

# Engaging the STEM Intermediate Student with Technology

Middle School



## Introduction

In Chad Pavlekovich's middle school classroom, students consider the consequences of plagues on populations while reading the novel *Fever, 1793* for language arts and discuss the impact of the cholera outbreak in Haiti when reviewing current events. At Salisbury Middle School in Salisbury, Md., science is integrated into every subject. Students are taught to see science everywhere.

Pavlekovich (you can call him Mr. P) is a lead teacher at the STEM (science, technology, engineering and math) Academy that Salisbury Middle School launched in 2009. The academy weaves STEM into the daily curriculum for its 6th, 7th, and 8th-grade students. Every STEM topic is typically covered in multiple subject areas — *Fever, 1793* encompasses both history and language arts lessons — for a complete wrap-around.

"We are the guinea pigs for all things technology-related in the classroom," Pavlekovich says. "We designed our program with the big 'T' in STEM."

Technology is indeed an important aspect of the approach at Salisbury. One of Pavlekovich's recent projects is arming students with technology to track storm drains that flow into rivers. With help from a Maryland STEM Portfolio Project grant,

students worked with geographic information systems (GIS) to guide them around town, tracking storm water and learning about waste water management. "When you give a student the responsibility of managing their own technology to take home — their world opens up," Pavlekovich says.

Salisbury's strategy of weaving STEM into all curricula, accented by technological tools, is innovative and unique — and now a best practice for schools across the nation seeking ways to stimulate students in STEM.

## Stimulating STEM When it Matters Most

*"Eighth grade is a critical defining point for students in the college and career planning process. If students are not on target for college and career readiness by the time they reach this point, the impact may be nearly irreversible."*

- Cynthia Schmeiser, President and Chief Operating Officer, ACT Education Division<sup>1</sup>

It's known by different names, depending on the region of the country in which one lives — including middle school, intermediate school, or junior high — but it's one of the most crucial points in a child's educational life. Sometimes called the "tween years," these years represent the time in which students are no longer children and not yet full-blown teenagers. In this neverland, students struggle with their need for independence but are not quite educationally equipped to be as self-sufficient as they would like. It is precisely for this reason that one STEM-focused middle school — the National Inventors Hall of Fame School in Akron, Ohio — has an engineer-in-residence to bridge this gap. Sam Landers helps students channel what they are naturally interested in — solving real-world problems, but with a twist. What he has found is that this age group is "most interested in my patents and innovations," something that makes STEM tangible and illustrates that STEM careers have value and are within reach with the right planning.

Recent research from ACT (yes, the one of college entrance exam fame) shows that "the level of academic achievement that students attain by eighth grade has a larger impact on their

## Why the Focus on STEM?

- Top U.S. students are foregoing careers in STEM with steep declines in engineering (25%) and mathematics (19%).
- U.S. students finished 19th in math and 14th in science in the ranking of 31 countries by the Organization for Economic Cooperation and Development.
- Only 29 percent of American fourth-grade students, a third of eighth-grade students, and barely 18 percent of 12th-grade students perform at or above the proficient level in science.

college and career readiness by the time they graduate from high school than anything that happens academically in high school.”<sup>2</sup>

Combine this with the fact that the number of U.S. students entering STEM careers has been dwindling<sup>3</sup> — despite a nearly urgent need for these graduates in the workforce — and it equals a critical need for students to be engaged with STEM subjects in their intermediate school years.

## National STEM Initiatives

The Obama Administration made STEM one of its top priorities, announcing three overarching goals:

- Increasing STEM literacy so all students can think critically in science, math, engineering and technology;
- Improving the quality of math and science teaching so American students are no longer outperformed by those in other nations; and
- Expanding STEM education and career opportunities for underrepresented groups, including women and minorities.<sup>4</sup>

To meet these end goals, schools need to take critical steps at the middle school level to prepare students for STEM fields. Before students can shoot for the stars, there is a need for technological infrastructure on the ground in every district, school and class that creates, connects and communicates this digital learning environment.

## Teaching STEM Effectively with Technology

Setting the climate for student retention is critical at the intermediate grades as studies show that students start falling behind and losing interest in school in these middle years. Engaging digital natives requires the use of multiple classroom technologies, including various mobile computing devices and interactive presentation tools. There is a great opportunity at this age to infuse STEM with these technologies that help foster and build upon students’ intuitive exploration. Having tools that put the focus on the student rather than the teacher helps create a connected classroom where lessons become more interactive and student collaboration increases.

## Virtual Lab Resources

- **Northwestern University’s Office of STEM Education Partnerships**  
<http://www.osep.northwestern.edu/projects-and-programs/ilab-network>
- **Howard Hughes Medical Institute – Virtual Labs**  
<http://www.hhmi.org/biointeractive/vlabs/index.html>
- **Net Frog: The Online Dissection**  
<http://frog.edschool.virginia.edu/Frog2/>

By the time students enter middle school, evidence of the digital divide can be apparent. Students with access to technology will start outpacing those who don’t. With technology skills critical for STEM careers, there is an even greater need to get technology in students’ hands.

A recent 1:1 laptop pilot at Union County Public Schools in North Carolina demonstrates how integrating technology can create a dynamic environment where students are excited to learn. In the pilot program, the sixth-grade students who had their own laptops were only 10 percent as likely to have behavior referrals as students that did not. They also had significantly better class attendance than students in more traditional classrooms. Dr. David Kavitz, executive director of Technology Services for the district, says they are now implementing a full initiative in sixth, seventh and eighth grades as a result of the successful pilot and that the district plans to make one-to-one a standard practice in all district middle schools within the year.

Laptops and netbooks along with rich interactive curriculum can be used with other presentation tools to create a connected classroom environment and further advance STEM learning. For example, if a science teacher wanted to assign a botany project, a sample project displayed through interactive rich media could be used to bring life and excitement to content that inspires students to take their own assignments further. Students collaborating on the assignment could communicate their plant

## Cool STEM Contests for Middle School Students

### National STEM Video Game Challenge

Calling all middle school video game designers – President Obama wants you to get in to the game! No worries if you do not make the Feb. 5, 2011, deadline, a visit to this website will introduce students to video game design resources for future competitions. Creativity is a must, coding is not.

<http://www.stemchallenge.org/Default.aspx>

### Redesign Your Ride Contest

This middle school project gives budding car enthusiasts an opportunity to learn about STEM topics such as alternative fuels and environmental impact as they design a car for 2020.

<http://www.fuelourfuturenow.com/middle-school.cfm>

growth readings and soil observations to team participants in the classroom. The classroom students apply those data points to other data from previous observations and project their findings in graphical form through display technologies so the whole class can view. Later, the team would prepare a report to the class on how their various plants have reacted to differing soil and water conditions and use the interactive whiteboard to present findings and engage the entire classroom.

Using technology during a math lesson can bring a new dimension to a topic that is often dreaded by students. Three dimensionality is available so cones and spheres look like cones and spheres and not triangles and circles. When students can complete math problems online and record and track data through spreadsheets, the work becomes more engaging and

makes difficult problems more approachable. Information is presented clearly in an online format, and it is simple for the student to review past work. Collaboration increases as students can instant message each other for tips or even track and share other students' work through available software programs. Teachers can monitor the communication in a safe and meaningful way to foster project-based learning. Multi-media presentations incorporating images and audio bring new life to data-intensive topics.

Hands-on learning has often been a requirement for students to grasp some of the more abstract concepts in science, but many intermediate schools lack the financial means or physical space to provide a fully equipped lab for students. Virtual labs, however, are quickly growing in popularity as a solution to this problem. Students are able to progress at an individualized pace. Virtual labs allow students to conduct experiments that would be dangerous in a physical setting and make expensive, hard-to-obtain equipment a non-issue for budget-stretched schools and districts.

Northwestern University and MIT recently launched the iLab Network Project to bring the virtual lab to K-12 science classes. The iLab connects lab devices, such as microscopes and signal analyzers, to the Web, allowing teachers and students to access equipment remotely. These are not simulations — but actual devices. The tracked data is real; students learn that sensors need precise calibration for scientific study. This project gives students contact with equipment otherwise inaccessible due to costs, time restraints and safety concerns.

Online gaming using laptops and netbooks is a particularly effective way to engage students using a medium with which they are familiar and illustrating complex topics in a less intimidating way. NASA offers a free multi-player game that allows students to become virtual astronauts, restoring oxygen levels with robots after a meteorite strike at their station on the moon. The game allows students to learn STEM concepts while working collaboratively.

Dr. Daniel Laughlin, NASA Learning Technologies project manager, says that the organization is working to increase the STEM student pipeline for the future workforce. "Our work with games is



aimed at reaching students through a medium that is comfortable and familiar. Virtually all kids play video games. We are trying to inspire and increase interest,” Laughlin says.

The success of the game is in the numbers. “To date, we’ve had more than 240,000 downloads of Moonbase Alpha with about 175,000 hours of play time online,” Laughlin says.

## Importance of Professional Development

Ensuring a technology implementation at the intermediate level is successful takes more than just putting the devices into students’ hands — it requires a substantial commitment to professional development from both the school district as well as from the teacher. Teaching practices must be modified to utilize resources made available by technology and to integrate these into the prescribed curriculum. School leaders must understand that teachers need their support and meaningful reassurances as they make this transition.

Union County Public Schools understood that for its one-to-one computing program to be successful, teachers needed effective professional development. In the summer before the pilot began, 10 sixth- and seventh-grade teachers underwent intensive development with a technology educational consultant and the district’s curriculum specialist. This winning combination of professional

development allowed the group to learn not only how to use the technology, but to effectively utilize it to further curriculum goals. District leaders equipped each teacher with a laptop, demonstrating how to use the mobile device to interact with the class and integrate it with interactive whiteboards. Teachers were prepared when the one-to-one program began.

The following summer, all sixth- and seventh-grade teachers had two days of training to ready them for the full launch later in the year. They received a day of training on using the laptop in the classroom and a day on integrating the district’s learning management system to support instruction in their classrooms. The goal of the training was not only to have them learn how to use the technology, but to help them re-engineer their teaching methods to address a student-centered learning model.

Integrating technology is an evolutionary process as Rome was not engineered in one day. However, with the right technology at the right time, budding STEM students might just be able to virtually create Rome, learning not only history but the engineering and mathematics that undergird the historic city. As students learn, mentoring opportunities within the STEM disciplines need to be established to assist them with career preparation. Teachers also need assistance to navigate through deployment issues with technology mentors. Continuous professional development is necessary to ensure that teachers are utilizing technology to make the most of the middle school learning experience.

## Benefits For Every Stakeholder

Introducing technology at the middle school level can make the overall education experience better for everyone that’s involved — including administrators, teachers, students and parents. Below are just a few of the ways that each of these parties can benefit from a more connected classroom:

### Administrator Benefits

Administrators at the central office can benefit when technology infrastructure is transparent to the end user and rich media content is provided for the digital classroom to better augment curriculum choices. In STEM areas where the con-

tent changes rapidly, the ability to provide more and varied digital content is critical. Professional development is designed beyond a shot in the arm approach and continues to evolve with the technology it supports. Principals and district personnel have greater confidence that the technology chosen for the classroom is the most cost effective and student friendly for maximum student achievement. IT departments feel more secure in identity management protocols and help desk scenarios as the technology purchased allows more time to focus on long-term IT initiatives. Well-thought-out technology plans and priorities help reduce runaway spending.

### Teacher Benefits

Connected classroom technologies better equip teachers to address individual student needs. No longer must they focus primarily on delivering content; they can become the learning coach for students, helping them master higher-level skills that make use of the information in meaningful ways. They can help students develop more effective ways to collaborate and communicate their ideas with fellow students and others. Learning concepts, processes and activities can be structured in a way that is safe, age-appropriate and aligned with course objectives.

## NASA's Top STEM Resources for Middle Schools

### Summer of Innovation Program

Piloted in 2010, the program includes physical and virtual STEM events around the country for teachers and students. Look for events in your part of the galaxy.

<http://www.nasa.gov/offices/education/programs/national/summer/home/index.html>

### Kennedy Launch Academy Simulation System

Houston doesn't have a problem when middle schoolers take over simulations of shuttle deployments based on real launch information. Student engineers use five console stations, each with a different STEM function related to mission control.

<http://www.nasa-klass.com/>

### Introduction to Student Podcasting with NASA

Need a quick introduction to STEM podcasting? Look no further than NASA to come up with a complete walkthrough for your middle school students. Students can choose from a wide variety of video clips of both space and land experiments ranging from lab safety, sports, robots and of course, all things space related. Narration, production and editing are all demonstrated as the student builds podcasts.

<http://www.nasa.gov/audience/foreducators/diypodcast/index.html>



## Student Benefits

When students are learning in a connected classroom, they are better engaged and find that their learning activities have more meaning. For STEM subjects, the real-world connection can be the missing excitement factor for the middle school student. When students control more of their learning through experiential project-based activities and increasing levels of technological responsibility, they flourish. They can proceed at a pace that better suits them and pursue enrichment activities that more effectively match their interests. Furthermore, when students have access to an online learning type of curriculum, they can seamlessly extend their learning day.

## Parent Benefits

Connectedness allows parents to have greater involvement in student learning. Parents can log on to the school's portal from home and have immediate access to their child's educational information, including problem areas and the current curricula students are studying. Not all parents will have a background in STEM, so reaching out to them with the technology their students use on a daily basis and providing them with access to digital content and resources ensures parents are not overlooked as the key providers of support.

This kind of supervision and support from home allows parents to monitor their middle school-aged children at a time when they are most likely to falter and become disinterested.

## Building A Foundation

Middle school is a critical time for students as it often determines their level of commitment to not only continuing their education, but also to what type of a career path they may take. Teachers must engage students in the classroom setting today while promoting 21st-century learning skills if we want to see them serving as tomorrow's STEM leaders. Through the use of technology, middle school teachers can tailor their curriculum with the right digital content adoptions that makes learning more student-centered and teaching more effective.

District leaders need to provide teachers with the rationale and the confidence to incorporate STEM curricula. Teachers cannot tackle the use of technology alone. Through district support and continuous professional development, teachers can effectively integrate technology into their classrooms. Everyone can benefit from a more connected middle school classroom — including teachers, parents, and administrators — but the biggest benefits are seen by the middle school student who, through the use of technology, will be better prepared for the future.

## Endnotes

1. <http://www.act.org/activity/spring2009/eighthgrade.html>
2. <http://www.act.org/research/policymakers/pdf/ForgottenMiddle.pdf>
3. CRS Report for Congress STEM Education; Background, Federal Policy, and Legislative Action
4. <http://www.whitehouse.gov/the-press-office/2010/09/27/president-obama-announces-goal-recruiting-10000-stem-teachers-over-next>



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Dr. Kari Kelso is a senior fellow for the Center for Digital Education. Kelso earned her Ph.D. from the University of Texas at Austin in Organizational Communication and has over nine years of experience as the lead manager for two of California's larger school districts in Research, Evaluation and Assessments and one rural district. Having taught at the university level at three universities — combined with her K-12 school district leadership — she knows K-20 education from the inside out.



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