STEM Success: How Technology Can Drive STEM Education for Better Student Outcomes

Students graduating and preparing to succeed in college and the workplace require a solid foundation in science, technology, engineering, and mathematics (STEM). A strong background in this skill set is not just for aspiring scientists and engineers — it is essential for all students.

WHAT'S INSIDE

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STEM STATS

- In 2010, there were 7.6 million STEM workers in the United States[1]
- STEM occupations are projected to grow by 17 percent from 2008 to 2018[2]
- STEM workers earn 26 percent more than their non-STEM counterparts[3]
- More than two-thirds of STEM workers have at least a college degree[4]

This paper examines how the right devices can help students and teachers connect in powerful, positive ways.

OPPORTUNITIES IN STEM

There is ample evidence to suggest that the fastest growing and highest-wage jobs of the future will be in STEM fields. According to the U.S. Department of Labor, STEM jobs are growing at 1.7 times the rate of non-STEM jobs.[5]

While STEM jobs are growing rapidly, schools in the US are not producing enough candidates to fill them. According to the US Department of Education, only 13 percent of college degrees are awarded in STEM areas each year, compared with 41 percent in China.[6] Experts have noted student interest in science and mathematics is waning at a time when the job market in these fields is increasingly robust.

As a result, a national pro-STEM movement has emerged, aimed at driving an overall boost in STEM participation among all students. The movement is also increasing interest in STEM careers among underrepresented groups, including female, African-American, and Hispanic students.

ABOUT THIS PAPER

This paper looks at how a strong foundation in STEM at the secondary level starts with a greater emphasis on combining real-world problem-solving with project-based learning across disciplines. In successful STEM programs, teachers work together with students to develop critical thinking, communication, assessment, and inquiry skills.

It also examines how the right devices can help students and teachers connect in powerful, positive ways. Those connections boost interactive learning, engagement, the success of technology-driven STEM initiatives and, ultimately, student achievement.

- Technology greatly impacts how STEM subjects are taught and internalized across digital districts.
- Successful STEM programs incorporate collaborative, active learning activities.
- The right devices can foster dynamic, personalized learning environments around STEM subjects and drive stronger learning outcomes.

The right classroom technology is critical to making hands-on learning accessible to students.

REINVENTING STEM LEARNING: INSPIRING STUDENTS THROUGH REAL-WORLD INQUIRY

Experts widely agree that STEM is more than just a grouping of subject areas. STEM success requires the development of the mathematical and scientific underpinnings that students need to be competitive in the 21st-century workforce. STEM goes beyond preparing students for jobs, ultimately helping them develop a set of creative thinking, reasoning, and teamwork skills usable in all areas of their lives.

Technology has the potential to redefine how STEM is taught and internalized across all coursework. Experts have long noted that grade level is correlated with attitude toward science — younger students have more positive perceptions of science than older students. Some experts point to the nature of instruction in traditional mathematics and science programs as the culprit here.

Algorithmic teaching of mathematics, canned science experiments, and emphasis on remembering facts and processes mask the true nature of math and science. They also don't provide the student with the same level of wonder and curiosity that drives most mathematicians, scientists, and engineers.

STEM experts recommend that students be given access to "hands-on, open-ended, real-world problem-solving experiences."[7] This practice closely resembles the work professionals do in science, math, engineering, and technology. The right classroom technology is critical to making hands-on learning accessible to all students.

In the past, in order to involve students in authentic learning experiences in STEM, teachers were required to gather information and create classroom collections of articles and papers. The analysis of data — a key job function for scientists, engineers, and mathematicians — was difficult to accomplish within a typical class period.

Today, a world of data is instantly accessible. For example, students can access real-time data from buoys in the Caribbean Sea to study water flow patterns and their relationship to weather. Math activities including sports statistics, game speed tracking, and nutritional analyses are readily available, along with links to data sources that are current and comprehensive.

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Giving students choices about the materials helps deepen their understanding and increase their interest in the subject.

ACTIVE LEARNING CLASSROOMS: NEW LEARNING STRATEGIES POWERED BY TECHNOLOGY

Traditional lectures have historically been ineffective in ensuring student success across STEM disciplines. According to a 2014 meta-analysis, 55 percent more students fail purely lecture-based STEM courses versus those taught with an active learning component.[8]

Active learning is defined by students engaging in the learning process through discussion, reflection, collaboration, or activities other than just passive listening and note-taking. In recent years, technology has played a pivotal role in implementing active learning across digital districts, involving everything from in-classroom computers to learning software and social media. Efforts are being made to involve students in STEM activities that mirror the work done in the real world, and this endeavor is largely fueled by education-ready technology.

While engineering is relatively new to US schools, it has been rapidly adopted, particularly at the middle and high school levels. Much of the work done within this new domain involves students in designing and building structures, as well as testing devices that drive or fly. Each of these activities is usually supported by access to devices for design references and/or data collection requiring those devices be used in the field.

Even in mathematics, active learning classrooms often have students collecting data as they measure, weigh, or estimate the subjects of study. To get there, they need devices that support new teaching methodologies. This means integrating rich media, dynamic image rendering, and sophisticated software for such activities as 3D modeling, mapping and measurement tools, and data visualization.

PERSONALIZED LEARNING ENVIRONMENTS: INDIVIDUALIZED MODELS FOR STEM CONTENT DELIVERY

Despite the shift toward active learning models, students still need content. For instance, in mathematics, students still need to be explicitly taught how to construct equations that appropriately express geometric concepts. While this instruction is often didactic and similar to “traditional” models of teaching and learning, there has been innovation.

Both media-based learning and flipped classrooms are proven to drive stronger student engagement and ultimately drive higher achievement.

The media-based instruction model and the "flipped" classroom model are often used in mathematics and science. These two methodologies are also aligned with moves toward personalized learning in and out of the classroom.

Individualization has historically been popular in the math curriculum because it allows naturally inclined students to move at a quicker pace, while simultaneously allowing struggling students to slow down and focus. While it's an old practice, best practices have evolved over time.

Individual math series in the 1980s often consisted of a teacher-led introduction followed by an assignment that might exercise the skills taught. Based often on a quick assessment, students would be assigned to high-, medium-, or low-complexity exercises as appropriate. Personalized learning goes beyond this.

One of the hallmarks of personalized learning is choice, not assignment. In a personalized geometry class, for example, a teacher might teach a lesson or a series of lessons on geometric constructions. For the next phase of the unit, all students are expected to delve more deeply into the concept, but through a variety of means that would be self-selected and self-driven. Giving students choices about the materials helps deepen their understanding and increase their interest in the subject.

Some students might have a preference for traditional text-based materials. Others might prefer lighter media. For example, a lesson from the popular math series from Khan Academy, available for free on YouTube. Other students might form a study group that would deepen their learning through discussion and collaborative effort.

With personalized learning, students can also choose how they demonstrate learning. Some, usually those who excel with traditional teaching, may choose a final test, while others elect to build geometric models that illustrate various construction techniques. The diversity in difficulty, media, and content support a robust, personalized learning environment.

A CLOSER LOOK AT PERSONALIZATION: MEDIA-BASED LEARNING AND FLIPPED CLASSROOMS

There are two similar strategies to support personalized learning and both emphasize the need to implement the right technology devices for successful STEM education.

Lenovo's broad education portfolio lets educators leverage technology with confidence, creating new strategies that engage and educate students on the importance of STEM skills.

Both media-based learning and flipped classrooms are proven to drive stronger student engagement and ultimately drive higher achievement. While not limited to personalized learning, the two strategies are perfect for the purpose of tailoring coursework to a student's needs and strengths.

MEDIA-BASED LEARNING

In many classrooms, educators are finding and creating media for just-in-time delivery of instruction. Once created, videos can be reused and updated. Teachers find that the creation or identification of media-based instructional resources frees them up to work more intensively with individual students or small groups of students.

Luckily for educators, there are lots of tools available to help, many of them free. For quite some time, YouTube has allowed users to create channels for the organization of related resources. Now tools like Gooru exist to allow teachers (and students) to create and share collections of resources for topics they teach and that capture interest.

THE FLIPPED CLASSROOM

A second strategy related to personalization that has gained traction during the past decade is the "flipped" classroom. The flipped classroom is an attempt to provide additional time during the school day for project-based work and more individual support by the teacher.

In a flipped environment, the teacher records instructions and makes a video version available to students rather than lecturing in class. Homework consists of learning content to prepare for the next day's classroom activities rather than exercises to solidify the learning. Integrating this strategy with videos designed for different levels or choices of learning media can elevate this practice to a linchpin of personalized learning.

HIGHLY EFFECTIVE STEM DEVICES: CHOOSING THE RIGHT TECHNOLOGY

Many of these changes are driven by in-classroom technology optimized for personalized learning environments, as well as the devices students use at home and outside the classroom. For dynamic STEM instruction to succeed, devices used by teachers and students need to share a few compelling characteristics. Personalization is ultimately about choice, and is composed of a combination of compelling choices offered by a dynamic STEM curriculum and solutions.

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Lenovo's broad education portfolio lets educators leverage technology with confidence, creating new strategies that engage and educate students on the importance of STEM skills.

1. DURABILITY

In active learning environments, particularly those driven by 1:1 laptop or tablet initiatives, the danger of damage to devices from students is very real. The student-ready durability of Lenovo® devices, featuring MIL-SPEC toughness, can endure the inevitable drops, bangs, and spills of long hours of use.

2. FLEXIBILITY

In modern classrooms where the method of instruction is shifting constantly, Lenovo multimode devices can help student learn and collaborate in new ways. Laptop, Tablet, Tent, and Stand modes allow students to transition to the task at hand.

In a single classroom, some students may be watching instructional resource videos while others are collaborating on a website. Other students are taking a quiz to test learning and identify gaps. In each of these cases, the right device matters, and Lenovo has a product to fit the need.

3. PERSONALIZED

Optimum STEM learning is driven by diverse media choices that support both learning and demonstrating the results of that learning. Lenovo PCs deliver excellent audiovisual capabilities that bring a wide range of media to life—from integrated cameras and microphones to onboard Intel® graphics.

4. STEM-GRADE PERFORMANCE AND COMPATIBILITY

Classrooms focused on a strong STEM curriculum need the latest computer technologies for smarter teaching and learning to prepare students for a future increasingly defined by digital technology and shared workspaces. As a result, those students are required to use devices that can integrate seamlessly with technology not found in typical consumer devices.

- High-end graphic capabilities
- ISV workstation certifications
- Multiple monitor support

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ThinkStation P320 Tiny

ThinkPad P52s

STEM-READY: LENOVO DEVICES UP CLOSE

Lenovo's education-built solutions featuring Windows 10 are designed to boost technology across your entire school or district. While all our server, desktop, and workstation products have distinct education benefits, the Lenovo ThinkStation® P320 Tiny and Lenovo ThinkPad® P52s are especially well-suited for STEM engagement.

THINKSTATION P320 TINY	THINKPAD P52s
From STEM-focused classroom and lab applications to the latest in multimedia tools, the ThinkStation P320 Tiny with Windows 10 delivers serious security, easy manageability, and maximum PC performance.	Lenovo's first quad-core Ultrabook™ mobile workstation, running Windows 10, and ISV certified including Autodesk Revit.
Available with Intel® Core™ processors	Fast performance with up to Intel® Core™ i7 processors
NVIDIA Quadro graphics to deliver faster, crisper graphics	NVIDIA Quadro graphics cards with a stunning 4K UHD IPS display
Weighing in at only 2.9 lb, the P320 Tiny accommodates the tightest of space constraints	Ultraportable, starting at 4.3 lb/0.79" thin, making it easy for students to carry their device to classrooms, labs, and back home
Passes 12 military-stress tests and 200 rigorous quality checks	Rugged MIL-SPEC durability to stand up to student wear and tear

LENOVO AND YOU: DRIVING STEM LEARNING FOR CONTINUED SUCCESS

As a leading provider of educational technology, Lenovo recognizes the challenges of aligning technology and STEM learning. Our portfolio of STEM-ready devices features Windows 10 to give learners an approachable platform for learning, creating, and exploring. With Windows 10, students and teachers can access the expansive Windows Store for a variety of exciting and engaging STEM applications designed to give learners a flexible, hands-on experience. By inspiring student interest and contributing toward a solid foundation for learning, the right technology can sustain compelling STEM curricula that fosters long-term student success.

To learn more, visit solutions.lenovo.com/products/workstations or contact eduteam@lenovo.com for more details. Follow us on Twitter at @LenovoEducation.

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