

Using their developing coding skills, Stratford School Kindergartners explore the world with Dot and Dash.



ROBO KIDS

Bay Area students learn robotics, teamwork, and more to prepare for real-world careers.
By Julie Vallone

IN HER FRESHMAN YEAR OF HIGH SCHOOL, Yashna Bansal fell in love—not with a person, but with a robot, or more specifically, with a robotics club. It happened at her first school robotics competition. ¶ “The moment I saw the robot on the field, along with people interacting with each other and having so much fun, I wanted to be a part of that process, and be a part of the team that made that robot possible,” she recalls. ¶ Bansal, now a senior at Notre Dame, an all-girls private high school in San Jose, admits that she had no real interest in robotics when she joined her school’s club that year. She tried it out mainly at the urging of her parents and in support of a friend who didn’t want to join alone. But once she got there and experienced what it was like to build robots as part of a competitive team, she was hooked. Today, she’s the team captain.

Team captain and technical overseer of Notre Dame High School's robotics team, Yashna Bansal '17, makes some last-minute adjustments to the robot.



Bansal is one of thousands of Bay Area students—including a growing number of girls and young women—who are learning about technology and teamwork, along with other work and life skills, through robotics. As a way to strengthen science, technology, engineering and math (STEM) education, now a top priority, schools and teachers throughout the area have homed in on robotics programs. The classes and clubs are designed to help kids apply what they learn, develop new skills, and prepare them for the highly competitive job market that awaits them on graduation.

Bansal says her participation has helped her to understand the value of many math and science subjects covered in her earlier classes, bringing those concepts to life.

"In middle school, it was just about learning the facts, and applying them to tests," she recalls. "But going to a robotics competitions and seeing our robot competing on the field—life-size robots that were bigger and taller than me—was a totally different experience."

GIRLS JUST WANT TO BUILD ROBOTS

Bansal's experience exemplifies the efforts of many schools to address the gender gap by attracting more young women to STEM-based learning and related careers. There is an obvious need: While women make up 47 percent of the total U.S. workforce, according to the U.S. Bureau of Labor Statistics, they are much less represented in the fields of science and engineering.

Robots to the rescue? If not guaranteed to close the gender gap one electrode at a time, robotics participation adds a vital element of play and creativity that seems to help bridge the divide. Numbers and equations translate to programmed movement and, in some cases, speech as well. And that, in turn, offers a tangible reward to the process of problem solving.

The enticement comes at a critical time. Girls Who Code, a nonprofit focused on increasing the number of women in STEM fields, tells us that although 74 percent of young girls express enthusiasm in STEM and computer science careers, their interest declines dramatically in their teenage years. Women hold only 18 percent of college undergraduate computer science degrees and 26 percent of computing jobs after graduation. In the corporate world, they hold just 5 percent of leadership positions in the technology industry.

Educational venues appear to play a significant role in defining levels of interest. In coed schools, relatively few girls show up to take part in robotics. But at all-girls schools, there's widespread involvement. Angi Chau, director of the Bourn Idea Lab at Castilleja School in Palo Alto, says her robotics team is often surprised to realize that so many of the teams they compete against are made up of only boys. They're also surprised at comments they get along the way, especially when travelling for competitions.

"They're asked questions like 'Where are the boys?' and 'How do you get anything done?'" says Chau.

She recalls one incident in particular, when the team stopped at a restaurant and got into a conversation with the waitress. When they told her they were a robotics team, the waitress asked, "Are you the cheerleaders?"



In Nueva School's Innovation Lab, teacher Steve Westwood guides students as they design and build toys using laser cutter, 3D printer and woodshop tools.

At Notre Dame, the team started out with just about 20 students, but grew to 60 through recruitment through class visits and exhibitions.

Some girls had been hesitating to join because they hadn't yet taken STEM courses like engineering. So the Notre Dame team created a four-day summer boot camp where they gave participants simple projects to teach them skills like computer-aided design, programming and basic power tools usage. For many, it clicked. Program director Marta Carrillo says 70 percent of the girls who have participated in boot camp join the robotics team. "It's a fun environment where girls can be successful," she explains.

Yashna Bansal agrees. She believes that sometimes it's easier to girls to be more sure of their own technical skills and decisions when working with other girls.

"STEM is a very male-dominated field. Sometimes when you visit a company, all you see is guys who are doing robotics. And I know that the first time I went to the robotics competitions, I was shocked at how many teams were almost all guys; you could count the number of girls on one hand."

Why is that? Bansal has noticed that "sometimes when you're working next to a guy and you've never done something, you take a step back," she explains. "It's because they may seem overly confident, and you're unsure whether you're able to step up to the plate as well."

She adds that having a robotics team at an all-girls school fosters confidence, and creates an environment where girls can explore STEM without worrying about messing up in front of their peers. "You're surrounded by girls who have the same past experience as you, and are learning at the same rate as you are. So you are confident in making mistakes and learning from them."

At the same time, coed schools are also doing their part to inspire young women to get involved in robotics, develop confidence, and ultimately go on to pursue higher education and even a career in a STEM fields.

Annette Lane, robotics program director at coed Valley Christian High School in San Jose, says she started the school's program 14 years ago because she wanted to show students why it was important to learn math and science. "I realized that students might feel like I used to. They liked math, but also wondered where the applications were. I realized that robotics offered them a great opportunity to see how math, science and engineering could come to life."

Lane explains that her own daughter participated in STEM and robotics programs at the school from elementary to high school years. She is now at MIT getting a masters in artificial intelligence, with a focus on robotics. Last summer, she did an internship with Amazon, where she was working on drones.

Still, males dominate the Valley Christian robotics program, at least as measured by percentage. Girls represent only about 12 percent of the participants (varying with the age group and year). Lane's goal is to drive the ratio up to somewhere between 30 and 50 percent.

"We do programs and exhibitions throughout the year so girls can see what we are doing. Being an engineer myself, I can talk about it, and bring other women from the industry to promote it. But right now, (girls' participation is) not as high as I want it to be."

Carrillo's daughter at Notre Dame went through the program (before Carrillo was its coach) and is now majoring in a very chal-



In Valley Christian Schools' robotics lab, "WarriorBorgs" team member uses his machining skills to ready a robot for a competition.

lenging engineering program at college. Carrillo says the robotics team experience helped, because it was also difficult at times. Still, she remembers the fun and rewards that came with overcoming each problem. Like Bansal and Lane, Carrillo believes it's all about showing girls what women can do in STEM, and building their confidence. "It goes a long way," she says.

Robotics is projected to be a \$135 billion market by 2019, nearly double what it was in 2014.



FROM TOP: WAYNE HALL; OPPOSITE: COURTESY OF THE NUEVA SCHOOL

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EARLY STEM AND ROBOTICS LEARNING

The participation of girls and young women constitutes an important chapter in the story of STEM, and robotics training. But that by itself is not a reliable gauge of the importance of the training in many Bay Area private schools, where programs like FIRST (For Inspiration and Recognition of Science and Technology) find wide popularity.

FIRST was founded in 1989 by Dean Kamen, who created the Segway, a two-wheeled motorized personal vehicle, among many other inventions. His mission: to help young people get excited about science and technology, and experience the rewards that come from working and innovating

in these fields. FIRST programs range from Lego Leagues (using Lego Mindstorms kits) for grades 4 to 8, to the FIRST Robotics Competition (FRC), a full-on high school robotics challenge where students build life-size (or even larger-than-life-size) robots that can compete in regional and national events. FIRST events are designed to be fun as well as competitive and educational. You're apt to see students climbing over ramps, hanging from and limbo-ing under bars, or scaling a makeshift castle.

Eric Nelson, upper school robotics program director at The Harker School in San Jose explains that the FRC "is a fast-burn engineering environment where they have to go from concept to design to implementation and testing, then ship the robot to the competition, all in a six-week time frame."

Erik Mitchell, a sophomore at Valley Christian School, started working with robotics in the fifth grade, and likes the problem-solving nature of the competitions.

"The league presents a problem, and so we'll design arms and fabricate other things so the robot can get around these obstacles. I've learned how to look at these obstacles we have to traverse and fix these problems," he says.

Many teachers start laying the foundations for a STEM education at an early age. For example, Stratford School in Saratoga uses Bee-Bots, a small, toy-like programmable floor robot, to



Karthik Sundaram, grade 12, from the Harker School, works in the robot lab salvaging electrical components from a prototype system no longer in use.

introduce basic coding concepts to preschoolers. Valley Christian School in San Jose starts teaching kids design, electrical and even coding concepts in the second grade (using software and other resources specifically geared toward their age groups).

Michelle Grau, an engineering teacher at Nueva School in Hillsborough, begins preparing

young students for STEM programs by engaging them in projects that teach them a problem-solving methodology, Design Thinking, a system developed by Stanford's Institute of Design. That methodology focuses on solutions that meet the real needs of clients who will be using what the designers create.

Grau believes this kind of problem-solving starts with empathy. "It's not always the obvious thing on the surface that you think is the problem. There are a lot of developers out there who create projects that no one actually needs or wants, because they didn't actually pause to think about why a person would want what they made," she explains.

Another piece focuses on creative confidence and brainstorming. "When you talk to a kindergartener,

Women hold only 18 percent of college undergraduate computer science degrees and 26 percent of computing jobs.

they usually have no problem spewing out ideas, but by the time they get to middle school, they tend to lose that confidence," says Grau. "They'll say 'My teacher asked me to brainstorm 10 ideas; I don't have those ideas, so clearly I'm not a creative person.' We try to combat that by explaining that everyone is creative; it just may take people different amounts of time to come up with ideas."

A third part of the Design Thinking mindset involves attitude toward failure. "When that thing doesn't work, now what? Instead of just giving up on it, we ask, 'What would you do differently?' and keep pushing forward on the idea," Grau says.

Nueva, and other schools like Harker, Valley Christian, Stratford, Notre Dame and Castilja, invite kids in grades 4 to 8 to participate in the FIRST Lego Leagues, where they create robots using Lego Mindstorms kits. Last year's theme, Animal Allies, challenged kids to design robots that would do things like feed an animal, and fit a prosthesis to a pet.

At Bellarmine College Preparatory School in San Jose, middle school students participate in other competition programs run by VEX robotics. It centers its challenges around accessible and affordable robotics for kids, and invites them to compete regionally, nationally and even globally.

Once kids hit the ninth grade, they are eligible for the FIRST Robotics Competition. In these district to global events, high school teams create robots that are often big and heavy and can handle a variety of tasks, such as stacking bins and recycling litter, throwing a ball into a hoop, and scaling a "castle."

NOT JUST FOR TECHIES

Most robotics teams do a lot more than design and build robots. Usually some of the team members also like taking charge of the websites and social media, doing outreach to businesses for sponsorships and mentors, grant-writing and even handling administration.

At The Harker School, Nelson designed the program to work like a Silicon Valley startup.

"I act as the board of directors along with the other faculty," he explains. "The students elect key officers." That includes the CEO, chief technology and operations officers. Other students in the club decide which area they want to be a part of, such as software design, outreach, or promotion.

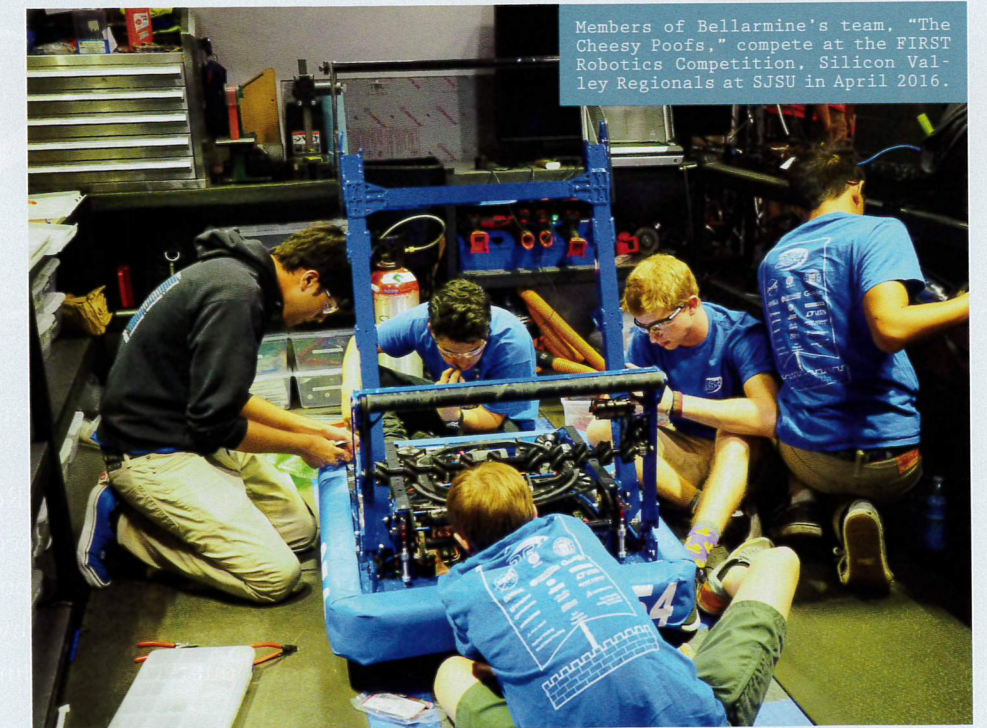
"They can go to the same cycle as a startup will go through,"

says Nelson. Sometimes they "go public" and enter competitions. "And sometimes we go 'Chapter 11,' and our robot goes down in flames in front of the students' peers. It's a very public failure when it happens, but just as they are responsible for the failures, they can take credit for the successes."

Daniela Obringer, a sophomore at Valley Christian School in San Jose, chose to get involved in the business side of the team's activities.

"You definitely get a lot of experience that you wouldn't get," she said. "It connects you with different businesses, giving you hands-on experience in the field. You learn how to negotiate and pitch ideas."

Peng Yav, who leads the robotics program at Bellarmine, says his program fills a particular niche for Bellarmine students who



Members of Bellarmine's team, "The Cheesy Poofs," compete at the FIRST Robotics Competition, Silicon Valley Regionals at SJSU in April 2016.

aren't athletes and aren't in the school's Speech and Debate club. "It gives them the opportunities to collaborate with peers who have similar interests," he says.

MENTORS HELP PREPARE STUDENTS FOR REAL-WORLD CHALLENGES

A key part of many middle and high school programs is the practice of inviting mentors to help kids with not just building their robots, but also with other aspects the project, such as budgeting and marketing.

"They get exposed to the working world, (continued on pg 104)

Castilleja's all-girls team, "Gatorbotics," construct a 120-pound robot for the FIRST Robotics Competition.



FROM TOP: MARK KOCINA/THE HARKER SCHOOL; COURTESY OF CASTILLEJA SCHOOL; PENG YAV

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and that gives them a feel for what it's like outside of school," says Yav.

Some programs also have developed relationships with well-known sponsors that provide students with other opportunities. Bellarmine, for instance, counts NASA among its sponsors. The agency provides money for equipment, along with assistance for shipping and transporting their robots. Yav says NASA is not involved in designing or building the robots, but they do give the school's students access to a lab with special machine tools.

Valley Christian School relies on sponsors like Google and NVIDIA who give them donations and other support. To approach them, students need to learn how to write a grant, showing their budgets to the companies and explaining how they plan to use it.

Many other schools also need to get sponsorships, and these are important as this activity can get pretty pricey. The costs are usually somewhere in the neighborhood of \$35,000 to \$40,000, once you factor in running the club, equipment, building the robot, competition fees, travel and other expenses.

In addition to supporting STEM education, sponsors have other motives for donating.

"Why would a company like NVIDIA or Google donate \$3,000 to a team? Because they are the ones who are going to be hiring those students four or five years from now," says Lane.

The timing of this focused effort to create tomorrow's leaders in the field is especially critical, Lane adds, and as a former engineer at IBM, she's in a position to know. The United States has been having trouble finding people for STEM jobs, she says. Companies have had to look to other countries for people to fill these jobs. She and other coaches hope that robotics programs will inspire their students to pursue STEM careers, and meet the industry needs. According to International Data Corporation, robotics is projected to be a \$135 billion market by 2019, nearly double what it was in 2014, and it is set to grow at a rate of 17 percent a year.

Whether male or female, the participants in these robotics training programs will have a marked advantage in pursuing STEM opportunities in an evolving technological era where their skills and training will be recognized and rewarded. ■