



# EDTECHNEXT

Emerging technology  
for K–12 education

## Digital Tools for Problem-Based Learning

**T**o say that students at The Incubator School in Los Angeles are solving the world’s problems is not hyperbole. In fact, this is the heart of their education.

Project- and problem-based learning is the lens through which all students at The Incubator School learn—not as an occasional culmination of instruction, but as the process of learning every day, in every subject. “Impact projects,” as the school calls them, elevate traditional project-based learning with an explicit framework, methodologies, skills and digital tools, which can amplify the rigor, relevance and appeal of projects and problems to students. It’s an approach that forward-thinking schools are pursuing.

This year, sixth graders at The Incubator School are working on one of the biggest environmental and human rights disasters in the world—oil spills, pollution and health crises in the Niger Delta of Nigeria. With their classmates, Louie, Luke and Robby are immersed in raising awareness about this challenge in Nigeria and around the world. They’ve interviewed Chi Nnadi, the founder and CEO of Sustainability International, a nonprofit headquartered in Los Angeles. They’ve Skyped with a social and environmental activist in Nigeria.

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These students are brimming with ideas—inexpensive cell phones and cameras for Nigerians to document oil spills with videos and photographs, high-tech foot bridges that monitor water quality, and improved satellite feeds and Wi-Fi access to publicize this reporting in real time. They're developing concepts and prototypes for clean technology, such as special machines and filters to separate oil from water, based on what they learned from Nnadi about biotechnologies that can turn the oil into energy to power Nigeria, and purify the water so it's safe to drink.

"Essentially, they're developing solutions for the challenge of youth needing to have ways to report oils spills and other environmental disasters that happen in the Niger Delta so that they can get the attention of government and media," says Ryan Oliver, entrepreneurship education manager at The Incubator School, a pilot launched in 2013 by the Los Angeles Unified School District.

"This goes a step beyond the traditional idea of project-based learning," says Pam Stiles, technology and STEM (science, technology, engineering and math) lead at the school. "It's project-based learning with a real-world impact. There's a real purpose for students—solving a real problem not necessarily provided by a teacher for a grade."

This "startup" school educates students in grades 6–9. Entrepreneurship, social and emotional learning, and blended learning are the school's foundation, Oliver says. Projects and problems are central to that focus.

## *Student Voices:* **THE NIGER DELTA PROJECT AT THE INCUBATOR SCHOOL**

"It's a really good project for a few reasons. It makes you think because you have to use the materials they have. You can't use things that are going to cost too much money. They have limited resources. It also teaches you how to do a full-fledged project, because it helps you do a storyboard and that type of stuff. And at the same time you work in groups" and, by using a Summit Personalized Learning Platform, "we learn to be responsible."  
— Robby

"Basically you're taking a real problem and you're trying to raise awareness in sixth grade. It's taking a big opportunity to change something and make people notice it so they can see how they can help. People can actually see what is happening in Nigeria and not only worry about themselves."  
— Louie

"I think it's an amazing idea that people can use their phones to call and take pictures and make videos. I just wish we had better satellite feed. What I want to try to help them with is promote how we need to help them, what we need to do. My idea is to try to get them better Wi-Fi so that they can do live stuff so that people can see what actually happens when it happens. Sometimes it's too late and then when the people come by, the oil is already gone from the Niger Delta."  
— Luke

# The New Contours of Projects and Problems

## How Digital Tools Can Support Project- and Problem-Based Learning

Digital tools can support students not just in completing a project, but also in learning how to think through any project or problem in a disciplined way. As educators adapt the problem-solving approaches of computer scientists, engineers, designers, entrepreneurs and makers, specialized learning platforms are beginning to incorporate their techniques.

See page 8 for a roundup of technologies that support project-based learning.

While technology is not essential to project-based learning and problem solving, “it amplifies the work students are able to do,” says Ashley Ellis, director of instructional programs, Loudoun County (VA) Public Schools. “The technology depends on the projects and teachers,” Ellis says. “Teachers have a lot of choice.”

Maker technologies are in the mix as well. One 16-year-old student in Loudoun County worked with his teacher to solve a problem close to his heart: They built a prosthetic hand for his six-year-old brother, using a 3D printer donated by a local business (Balingit, 2016).

To learn more about maker technologies, see the Spring 2016 *EdTechNext* report, “Students as Digital Creators.”

Projects and problem solving aren’t new to K–12 education. In fact, this definition, developed a generation ago, still captures the essence of projects and problems today:

**Project-based learning is a pedagogical approach in which “students pursue solutions to nontrivial problems by asking and refining questions, debating ideas, making predictions, designing plans and/or experiments, collecting and analyzing data, drawing conclusions, communicating their ideas and findings to others, asking new questions, and creating artifacts”** (Blumenfeld et al., 1991).

What’s different now is that educators are rethinking the role of projects, which offer “a construction site of learning” (von Kotze & Cooper, 2000) in which students actively participate in building knowledge collaboratively. Rather than assigning projects at the end of instruction, educators are integrating them with everyday schoolwork and making them the centerpiece of learning. They are challenging students to take ownership and have a voice in authentic, complex and rigorous problems and driving questions. And they are becoming more deliberate in teaching students how to think through projects and take on project roles and tasks.

In the Loudoun County (VA) Public Schools, project-based learning fits within the district’s One to the World instructional vision, the outcome of strategic planning. This initiative has four key elements: significant content and important competencies, authentic and challenging problems *in* the world, public products *for* the world, connected *with* the world.

“Project-based learning is a way to give all students access to opportunities to make meaningful connections and contributions to the world,” says Ashley Ellis, director of instructional programs in the Loudoun County district. “It used to be that we would teach content and have a fun activity at the end and call it a project. We wanted students to learn the content through the project, not after instruction.”

Specifically, forward-thinking educators engaged in project- and problem-based learning are:

- Addressing problems with real-world purpose, impact and interest to students
- Teaching structured, professional-grade problem-solving processes, such as computational thinking, human-centered design and design thinking
- Promoting interdisciplinary approaches to problems with blended learning of academic subjects
- Aligning project learning objectives with academic standards

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### New Contours *continued from page 3*

- Cultivating an entrepreneurial mindset and 21st century skills, including critical thinking, communication, collaboration and creativity—also known as college and career readiness skills and as deep learning
- Partnering with businesses, nonprofits, postsecondary institutions, community organizations and experts, and collaborating with other schools domestically and internationally
- Using digital tools for students and teachers to manage projects and tasks, collaborate, conduct research, develop solutions, offer feedback, encourage participation, assess student work, create portfolios and archive projects
- Providing maker technologies for designing and creating prototypes and products

These approaches correlate to the 2016 ISTE (International Society for Technology in Education) Standards for Students, which describe the skills and knowledge needed to learn effectively and live productively in an increasingly global and digital society.

### Project- vs. Problem-based Learning

The terms project- and problem-based learning often are used interchangeably. The Buck Institute for Education, a leading proponent of project-based learning, views problem-based learning as a subset of project-based learning: Students try to solve problems while they're working on projects (Lamar, 2013). For purists, there are differences:

## PROJECT-BASED LEARNING VS. PROBLEM-BASED LEARNING

### SIMILARITIES

- Focus on an open-ended question or task
- Provide authentic applications of content and skills
- Build 21st century success skills
- Emphasize student independence and inquiry
- Are longer and more multifaceted than traditional lessons or assignments

### DIFFERENCES

#### Project-Based Learning

Often multi-subject

May be lengthy (weeks or months)

Follows general, variously named steps

Includes the creation of a product or performance

May use scenarios but often involves real-world, fully authentic tasks and settings

#### Problem-Based Learning

More often single-subject, but can be multi-subject

Tend to be shorter, but can be lengthy

Classically follows specific, traditionally prescribed steps

The “product” may be tangible or a proposed solution, expressed in writing or in a presentation

Often uses case studies or fictitious scenarios as “ill-structured problems”

Source: Lamar, J. (2013). Buck Institute for Education.

# Computational Thinking

**“I feel like the United States used to be a leading force in science and innovation in the world. I started seeing this generation that is not capable of solving problems. The world is changing. The jobs that are valuable in the market actually value these types of skills. And these types of skills are scarce because nobody’s teaching them. If we fail to teach these skills, the United States will not be able to keep its leading role in science and innovation.”**

— Miriam Bogler,  
CoSN Emerging Technologies  
Committee member and  
founder and CEO of Project Pals

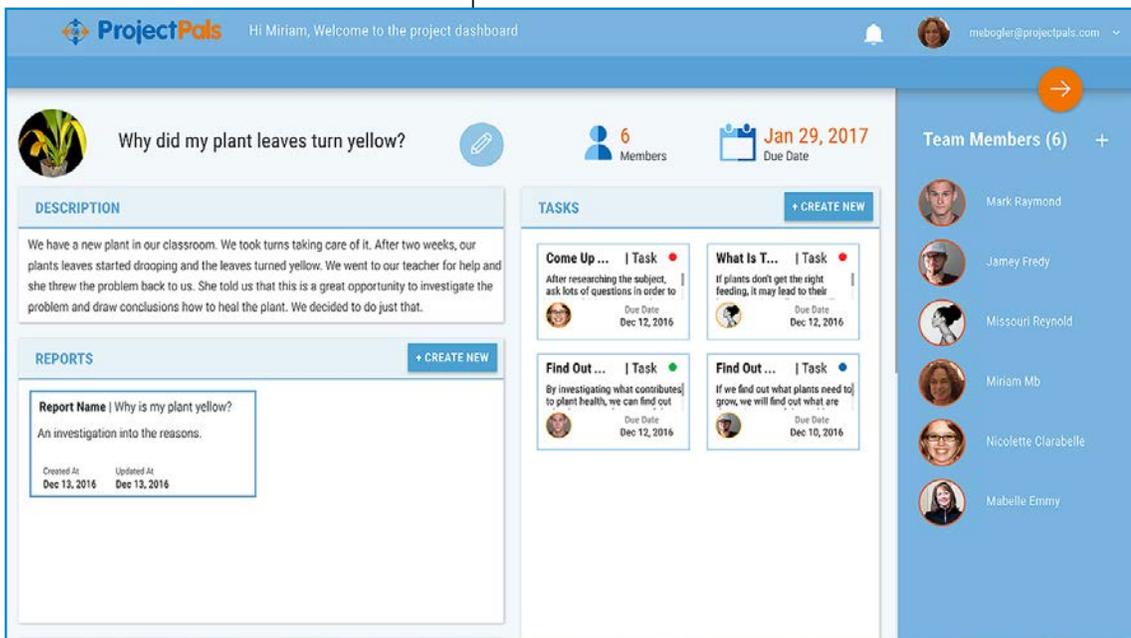
Miriam Bogler of CoSN’s Emerging Technologies Committee recognized the need for project-focused digital tools when she was a computer teacher. “Students would come to my computer lab to work on projects that the teacher had assigned to them,” she says. “I noticed that they had no clue how to go about it. Instead of approaching the project as an investigation, they would look at the guiding questions and try to find answers.”

As founder and CEO of Project Pals, Inc., she’s now piloting a beta version of a web-based application that supports inquiry-driven projects and deeper learning. The application takes a methodological approach inspired by her training in computer science and programming.

Computational thinkers approach problems by first breaking them down into component parts, processes or events, Bogler says. They address, research or analyze each piece of a problem separately, then put the pieces together to see how they relate or interact. This legwork helps them refine the main problem (or problems), generate solutions to the problem(s), and narrow their focus to an aspect of the problem for which there is evidence, or that they find interesting. Then they test the causes or effects of applying certain solutions to the problem, analyze their findings, produce a report or product, and present their work.

The Project Pals application provides a platform for students to structure their thinking as they carry out project tasks as individuals and with multiple contributors. Essentially, the application is a real-time, collaborative workspace for gathering, manipulating and refining information, which can include texts, images and videos. Embedded in the application are digital

tools for creating visual representations, such as mind maps, timelines and geographical maps, which help students “see the big picture” by building understanding of the relationships or interactions of different aspects of complex problems. Teachers are involved throughout the process, monitoring and commenting on student work.



Project Pals dashboard screen

# Human-Centered Design and Design Thinking

**B**oth The Incubator School in Los Angeles and the Avonworth (PA) School District explicitly teach students how to use human-centered design and design thinking methods for projects and problems.

The Avonworth district, now in its fifth year of deepening learning with projects, spurred its initiative by bringing in the Buck Institute for Education to train all teachers in project-based learning and then by sending all administrators and most teachers to workshops on human-centered design from the Luma Institute. This organization helps schools, businesses, non-profits and governments accelerate innovation using dozens of methods framed by three key design skills (Luma Institute, 2012):

- **Looking:** observing human experience
- **Understanding:** analyzing challenges and opportunities
- **Making:** envisioning future possibilities

The Stanford Institute of Design articulates a similar set of design thinking processes (Plattner), which also inform project-based learning practices in schools:

- **Empathize:** understanding people within the context of the challenge
- **Define:** bringing clarity and focus to the challenge
- **Ideate:** generating ideas for concepts and outcomes
- **Prototype:** generating iterative artifacts to answer questions and get closer to a final solution
- **Test:** soliciting feedback to refine prototypes and solutions

Project-based learning throughout the Avonworth district, which is a member of the Digital Promise League of Innovative Schools, now combines design thinking and arts integration. In the wake of the 2008 budget crisis, “others started cutting arts programs,” says Kenneth Lockette, assistant superintendent. “We’ve strengthened ours, and find that to be very important” to project-based learning. Three sample projects illustrate how these approaches play out for students:

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## BRIGHT IDEAS

The Avonworth district has shifted from boxes of maker materials for discrete instructional units to mobile maker carts that traveled from classroom to classroom to well-equipped makerspaces in every school.

The district also partners with community organizations and industry to provide access to digital tools. For example, eighth graders recently completed project-based coursework based on a nine-step inventing method from the *Inventionland Institute*, an organization that offers a creative, Disney-like environment and resources for innovation, including engineering, maker and multimedia technologies. Student teams developed product prototypes, created video and web assets to market the products, and presented their projects Shark Tank-style to a panel of industry experts.

- **In elementary school**, third graders investigate the colony collapse of honeybees. “That brings in the driving question, ‘How can we as third graders help our honeybee population in our area?’” Lockette says. Art is an entry point into this inquiry. The district recently hosted a Studio A Workshop with the Pittsburgh Center for the Arts for 20+ districts. In hands-on workshops, teaching artists and Avonworth teachers worked alongside other teachers to experience how art mediums, such as puppetry, visual arts, dance and playwriting, can ignite students’ curiosity.
- **In middle school**, eighth graders take on a project in which they get to shape their city. Pittsburgh is home to 446 bridges that span the city’s three rivers, ravines and hills. “A lot of those bridges are in poor shape,” Lockette says. “So the driving question is informed around that: ‘What kind of bridges do we need to build?’” State transportation officials, architects and engineers give students a sense of the infrastructure challenge, then guide them and provide feedback in using human-centered design strategies to design plans and build prototypes of bridges. The prototypes are then put to the test for weight-bearing capacity.
- **In high school**, students become art curators through the Pittsburgh Galleries Project, a partnership between the district and six museums and art galleries in the city. Student teams first work alongside museum and gallery professionals to learn about their behind-the-scenes world (and careers)—program management, the thought process of designing exhibit spaces, the craftsmanship of installations, the use of lighting technology to enhance the viewing experience. Then students plan, design and create museum exhibits on their school campus with the partnering museums. Among many other awards, this project was a winner of the 2016 Digital Media and Learning Competition’s *Playlists for Learning Challenge*, which is supported by the John D. and Catherine T. MacArthur Foundation.



## A ROUNDUP OF TECHNOLOGIES FOR PROJECT- AND PROBLEM-BASED LEARNING\*

Platforms Specializing in Projects	
ePals	A global community of collaborative classrooms engaged in cross-cultural exchanges, project challenges and sharing, and language learning
Defined STEM	An online resource with performance tasks that challenge students to apply knowledge and skills, literacy tasks and constructed responses to create argumentative and informative responses to real-world issues and real-world videos that set the stage for problem-based learning
LearnHub	A shared learning space that supports student participation, collaboration, projects and digital learning portfolios and makes classrooms more productive and easier to manage
PeerSpring	A project-based learning platform that enables students to identify and solve real-world problems, design and code technology for social good, forge ties with stakeholders outside of school, build community and/or raise money with social and mobile technologies, and become masterful digital storytellers
Project Foundry	A software as a service (SaaS) platform and resources that support personalized, deeper, project-based learning with a collaborative workflow and management tools
Wikispaces Classroom	A social writing platform and project-based learning environment where students can communicate and work on projects alone or in teams. Wikispaces Campus is a solution for entire schools and districts.
Workbench	A platform for makers, students and educators to connect, find and share projects, and build online communities
Platforms for Productivity, Communication and Collaboration	
Learning management systems	Many learning management systems for schools and classrooms offer productivity, communication and collaboration tools that support project- and problem-based learning. Examples include Blackboard, Canvas, Edmodo, itslearning, Moodle and Schoology.
Cloud-based solutions	G Suite for Education (formerly Google Apps for Education) is a collection of free productivity tools for classroom collaboration. Google CS First offers a curriculum and theme-based clubs to introduce fourth–eighth graders to computer science. OneNote Class Notebook provides a personal workspace for every student, a content library for handouts, and a collaboration space for lessons and creative activities from Microsoft, which integrates with Office 365 and many learning management systems.
Chalkup	A class collaboration platform the facilitates class discussions, resource sharing and connections
Project Pals	A web-based project creation environment that guides students through a process of discovering and deep learning. Students working in teams collaborate on projects in real time, using a methodological approach to problem solving that is focused on how to solve the problem.
SMART amp	A digital canvas that scaffolds collaborative, creative learning with embedded lessons, PDFs, videos, images or content from leading educational publishers. SMART amp is integrated with Google Apps for Education.
Verso	A suite of mobile web tools that helps teachers activate student voice, design deeper learning activities, elicit original thinking, develop their own questions and provide feedback. Verso embeds professional development for teachers to strengthen their pedagogy and offers professional learning communities.

\*These are examples of available technologies, not a comprehensive list.  
CoSN does not provide endorsements of any technologies.

# Thinking Critically in a STEM-Focused, Energy-Themed School

Teachers and students love this “kind of magical” way of learning.

—Lori Lambropoulos, principal, Energy Institute High School, Houston

**A**t the Energy Institute High School in Houston, both students and educators are engaged in meaningful, energetic projects.

The magnet school in the Houston Independent School District, which opened in 2013 with support from the energy industry, is an unusual STEM-focused, energy-themed school that aims to develop students’ skills and passion for careers in energy. “We’re not just talking about STEM,” says Principal Lori Lambropoulos, “and it’s not just oil and gas energy, but alternative energy, geosciences, robotics, computer science, even accounting, the business side of the industry.”

The school made its way into project-based learning gradually—and by chance. “There are three things I cling to that make our school very unique from the average comprehensive high school,” Lambropoulos says:

- 1. UPDATED TECHNOLOGY.** The school keeps technology current for students—and teaches them to use it as professionals do. For example, students use professional engineering software, which industry professionals tell her they didn’t use until their junior or senior years of college as engineering majors. Students also use scientific technology to collect, analyze and interpret data. And they use GPS sensor technology that connects to iPads and is used to track and record movement, voice and video as students practice presentations—and polish their communications skills.
- 2. THE “CORPORATE DYNAMIC.”** To stay abreast of the fast-changing energy industry, the school partners with companies that provide networking and collaboration opportunities for educators and students.
- 3. PROJECT-BASED LEARNING.** “The most pivotal point that makes the school look and feel different was an accident,” she says. Project-based learning wasn’t in the initial school plan. But during a visit to Manor New Technology High School near Austin, TX, students there impressed Energy Institute educators with their enthusiasm for projects. Lambropoulos also liked that school’s “formula-based approach” to projects that aligns well to the needs of high school teachers responsible for teaching to standards and curriculum.

**Getting Started with Project-Based Learning.** So that first school year, the school provided training in project-based learning. All ninth-grade teachers created one project with a driving question, learning objectives, a research base, small-group workshops for focused instruction, and some type of product, prototype or presentation. Teachers and students loved this “kind of magical” way of learning, so the projects piled on the next year.

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“The problem was that each content area was doing projects and kids were complaining, ‘We have seven projects due in four weeks and we don’t know how to manage our time,’” Lambropoulos said.

Project overload contributed to another innovation at the Energy Institute. The school had already merged English and social studies classes together. “We started thinking,” she said, “what would reduce the number of projects and increase the amount of learning at the application level in the content areas?” To solve that problem, the school merged English, social studies, science and engineering classes into team-taught cohorts—an approach educators saw in action when they visited High Tech High in San Diego. The 45-minute bell schedule gave way to a four-hour block of cohort instruction, which allows more time for more complex, interdisciplinary projects.

For example, students this year explored how the energy infrastructure has shaped East End Houston communities, and how the city’s population

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### *Teacher Voices:* **PROJECT-BASED TEACHING AT ENERGY INSTITUTE HIGH SCHOOL**

“Project-based learning really helps students who are going to go into any career, but specifically engineering fields, where they must think critically about how to solve a complex problem. They go through the scientific method and understand that things are not always done. We can revise things, we can test things and regroup and recalibrate.”

— Jillian Estrella, AP Environmental Science teacher

“Coming from a traditional high school, I think project-based learning is very beneficial for kids. We share close to 100 students. We plan every day together, whether or not we have a planning period. We’re glued to the hip professionally, willingly so. I’ve never been to a school that really values teachers’ time in terms of giving us time and trusting us with that time to do what’s best for students. ... For teachers it’s an incredible experience because we have this opportunity to create everything from the ground up. Students have voice and choice. They take ownership of projects and products. There is no curriculum. We create everything from scratch. There’s an amount of pride and passion that our kids see from us every day because we created this thing for them, for this year, that we probably won’t use again.”

— Elizabeth Harris, English teacher

“This is my first year of teaching. I walked in with the expectation that you cannot teach this class as you would every other history class you’ve taken from elementary school through college. This is a unique challenge and opportunity for me. ...When it comes to using history to address content across the classes, you can easily tie things from engineering with United States history. Like when we’re doing Western expansion, you talk about that fact that before we were drilling for oil, we were actually using those drills to find salt to preserve food. Or when we get to the Civil War, we’re going to talk about the environmental impact that destroyed entire ecosystems, and that ties in with the environmental science class.”

— Thomas Benson, history teacher

boom has resulted in food deserts and a dearth of community parks in residential neighborhoods. Students researched the history of industrial and residential development, investigated food sustainability and proposed solutions for redesigning Houston as a livable city. Throughout the project, they collaborated with Houston Tomorrow and the Houston–Galveston Area Council, organizations that work on business, economic, environmental and quality of life issues in the region, and with a commercial real estate professional.

“This turns into a complex problem,” says English teacher Elizabeth Harris. “The driving question is, ‘How can we as students revitalize Houston to support our community and culture?’ When creating the driving question, we really have to think in a way that draws in all the content. Talking about the community and culture really builds on the history component, in English we look at gentrification,” and students develop science and engineering skills as they work on concrete ways to improve their city.

## Advice for Succeeding with Project-Based Learning

Educators interviewed for this report shared their strategies and wisdom for making steady progress in embedding project-based learning into their instructional programs:

**Strengthen the role of educational technology professionals.** It takes time, energy and “all hands on deck” effort to make project-based learning work, says Harris of the Energy Institute. That includes Jimi Cavazos, the school’s information technology specialist, who is “running laps around the school all day” to support the instructional technology. With students using more technology, and more types of technology, the role of educational technology professionals is only growing.

**Gear up with technology—and let teachers and projects inform choices.** Digital tools can enhance students’ problem-solving and creative abilities. Technology options are limitless, however, and schools’ purchasing power is not. Teachers can provide insights into the projects their students are doing and the technologies they need or want to use. Businesses or outside organizations might be willing to let students use specialized technology or equipment for projects—and support student learning as well.

**Engage leaders.** Leadership support is critical for providing professional development; building community buy-in and forging outside partnerships; making changes to instruction, buildings, technology and schedules; empowering teachers to experiment; and celebrating success. “It’s OK to make a mistake and learn from it,” says Suyi Chuang, project management

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supervisor and project-based learning lead in Loudoun County. “We made a very deliberate decision to celebrate success and learning to change the mindset of a fear of failure.”

**Be deliberate.** Educators should think through the vision of education they are trying to achieve, then consider how projects align with that vision and how they can help students meet standards and learning objectives. Educators also believe it’s important to explicitly teach students problem-solving methodologies.

**Provide sustained professional development.** Instructional shifts required for project-based learning take knowledge, time and ongoing support. In Loudoun County, the Buck Institute for Education is a multi-year professional development partner. “They’re not just providing drive-by professional development in August,” Ellis says. “They’re providing professional development all year with a project-based learning coach in the district. Lasting change takes a lot of time. Teachers and leaders have to know the why of what we’re doing, not just the how.”

**Build out over time—but beware of project overload.** Districts and schools that now have robust project-based learning initiatives for all students started modestly and continued to deepen and expand their efforts year after year. When Energy Institute High School recognized that too many projects don’t serve students well, educators pulled back on the quantity of projects and made substantive changes to improve their quality.

**Consider a point person for outside partnerships.** As schools develop meaningful partnerships to support project-based learning, they’re finding that managing relationships and scheduling time for collaboration is time-consuming. Some are creating new positions or dedicating staff time to these emerging responsibilities.

**Be prepared to be surprised.** The openness of projects means that no one really knows at the outset where they will lead. For an English class at Broad Run High School in Loudoun County, students read *Dear Father: Breaking the Cycle of Pain* by J. Ivy, a Grammy Award-winning artist and hip hop poet. Ivy’s memoir about growing up without a father inspired his *Dear Fathers Letter Movement*, a call to action to heal through writing.

For their project, “kids wrote a letter to a father figure, which morphed into a letter to anyone who shows leadership potential in the community,” says Adina Popa, educational technology supervisor. “It was an authentic project and deeply rooted in English standards.” In one letter, a tenth grader thanked his father for his sacrifice of leaving his family to work and provide for them. When J. Ivy learned of the project, he performed a live concert at the school and gave the keynote speech at high school graduation.

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This CoSN resource is related to the following skill areas from CoSN's *Framework of Essential Skills of the K-12 CTO*:



Leadership/Vision



Instructional Focus



## Closing Thoughts

The schools and educators profiled in this report exemplify best practices in using technology to support learning. Just as the Montessori method advises educators to “follow the child” to understand and meet each child’s learning needs in the moment, teachers and educational technology professionals follow specific projects and problems to guide their technology choices for their students. The problems that students are trying to solve drive the selection of digital tools.

In other words, learning comes first, not technology. But technology supports and intensifies inquiry, collaboration, discovery, making and presenting. In this way, it becomes a transparent, organic and effective tool for problem-solving.

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