ownership of their learning experience?

- **Quality of reports.** Does the technology only report time on task and completion or does it give teachers real-time analysis of comprehension and class-wide data to help with grouping and differentiation?

DEGREE OF ADAPTATION

Many learning technologies differentiate instruction by adjusting pace or using a decision tree to direct students down a few, pre-determined learning paths. This simple degree of adaptation may keep students occupied while the teacher works in small groups or one-on-one, but it doesn't effectively challenge all students or enhance the effectiveness of the teacher. Most teachers can manage instruction on several learning paths and simple adaptation does little to extend the range of instruction and improve productivity in the classroom.

Instead of narrowing options to a few paths, an adaptive learning technology with a high degree of adaptation responds to every mouse click and draws from a vast pool of proven instructional strategies and scaffolding techniques. The result is millions of possible pathways through a rich and rigorous curriculum. The more adaptive the system, the more time students spend on appropriate tasks, engaged in faster, deeper learning.

Highly adaptive systems don't just record an answer as right or wrong, they watch how a student solves a problem to respond immediately and appropriately. Like a good teacher, the system asks and answers these questions after every mouse click:
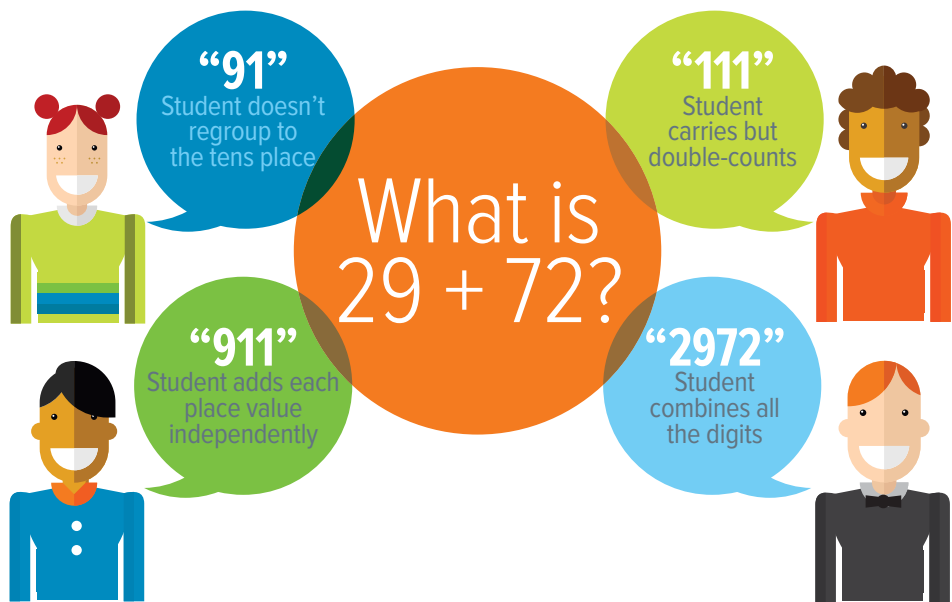
- **What supports (scaffolding and hints) are needed to keep this learner from getting stuck?**

- **Does the learner understand this concept well enough to move on?**

- **Is this learner struggling due to gaps in understanding that need to be filled before continuing?**

- **Is the learner falling behind, zooming ahead, or staying in the zone of proximal development?**

- **What instructional tools and types of instruction work best for this learner?**

- **Where should this learner go next?**

Adaptive learning technologies with a high degree of adaptation use sophisticated analysis and understanding of a broad range of learners to determine what works best for different types of students. Through aggregation of data from a vast pool of users, logging hundreds of thousands of hours, they are able to observe the full scope of students with all their varied backgrounds, learning preferences, and abilities. Sophisticated data analysis for segmentation and prediction identifies groupings that actually exist among students and makes informed assignments to student cohorts. Analysis on a concept-by-concept basis allows for dynamic adjustment as more data is gathered.

Truly adaptive learning technologies have deep insight into how lessons are used and can respond immediately to curriculum issues that derail groups of students. By applying analysis to the overall structure and connections between lessons, in addition to the lessons themselves, an adaptive learning technology can identify gaps or missed connections within

> To build a solid foundation for higher mathematics, **students need to be appropriately challenged and encouraged** to develop conceptual understanding, computational fluency, and problem-solving abilities.

Teachers wouldn't respond to each of these students in the same way.

What is 29 + 72?

"91" Student doesn't regroup to the tens place

"111" Student carries but double-counts

"911" Student adds each place value independently

"2972" Student combines all the digits

DreamBox Learning Math doesn't either.

days of going online. New lessons can be developed, implemented, tested, and launched in a matter of days. Teachers, using adaptive learning technologies to complement the core curriculum, have confidence that every student is engaged in appropriate, meaningful work whether or not they are working with them directly.

RIGOR OF THE CURRICULUM

To build a solid foundation for higher mathematics, students need to be appropriately challenged and encouraged to develop conceptual understanding, computational fluency, and problem-solving abilities. Adaptive learning environments are only as rich as the curriculum at their core and the assessments used to determine understanding of that curriculum.

Students may work with "drill and kill" games or programs to practice what they know, but what have they learned? A direct-response question has discrete choices and only one right answer. A wrong answer provides little insight into a student's strategy for choosing it; a right answer might be achieved by guessing. The constructed-response questions in adaptive learning systems present learners with problems and many ways to solve them.

An effective adaptive learning system with a rigorous curriculum starts with the best pedagogy of national board-certified teachers who create lessons and assessments to help place students for success. Continuously applied analysis determines sequencing (transitions between lessons) and recommends different manipulatives based on what works well for the learner or where they need practice. Outlier analysis automatically adjusts many aspects of the learning experience to keep students from becoming either frustrated or bored.

Adaptive learning technologies that gather data and conduct analysis about how students solve problems have more information to keep students engaged in a more rigorous

curriculum. In addition to right or wrong answers, online technology has the potential to capture all mouse movements and timings to gain insight into the strategies used to solve a problem. The system watches the student work and provides a thoughtful response so that each student receives the right next lesson, at the right level of difficulty, with scaffolding tailored to their level of comprehension. As students learn and modify their strategy, elements of lessons change to help students develop mastery.

By analyzing behavior and the strategies used, adaptive learning technologies have the potential to provide deep insight into a child's conceptual understanding and respond immediately. Students who are struggling because they have a gap in comprehension don't need more of the same for an increased feeling of failure. They need to go back to learn what they have missed and persist. When students gain a firm grip on a concept, they can be challenged immediately in new ways. This continuous process of fine-grained assessment, sophisticated analysis, and dynamic response keeps students challenged, engaged, and moving forward successfully.

LEVEL OF ENGAGEMENT

Kids love technology and they love games. Even the simplest learning technologies give students a choice of an avatar and options for a framing story to put learning in a context that interests them. But too many learning technologies are like candy — sweet and tasty at first with little nutritional value. If the work is too hard, students become frustrated. If it is too easy, they become bored. They are not deeply engaged in learning, they are just keeping busy.

A deeper level of interaction increases student persistence, time on task, and achievement. By drawing students in to activities at a level where they can succeed and giving them options based on their personal level of comprehension, adaptive learning technologies improve learning outcomes by keeping students engaged. That engagement builds conceptual understanding, improves retention of what's learned, and the ability to apply what's learned to different situations.

In a rich learning environment with many different options, students choose the lessons and games they enjoy playing, helping them become self-directed, life-long learners. Virtual manipulatives within a fun context present learners with interesting situations and many ways to solve a problem. Students who may be reluctant to use manipulatives in class often become comfortable with them in virtual play and their attitudes toward math improve. By using dozens of archetypal manipulatives, a highly adaptive learning technology is able to support hundreds of distinct lessons covering multiple years of standards-based curriculum for millions of students.

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Analysis and Reporting That Empowers All Learners

Teachers and administrators gain a deep insight into what math concepts students have mastered and what they need to learn.

Adaptive learning technology does not take the place of classroom instruction, but enhances and extends it seamlessly by increasing productivity of both students and teachers. When students spend time using adaptive learning technologies, they are not only receiving instruction, their skills are constantly assessed. That integration of assessment and instruction allows for real-time adaptation and analysis of students' conceptual understanding as well as their progress. Teachers and administrators gain a deep insight into what math concepts students have mastered and what they need to learn.

Class level detail and reports can be used for flexible groupings, remedial lessons, or enrichment in day-to-day instruction. Teachers have more time and information to differentiate instruction with small groups of students or one-on-one while the rest of the class is engaged in meaningful, independent work. At the end of the day, teachers and administrators see each student's detailed progress as well as class-level data to ensure curriculum alignment and raise student achievement. At the end of the year, administrators have reliable, accurate information about how much time students spent engaged with the technology and what they achieved.
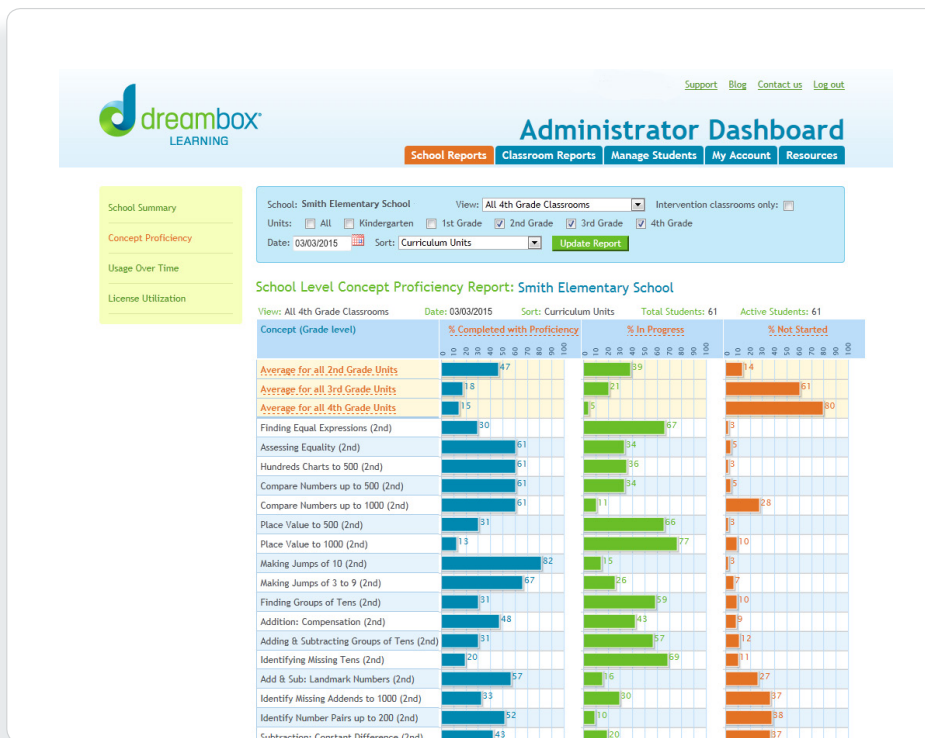
CONCLUSION

Adaptive learning technologies can significantly improve student outcomes by motivating students to engage with a rigorous curriculum that complements and extends traditional classroom instruction.

- **Teachers have deep insight** into each individual student's comprehension and progress and have the time and resources to truly differentiate instruction.

- Even a broad range of learners in a single classroom receive **appropriate, timely, individualized math instruction**.

- As a classroom resource, an adaptive learning system has the capacity to **deliver millions of different learning paths** based on analysis of many thousands of different learners.

- **Rapid response and detailed reporting with sophisticated analysis** help teachers and administrators make daily instructional decisions to keep each student in the zone of proximal development.

The result is an effective, engaging, and highly individualized learning environment for every student that helps teachers improve classroom productivity and differentiate instruction for a broad range of learners.

...effective, engaging, and highly individualized learning environment for every student...

Considerations When Evaluating Adaptive Technology

Your Digital Curriculum:

- ☐ Seamlessly integrates standards-aligned lessons with continuous, embedded formative assessments.

- ☐ Deepens each student's mathematical understanding, knowledge, and skills.

- ☐ Engages students with a highly motivating learning environment and frequent opportunities for independent critical thinking.

- ☐ Delivers a personalized learning experience for each student, whether attempting a problem for the first time or the fifth.

- ☐ Responds in real-time with useful feedback and meaningful scaffolds as a student develops conceptual understanding and procedural fluency.

- ☐ Empowers all students to take ownership of their learning by presenting appropriate lesson choices and personalized challenges.

- ☐ Enables millions of unique learning paths, responding to students both within and between lessons.

- ☐ Offers age-appropriate learning environments and engaging experiences that are agnostic of grade level content.

- ☐ Supports data-informed classrooms by providing teachers with deep insight into each student's unique progress and proficiency.

- ☐ Provides access and equity for English Language Learners (ELLs).

**To learn more about Intelligent Adaptive Learning™,
visit: dreambox.com/why-dreambox**

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DreamBox Learning, Inc. was founded in 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® platform offers a groundbreaking combination of Intelligent Adaptive Learning™ technology, a rigorous K–8 mathematics curriculum, and a highly motivating learning environment. DreamBox in English and Spanish 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 the student's unique needs. DreamBox supports teachers and their practice in every type of learning environment. For more information about DreamBox Learning Math and the DreamBox Math for iPad app, please visit **DreamBox.com**.

For a demo, call 877.451.7845