EDITOR’S NOTE
STEM-based education can equip students with the knowledge and skills needed for the modern era. This Spotlight will help you discover how new technologies and initiatives can increase engagement in science; explore the benefits of teaching coding skills to young learners; examine how a NASA-supported program is preparing students for STEM careers; investigate how to support the STEM proficiency of Indigenous students; and more.

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How the Webb Telescope Can Take Students Back a Long Time Ago, To Galaxies Far, Far Away

By Alyson Klein

When the James Webb Space Telescope officially launched Dec. 25, it was a literal and figurative Christmas morning for Jennifer Basalari and about a dozen and a half students, who took a break from opening presents to watch the launch together in an online video platform.

The excitement for Webb had been building in Basalari’s classroom since 2016, when she and other teachers visited a Northrop Grumman laboratory and saw part of the telescope under construction.

That experience, “completely sucked me in,” said Basalari, who teaches 5th grade STEM classes at Lakemont Elementary School in central Florida. She already is building a science unit for next year around Webb’s images, which NASA began releasing a little more than a week ago.

The telescope will change “what we understand about science, what we know about black holes and what we know about the beginning of stars and life and potentially the Big Bang,” she told her students.

Her enthusiasm has been so infectious that about a third of the kids joining her that morning were former students, who wanted to experience Webb’s launch with the teacher who had gotten them so jazzed about the project.

Though pictures—let alone teaching resources—from Webb are only beginning to emerge, Basalari predicts that educators around the country will make use of the show-stopping images to teach not just about astronomy, but about the scientific method, and how a big project comes together.

“Those images are going to be kind of the hook, because I don’t care who you are, if you’re looking at an image of space, especially new ones that haven’t been seen, 99 percent of people are intrigued and interested in that,” she said.

**A powerful tool for teaching science**

The Webb telescope, the most powerful ever built, enables scientists to see parts of the universe as they were about 200 million years after the Big Bang, according to the National Aeronautics and Space Administration. That’s fairly close to the beginning of time, given that the universe is projected to be more than 13 billion years old. Through the images, scientists—and schoolchildren—can glimpse some of the earliest galaxies ever formed.

The concept can be overwhelming to seasoned scientists, much less 7th graders.

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Want to Spark Students’ Interest in STEM? Initiative Brings Parents Into That Effort

By Lauraine Langreo

Ronak Suchindra was 8 when he attended a 4-H program that sparked his passion for robotics.

Now 15 and a rising sophomore at Downingtown East High School in southeastern Pennsylvania, he hopes to spark other kids’ passion for STEM (science, technology, engineering, and math).

Suchindra spent a recent Saturday afternoon in May teaching elementary school students remotely how to use Scratch, a programming language, to code their own games.

“It’s a way for kids to find their passions” while learning programming, Suchindra said. “Being able to foster that passion for coding in kids at such a simple level will start getting them thinking, ‘How can I build on what I’ve learned and how can I develop my skills?’”

The event was part of Remake Learning Days Across America, a nonprofit after-school initiative spreading across the country that aims to inspire and nurture kids’ interest in science, math, arts, technology, and more, through hands-on or project-based activities. And the initiative emphasizes the importance of starting the process early, when students are in elementary school.

Programs like Remake Learning Days are especially important at a time when there is a vast talent gap in the STEM industry. Jobs in STEM fields are expected to grow twice as fast as those in non-STEM fields, and millions of STEM jobs are expected to go unfilled in the near future, according to the U.S. Bureau of Labor Statistics. Research has also found that Black, Hispanic, and female workers are underrepresented in STEM professions.

Remake Learning Days Across America was launched in 2016 in the greater Pittsburgh region by the Remake Learning Network, an organization that wants to “transform teaching and learning to better serve today’s young people,” according to its website. Since 2016, the initiative has expanded to 13 states and the District of Columbia.

This school year, there were 1,270 events hosted by schools, libraries, museums, universities, child care centers, tech startups, and other organizations. Every event focuses on one or more of the following experiences: arts, makerspaces, outdoor learning, science, technology, youth voice, and professional development.
Getting students career ready

One of the goals of Remake Learning Days Across America is to build up kids’ knowledge and curiosity about a variety of careers in hopes that they will want to dive deeper into whatever interests them the most. While many of the events offer hands-on or project-based activities, some also introduce kids to professions they might not have been aware of before.

The goal of the events is for kids to find something that they’ll become passionate about, which can turn into a career pathway, said Dorie Taylor, one of the producers of the initiative.

The Pennsylvania Education Department has partnered with the Remake Learning Network to elevate the initiative and promote hands-on learning and career readiness in schools statewide, said Laura Fridirici, career readiness adviser for the department.

The department created the Career Ready PA backpack challenge. Students who attend Remake Learning events that teach “STEM employability skills” and career readiness will earn a Career Ready badge, Fridirici said. Schools that earn more than a hundred badges from their students receive a banner declaring their school career ready.

Pennsylvania students are required to have a portfolio that shows they have engaged in the state’s Career Education and Work Standards, which includes career awareness, preparation, acquisition, retention, and advancement, Fridirici said. Students are also required to learn “Career Ready Skills,” such as self-management, relationship-building, and problem-solving.

“Sometimes, parents don’t know what’s going on,” said Yuling Cheng, one of the producers of Remake Learning Days. “They did a Herculean effort throughout the pandemic. If the pandemic has taught us anything, it’s that we all have a role to play in a child’s education. So [Remake Learning Days] is to support the work that they’re doing and to provide more resources to families.”

“Schools are doing so much,” said Yulin Cheng, one of the producers of Remake Learning Days. “They did a Herculean effort throughout the pandemic. If the pandemic has taught us anything, it’s that we all have a role to play in a child’s education. So [Remake Learning Days] is to support the work that they’re doing and to provide more resources to families.”

One of the things that every school has struggled with, especially since COVID, is making sure that the kids are reengaged with each other, reengaged with their learning, reengaged with the school community,” said Carrie Morgan-Davis, the principal of McQuiston Intermediate School in Butler, Pa. “Remake Learning Days gives us a vehicle for that.”

Engaging parents

The initiative also tries to deliberately engage parents and help them understand what their children are learning, especially amid all the increased use of technology in education over the past two years.

The introduction of technology during the pandemic “expedited” changes in learning, and “all these interesting projects were coming out for kids, but as a network, we started to realize we’re missing a really important

Capri Matusic, 8, shows her mom, Lorrie, her coding project at “Creative Coding: A Morning of Making” as part of a Remake Learning Days program held at South Fayette Intermediate School.

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YU-LING CHENG
Producer of Remake Learning Days

stakeholder, and that’s the parents and caregivers,” Cheng said.

“Sometimes, parents don’t know what resources are available to them,” she added. “As parents, we want to feel confident. We know that our kids turn to us for answers. And there’s nothing worse than feeling like you don’t know what’s going on.”

That’s why Remake Learning events are structured in a way that ensures families can participate, she said. Many events are after school time or on weekends, and if events are
happening during school time, the schools make sure the events are open to parents and caregivers.

In 2020, the Global Family Research Project found that “family participation in Remake Learning Days increases the likelihood that children and youth will really enjoy the experience and indicate that they want more of them.”

Chatón Turner, a mother of three children ages 11, 8, and 4, attended a Remake Learning event hosted by nonprofit Venture Outdoors called Outdoor Survivor with her two sons. It was a STEM-based activity so kids learned about the science of friction and how that can start a fire, as well as other outdoor, science-related survival skills. Plus, the kids got to make s’mores.

“Venture Outdoors did a great job of including things that all children, but especially boys, would enjoy,” Turner said. “There was fire, there was food, and there was fun.”

Had it been in another environment where “it was less tactical and less interactive,” it wouldn’t have been as memorable for her sons, Turner said.

Turner and her children have been attending Remake Learning Days events for about four years. She said she likes that there are so many events on a variety of topics that “you can easily pick something that will resonate with your child.”

When choosing which events she’ll have her kids attend, she doesn’t just pick events she knows her children will be interested in. She also picks events where her children will learn something important, even if it’s not something they’re interested in.

“I think our job as parents is to expose our children to as many things as possible so that they can decide what they enjoy and they can make thoughtful choices about how they want to spend their time as adults,” Turner said.

Some schools have used their Remake Learning Days event as an open house opportunity for parents and caregivers to gain insight into what their children have been learning during the regular school day.

A 2019 Global Family Research Project memo found that through Remake Learning Days, families are getting more knowledgeable about STEAM (science, technology, engineering, arts, and math) concepts and that “when families are engaged in [those topics], students are more likely to succeed academically, take more advanced courses, and pursue STEAM-related careers.”

“It also gives parents and guardians an opportunity to come into the school,” said Vanessa Boyd, the principal of Broad Street Elementary School in Butler, Pa. “It increases attendance because if parents start feeling like the school is part of them, they will have their children come more.”

**Bringing the community together**

Remake Learning Days help bring communities together, according to event hosts, parents, and school leaders who spoke with Education Week.

Hagarty agreed. “Hopefully, kids will go to an event and that will spark an interest in something and they’ll be able to go to a library or a community function in the summer and have another chance to do a similar activity or maybe dive deeper,” he said.

Event hosts pointed out that the initiative also brings awareness to smaller organizations and helps connect them with the surrounding community.

“The great thing about Remake Learning Days is that it can be difficult for a lot of these smaller organizations to connect with people in the community, and people in the community might not know much about them. Remake Learning Days does a nice job of centralizing all of that,” said Jesse Schell, CEO of Schell Games, an education and entertainment game development company that hosted an open house for students to learn about what it takes to develop video games. “They have a big megaphone, where they can let everybody know all this great stuff is going to be happening. It’s great because it lets the organizations be a little more aware of each other.”

But for some, there is still work to be done when it comes to community outreach and awareness.

“There are always opportunities to engage through more outreach through partnerships,” said Friderici. “It then comes to how I (through my state career readiness advisor role) can better prepare the educators to include and engage more learners, more classrooms, with additional support.”

For Turner, mother of three, the only suggestion she has for Remake Learning Days is for organizations to “better amplify its message and programs more broadly.” She suggested that Remake Learning Days partner with more schools and get schools to amplify events through their newsletters to families.

“A lot of marginalized communities don’t even know everything that’s out there,” she pointed out, “so they’re not looking for it.”

**Want to Get Girls Interested in STEM Careers? Try Minecraft**

By Lauraine Langreo

To get girls interested in STEM careers, two teachers in a Louisiana school district decided to start their own after-school club called Girls Who Game.

“Computer science is very, very under-taught,” said Allyson Turner, one of the teachers who sponsor the club, during a session at the 2022 International Society for Technology in Education conference in New Orleans.

In Louisiana, there are 2,677 open computing jobs, but only 574 computer science college graduates to fill those jobs, and only 23 percent of high schools teach the Advanced Placement Computer Science course, according to Turner. The U.S. Census Bureau reported that women represented 27 percent of STEM workers in 2019.

“The fundamental problem we’re trying to solve here is getting women involved in STEM,” Turner added.

Now with their third cohort at LeBlanc Middle School, Turner and her co-sponsor Jordan Allen have found that the program “opens [the girls’] imagination to everything that they could do in this world.”

Their club is part of the larger Girls Who Game program created in 2019 by Dell Technologies, in partnership with Microsoft and Intel. The program provides girls in grades 4-8 an opportunity to learn about STEM through gaming. The students use Minecraft, a 3D game based on Microsoft’s popular game, which is a block-based construction and game development environment.

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Get a Very Early Start on Teaching Coding Skills. Pilot Study Suggests Trying Robotic Toys

By Lauraine Langreo

Using age-appropriate coding toys has a significant, positive impact on preschoolers’ math abilities, according to the findings of a pilot study that will be discussed at the 2022 International Society for Technology in Education conference.

Because much of the existing research on the benefits of coding on children’s development were focused on elementary-age kids, Eastern Connecticut State University professor Sudha Swaminathan decided to look into how coding impacts younger children’s development.

The small pilot study was structured as a pre- and post-assessment with coding activities as intervention. Six 4- and 5-year-olds who attend the university’s Center for Early Childhood Education played with a Bee-Bot, a robotic toy shaped like a bumblebee with forward, backward, left, and right arrow buttons, as well as “go” and “clear” buttons, on its back.

The children worked in pairs during four coding sessions with the Bee-Bot. The first coding session was an introduction to the robot so they could play around with it and see what it does, along with some guided demonstration.

In the next sessions, the play time became more intentional. First, the preschoolers had to get the Bee-Bot from point A to point B in a straight line. After that, preschoolers were introduced to turns, and then they had to get the Bee-Bot from point A to point B with obstacles in the way.

Swaminathan found that after doing just these four coding sessions, there was a statistically significant increase in the youngsters’ math abilities overall. The post-assessment found that coding exercises challenged and enhanced the preschoolers’ problem-solving skills, creativity, and determination.

The assessment had a total of 13 items, with one point for each correct answer. At the pre-assessment, the average score across all children was 7. At the post-assessment, the average increased to 9.56, which Swaminathan said is statistically significant. The children showed gains in comparing quantities, comparing lengths, copying and finishing patterns, and building shapes.

“‘There’s a lot of research in preschoolers, and my study is showing that there is value in developmentally appropriate coding exercises in preschool,” she said. “Even four sessions
are really increasing children’s math abilities.”

Another important aspect of the study is that it uses “unplugged” technology, Swaminathan said. Toys like Bee-Bot stand alone and don’t need to be used with any kind of online software. Other researchers have used computer programming in their studies, but Swaminathan’s study found that unplugged technology is also effective in enhancing children’s computational thinking.

So people who want to teach kids coding skills but are worried about excessive screen time have other options, she said.

She added that using coding toys like Bee-Bot doesn’t require a lot of professional development for teachers.

“Sometimes, people tend to worry about the use of smart toys and how that might take the thinking away from the child,” Swaminathan said. “But something like Bee-Bot, these unplugged things, they don’t do anything unless the child thinks it through and implements it. The child does all the thinking.”

The pilot study was finished in fall 2019 and the full study was supposed to start spring 2020, but the coronavirus pandemic halted those plans. Swaminathan said the full study will start spring 2023.

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How a NASA-Supported Robotics Program Is Preparing Students for STEM Careers

By Lauraine Langreo

Hawaii is trying to prepare its K-12 students to fill the massive shortages of jobs in STEM-related fields.

The Hawaii Space Grant Consortium, a community educational program supported by the National Aeronautics and Space Administration, has partnered with schools across the state to implement robotics in the classroom.

“We’re trying to build this pipeline from K-12 and eventually have the students go on to college to build robotics or satellites, and eventually, hopefully, work at NASA as engineers,” said Adria Fung, robotics engineering education specialist at the consortium, during a session at the 2022 International Society for Technology in Education conference.

Fung created a robotics curriculum that schools across the state are using to prepare students for the STEM workforce. The Hawaii Space Grant Consortium provides lesson plans, resources, and support for the teachers so that they’re easily able to implement the curriculum into their classroom.

The curriculum is based on VEX IQ robots and is aimed at grades 4 through 8. Using the robots, educators can teach students robotics engineering concepts such as gear ratios, speed, and torque.

Fung, who formerly taught at a middle school and led a robotics competition team, developed the robotics curriculum after she realized that when robotics concepts are only taught during after-school robotics clubs, then not as many students are introduced to the material and the ones who do not understand the underlying concepts of robotics as well.

“Students just want to build and test and code and refine their robots, but without any kind of concepts or knowledge,” Fung said.

Kindergarteners in North Dakota work on a robotics activity that uses Ozobots. In some Hawaii schools, students use VEX robots to learn robotics concepts and to help prepare them for STEM careers.
“There’s not a lot of teaching time after school,” she added. “So that’s why I try to use the classroom time to teach the robotics engineering concepts so they can implement it in their competition robots after school if they choose to.”

The curriculum is not just for STEM educators. It’s designed so that teachers from all subject areas will be able to implement robotics into their classrooms easily, Fung said.

“Whether they teach math, or social studies, or English, [they] can easily apply robotics into those fields,” she said.

For example, for social studies in Hawaii, students are learning about the history of voyaging and about a canoe called Hōkūle'a that traveled the world using only traditional navigation techniques.

To apply robotics into that lesson, students print out a map to learn the navigation techniques and the path the canoe took by coding a VEX 123 robot, which looks like a hockey puck and can be coded by using the buttons on top of it. Students can also model the canoe using pipe cleaners or cardboard pieces and mount it onto the robot before it makes its voyage.

“Robotics is really just a tool,” Fung said. It can be used to teach across all fields.

The study, conducted before the pandemic, was funded by a National Science Foundation grant that asked education companies to look into how technology can solve a problem in schools. But educators who were interviewed “strongly felt that you couldn’t just put in technology as a Band-Aid, that it wasn’t a stand-alone thing. It had to be integrated with everything else, with kids learning their culture, with individualized curriculum,” said lead author AnnMaria De Mars during an interview with Education Week before the conference. De Mars is the president of 7 Generation Games.

Researchers, who also included Juliana Taken Alive from the Standing Rock Tribal Department of Education, noted that the themes are connected to each other. Without highly qualified staff, schools can’t easily have a holistic STEM education or can’t easily include culture in STEM education or can’t have proper tech integration. Without funding, schools can’t hire qualified staff, schools can’t afford effective technology, and schools can’t provide curriculum materials.

To really solve the achievement gap, schools also have to solve this “spider web” of interconnected issues, the researchers said.

“At the end of the day, the priority for the educators in Indigenous communities was having a STEM curriculum that included local culture and tribal languages,” Burns Ortiz said.

“When [students] see things in context, it makes more sense to them. They memorize it better. They remember it better. They pay more attention to it,” said De Mars.

The researchers said that during interviews, some educators expressed concern that nothing practical was going to come out of the research. So the researchers, with funding from the USDA, created math games that included Indigenous culture to help students connect to what they were learning. Analysis of students’ use of the games found that students’ math scores improved significantly, De Mars said.
Around 2.6 million years ago, in the savannahs of East Africa, our earliest ancestors began crafting the first stone tools. Using fissile rocks, including quartzites and volcanic rock, they struck these “cores” with a hammer stone, allowing them to harvest sharp stone pieces they would then use to craft choppers, scrapers and cutters.

Though rudimentary by today’s standards, these Oldowan tools, named after the Olduvai Gorge in Tanzania where they were discovered, represent some of the oldest human inventions and demonstrate our inborn desire as a species to create solutions to real-world problems.

The World Needs Big Ideas

From the early agrarian civilizations that cultivated large fields to support centralized populations to today’s modern societies that benefit from advancements in medicine, manufacturing and technology, our history is one defined by continuous improvement.

This constant innovation continues to improve the standard of living for people across the world, leading to global increases in life expectancy, literacy and access to electricity, as well as decreases in child and maternal mortality.³

While these improvements have undoubtedly benefited the lives of millions of people across the world, today we continue to face serious global challenges that we must not ignore, including climate change, loss of biodiversity, widespread infectious diseases and the rapid depletion of natural resources, to name a few.⁴

The world needs big ideas, and at the National Inventors Hall of Fame® (NIHF), we believe the best way to prepare today’s children for our increasingly complex future is to help them embrace their natural creativity through invention education.

What Is Invention Education?

Invention education is an approach that taps into a student’s inborn creativity by guiding them through the act of invention to develop a mindset that helps them navigate the complexities of their lives.

In stark contrast to passive learning strategies that task students with reaching predetermined answers, invention education is instead an open-ended approach to learning that challenges youth to solve real-world problems by developing unique ideas and making their thinking visible by creating invention prototypes.


Because all NIHF education programs are developed using lessons and insights from our NIHF Inductees, our style of invention education benefits from and features the collective knowledge, wisdom and experience of some of the world’s most accomplished and impactful inventors. Our programs’ authentic hands-on activities give children the opportunity to develop an innovative mindset — a framework of essential skills and traits that emerged from taking a deep dive into interview transcripts and decades of other interactions and exchanges with Our Nation’s Greatest Innovators™.

Each word or term in a hexagon has a treasure trove of stories behind it. For example, the “Persistence” hexagon is brought to life through the stories of NIHF Inductees Marshall Jones (industrial lasers), whose motto is “Never Give Up,” and Radia Perlman (robust network routing and bridging), who speaks about being dismissed by skeptics along her invention journey. The “Entrepreneurship” hexagon is made tangible by NIHF Inductee Lonnie Johnson (Super Soaker®), who reinvested his earnings into energy invention and Eli Harari (floating gate EEPROM), who paved the way for today’s flash memory industry.

For Alaina Rutledge, vice president of education research and development at NIHF, and her team of education experts, keeping these attributes top of mind when creating new curricula is essential to our education programs’ impact, year after year.

“We believe that invention education should foster a culture of acceptance, accompanied by a well-established innovative mindset that provides a platform for participating in innovation equitably,” Rutledge said. “This mindset helps students to not only build confidence in their own abilities but also realize that everyone has the potential to innovate.”

Similar in purpose to 21st Century Skills, competencies that are helpful in preparing children for the challenges of their time, an innovative mindset represents a grouping of skills that unlock students’ potential and help them deal with challenges while navigating uncertainty and ambiguity. One of the secrets to its effectiveness: It creates an environment that promotes creativity.

Can You Teach Creativity?

It’s a fair question, and one that continues to be asked and debated among educators and policymakers alike. One pivotal study concerning creativity was conducted in 1968 by George Land, who repurposed a creativity test used by NASA to select innovative engineers and scientists. After administering the test to 1,600 5-year-olds, he gave the same test to the children at 10 and 15 years old. Finally, in 1985, Land tested 280,000 adults 25 and older using the same study.5

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<table>
<thead>
<tr>
<th>Age Group Tested</th>
<th>Number Tested</th>
<th>Year of Testing</th>
<th>Percent Who Scored in the ‘Highly Creative’ Range</th>
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</thead>
<tbody>
<tr>
<td>5-year-olds</td>
<td>1,600 children</td>
<td>1968</td>
<td>98%</td>
</tr>
<tr>
<td>10-year-olds</td>
<td>1,600 children</td>
<td>1973</td>
<td>30%</td>
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<tr>
<td>15-year-olds</td>
<td>1,600 children</td>
<td>1978</td>
<td>12%</td>
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<tr>
<td>25-plus-year-olds</td>
<td>280,000 adults</td>
<td>1985</td>
<td>2%</td>
</tr>
</tbody>
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6. Ibid.,
“We were pretty shocked,” Land said in a TEDx Tucson talk he delivered in December 2011. He went on to explain that traditional education practices were causing children to use both convergent (judgment) and divergent (generating new ideas) thinking at the same time, causing the brain to work at a significantly reduced capacity.

“What happens to these children as we educate them, is we teach them to do both kinds of thinking at the same time. So when somebody asks you to come up with new ideas, [...] what we’ve mostly learned in school is to start looking at them immediately and trying to say... ‘we’ve done that, that’s crazy, it will cost too much,’” Land said. “When you actually look at what’s happening inside the brain, you find that neurons are fighting each other and actually diminishing the power of the brain because we’re constantly judging [and] criticizing.”

Land’s findings suggest that our educational policies are teaching students, through no fault of their own, to be less creative over time. While there exist subjects and competencies that must require students to identify predetermined answers, especially when building foundational knowledge in a particular field, solving the challenges of tomorrow requires the ability to formulate new ideas.

Land’s study also tracks with our personal experiences concerning children and creativity, and when left to their own devices, are often endlessly imaginative and original. Often expressed through the act of play, when given the space and permission to express themselves, children will naturally do so.

In this way, perhaps instead of asking if creativity can be taught, instead we should be asking how we can remove the impediments that cause children to become less creative over time. NIHF’s approach to this strategy is to develop invention education programming that gives the space and permission for children to dream. Combined with age-appropriate educational standards and exposure to a diverse group of Inductees, our programming has the power to both introduce children to a variety of STEM (science, technology, engineering and mathematics) career fields and help them construct their identities as confident creators.

Much like how an inventor’s work is never finished, invention education teaches children the importance of continuous improvement and how temporary setbacks are simply part of this process.

Helping Today’s Students Become Tomorrow’s Innovators

With over 30 years of experience developing invention education solutions for school districts across the country, NIHF maintains that this approach to learning is one that prepares children for all the times in their lives when answers aren’t clear-cut or straightforward.

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Can Computer Coding Be Used to Teach Values? This Scholar Thinks So

By Rick Hess

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In the new book Beyond Coding: How Children Learn Human Values Through Programming, Tufts professor Marina Umaschi Bers argues that schools can teach computer coding in ways that develop character as well as technical skills. Umaschi Bers, the director of Tuft’s interdisciplinary DevTech Research Group, penned the book during the pandemic. She says that the disruptions of COVID-19 were a stark reminder of how vital it is that technology be approached with respect for connection, community, and generosity.

Rick: Your new book tackles a topic that may strike some readers as surprising—namely, how children learn values through computer coding. Can you explain what you have in mind?

Marina: Any time we engage in an activity, we are expressing our values. We do this knowingly or unknowingly. The activity of coding is not different. In the book, I suggest to different values—such as persistence, curiosity, and generosity—that play out while learning how to program projects that are personally meaningful to the coder. I use the metaphor of a “palette of virtues” to describe these values. The palette of virtues, much like the painter’s palette, is dynamic and can change according to context and goal. For example, by engaging children in a team coding environment, it invites them to be generous with each other through sharing technical knowledge and problem solving together, or when things in the code do not work, it creates opportunities to learn to be patient and to persevere. Learning how to code, in which problem solving is at the center of the activity, provides a wonderful opportunity to explore moral and personal values, since there are not only cognitive dimensions, but also social and emotional aspects.

Rick: How did you come to this as a focal point in your work?

Marina: My doctoral thesis, back in 2001 at the MIT Media Lab, was already focused on how new technologies could help children explore and express personal and moral values. I created Zora, a three-dimensional virtual city for children to design characters and then tell stories to those characters. Those stories and interactions were guided by personal and moral values. Over time, I realized that it is not only through a specially designed tech environment, such as Zora, that we can explore values in an intentional and purposeful way, but we can also have this sort of exploration more generally, through the activity of creating with, and through, technologies.

Rick: In the book, you draw a direct link between programming and moral growth. Can you say a bit about this link?

Marina: Playgrounds invite fantasy play and require conflict resolution with little adult supervision. In contrast to playgrounds, playpens convey a lack of freedom to experiment, lack of autonomy for exploration, lack of creative opportunities, and lack of taking risks. Playpens are confined limited spaces with few options for children to make their own choices. Although playpens are safer, playgrounds provide infinite possibilities for growth and learning. In the playground, the child learns about the social world by negotiating for their favorite toys in the sandbox, about their own emotions when they struggle to keep up with others on the monkey bars, and about moral choices and consequences when they are faced with the dilemma to wait politely for their turn on the swing or to cut the line. In the playground, the child is encountering the multiple dimensions of human development. However, she is doing it in a safe space, a place where she can make mistakes and try again. Programming languages, such as KIBO and Scratch Jr, are coding
playgrounds in which children have freedom to create projects to express their thinking and to communicate who they are and what they love. For example, they can make an interactive birthday card for mom or dad with Scratch Jr or program a KIBO robot to dance the salsa.

Rick: You suggest that it’s useful to think about coding as if students are learning a second language. What does this mean for how we think about and teach computer skills?

Marina: I propose that learning computer programming allows children to gain an alternative form of literacy that is essential in the 21st century. However, my rationale for supporting the introduction of computer science and computational thinking starting in kindergarten is not the creation of the future workforce but the future citizenry. Most people know that reading and writing are tools for interpretation and have the potential to be tools of power. Echoing Brazilian educator Paulo Freire, literacy is a tool for critical comprehension, for understanding the world, and for actively changing it. This is the same with coding. Without understanding the fundamentals of what an algorithm is and how it works, people might not understand why and how certain data is displayed and become illiterate in the information age when so much of what we consume is managed by algorithms.

Rick: In 2019, you launched the Beyond STEM program, working with kindergarten teachers and school administrators in Boston and Buenos Aires. Can you say a bit about that work and what’s ahead for it?

Marina: Through this project, we brought KIBO robots, an age-appropriate robot that can be programmed with wooden blocks instead of screens, to kindergartners and their teachers in religious and secular schools, in Buenos Aires and Boston. Together, we explored questions such as how can we teach human values through computer programming that represent both universal and particular perspectives? Can coding support character development? How does a robotics-based program not only promote the acquisition of technological skills but also help children become better citizens and human beings? Can coding serve as a bridge by providing another language to get to know others who are different from us? Teachers attending the robotics training came with different levels of KIBO knowledge, but they all left with technical skills and a palette of virtues that allowed them to bring robotics lessons to their early-childhood classrooms. Each school worked to create a story using KIBO robots that would highlight the values of their school and shared the robots with the other participating schools in their area and also with their international counterparts through a virtual portal.

In the future, we hope to continue this work by providing more opportunities—face-to-face workshops and virtual interactions—for people from different cultures and ethnicities, religions and countries, and who speak different languages to get to know each other by engaging in the shared, universal language of coding.

Rick: OK, final thought. If you had one piece of advice for educators and parents hoping to help kids engage with technology in a generous, moral fashion, what would it be?

Marina: My advice is to look at your own palette of virtues first and ask yourself these hard questions: Are your own values exercised or displayed in your use of technology? Are you consistent in what you believe is good and bad in your own behaviors? For most of us, the answer is usually “no.” For example, we care about family time, but our phone sits with us during meals. We highly value confidentiality, but we forward emails. Our children are constantly watching us, so before we worry about them, we need to look at our own behaviors. Because like it or not, we are role models. And we must be intentional about what kind of modeling we are doing.

Rick Hess is a resident scholar at the American Enterprise Institute and the director of the think tank’s Education Policy Studies.

Working With the Likes of Lego, Disney, and Lucasfilm
To Engage Students in STEM

By Rick Hess

FIRST aims to engage students in science, technology, engineering, and math (STEM) by holding robotics and building competitions sponsored by the likes of LEGO, Lucasfilm, and Disney. Launched in 1989, FIRST now partners with more than 200 companies in the Fortune 500 and has 320,000 volunteers working with 650,000 students across 110 countries. I recently had the chance to chat with Erica Newton Fessia, vice president of field operations at FIRST, about their work.

Rick: So, what is FIRST?

Erica: FIRST was founded in 1989 by Dean Kamen, the inventor of the first portable insulin pump and many other innovative medical devices, who envisioned a world where young people dream of becoming leaders in science and technology as much as they do in sports and entertainment. Our mission is to inspire that interest by engaging young people in exciting team-based research and robotics programs that build well-rounded students with STEM capabilities and complementary life skills. FIRST teams complete our annual international challenges while operating under the FIRST Core Values, which encourage high-quality work, respecting the value of others, and helping each other while competing.

Rick: FIRST has some pretty high-profile partnerships, including with Disney, LEGO, Apple, NASA, Google, and more. How did you go about partnering with these iconic brands and how do these partnerships affect the work you do?

Erica: These partnerships are key to accomplishing our mission. With demand for technology and digital literacy skills growing, industry leaders increasingly recognize the critical need to develop STEM talent and
to bring young people of all backgrounds into the workforce in order to close the STEM gap—the gap between the number of STEM jobs available and the number of those qualified to fill those roles, as well as the gender and racial gaps in STEM careers. Many of our partners also connect to our Core Values and the ways FIRST inspires collaborative, innovative, well-rounded global citizens. They see it in the talent and engagement of employees who are FIRST alumni.

With these partnerships, we’re able to expand and sustain access to STEM learning for more students. This includes providing additional scholarships and grants, providing funds for equipment, bringing our programs to new regions, and using employee volunteers to support team creation and events.

Rick: I understand you have multiple programs. Can you tell me a bit about what these are and how they work?

Erica: Essentially, our three programs are designed to engage students and build confidence in STEM at any level, and any student can get involved. FIRST LEGO League, which has three divisions by age group, is directed toward students in Pre-K through eighth grades and provides them with real-world problem-solving experiences through hands-on learning using LEGO technology. For example, this year our teams are finding new ways and places to play and stay active, so our FIRST LEGO League Explore teams in grades two through four are building and coding a LEGO Education WeDo 2.0—an award-winning LEGO kit that provides an easy-to-use programming set—to power a model of a LEGO device or robot that they designed. FIRST Tech Challenge is targeted for students in grades seven through twelve and teaches students how to design, build, program, and operate robots to compete in head-to-head challenges through an annual floor game that includes autonomous and driver-controlled elements. FIRST Robotics Competition is our flagship program for high schoolers. Larger teams of students build and operate industrial-size robots to compete in three-team alliances in an annual field game that challenges them to work together to move game pieces and earn points around a large field—it’s the only sport where every kid can go pro.

Rick: How does someone create a team for each of these programs?

Erica: Building a team is essentially the same across all programs: Recruit at least two team members and two coaches to help facilitate. We also offer “Class Pack” versions of our FIRST LEGO League and FIRST Tech Challenge programs that are designed for in-classroom learning for 30 or more students and multiple teams.

Rick: What are the costs for your participants?

Erica: FIRST believes that all kids need equitable access to opportunity, relevant mentorship, and engagement. While costs vary by program and level of participation, all costs are assumed by the team as a group. Registered teams receive access to FIRST fundraising tools and resources, including local, regional, and national grants and sponsorships provided by many corporations. Most teams’ registration costs are covered by their school and sponsors, and they may do additional community fundraising for supplies and travel fees, like many school sports and clubs. High-school-aged participants are also eligible to apply for over 80 million dollars in exclusive college scholarships that range from 500 dollars per year to four-year full-tuition scholarships, depending on the scholarship provider.

Rick: How do you all think about evaluating whether what you’re doing is successful?

Erica: We are committed to rigorously evaluating our programs to ensure we are advancing the FIRST mission. One big way we measure impact is through a rigorous longitudinal study conducted via Brandeis University on the impact of FIRST participation, which continues to show positive impacts on STEM-related interests and career paths six years after students enter our programs. Both male and female alumni declare majors in STEM at greater rates compared with their peers, with 69 percent of alumni declaring a college major in engineering or computer science by year three of college. For young women particularly, 79 percent of female alumni declare a STEM major, compared with 51 percent of their peers.

Rick: FIRST recently partnered with Disney, Lucasfilm, and the LEGO Group to host a contest in which kids use LEGO bricks to create Star Wars holiday-inspired builds. The role of these powerful brands might lead skeptics to ask whether this is just a marketing ploy. How do you think about such concerns?

Erica: Our mission is to inspire and excite kids to explore STEM-related activities. When inspiration happens, education follows. Sponsors like Disney, Lucasfilm, and the LEGO Group play a critical role in helping to broaden awareness of FIRST to new audiences and increase access to our programs around the world. During a challenging year for all of us, especially students who saw their school year disrupted in many ways, we partnered with Lucasfilm and the LEGO Group to provide a fun family activity that also encourages kids to explore their creativity and use their STEM skills such as innovation, collaboration, and the engineering design process. Storytelling with Star Wars characters and building with LEGO bricks are engaging entry points for anyone to explore creativity and innovation and develop new skills.

Rick: What advice can you offer parents who want to help their kids stay engaged and motivated while they are learning from home?

Erica: Our education director recently shared some great advice that resonated with me as a parent: Be the lead learner in your home. Especially with STEM, we may not feel confident in our own skills—but we don’t need to have the answers. Embrace what you don’t know by asking questions and exploring the answers with your kids. Show them that STEM learning and fun can be found everywhere.

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