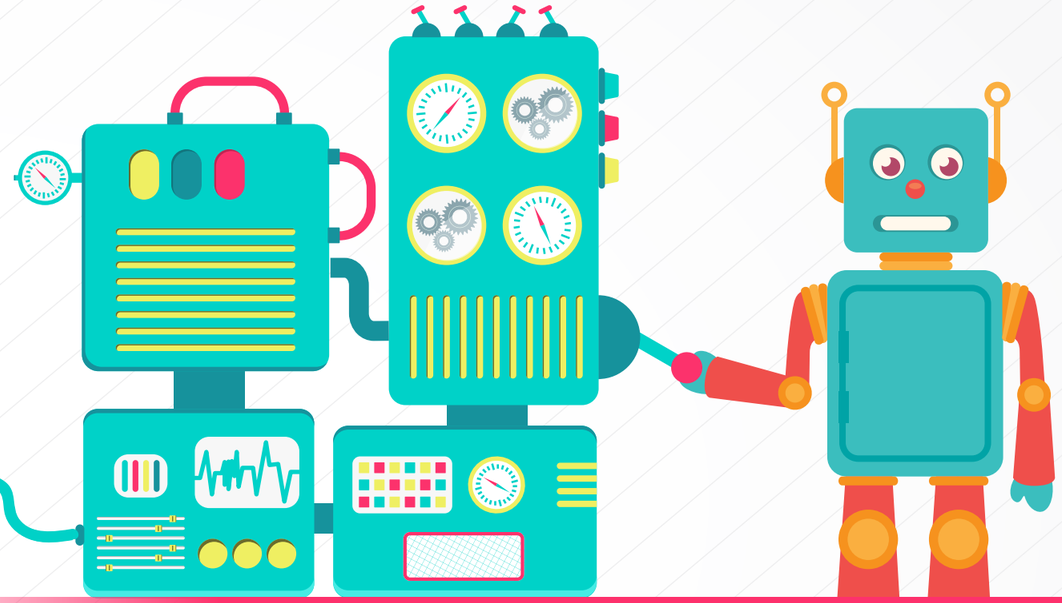
ROBOTICS CAMPS PROVIDE A

STEM-ULATING

EXPERIENCE

By Marilyn Barger and Marie Boyette



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Carefully crafted robotics camps provide a number of benefits and advantages for students who attend. For those new to science, technology, engineering and math (STEM), robotics camps may spark an interest that starts them on STEM education and career pathways. For those already interested in STEM fields, these camps encourage them to continue selecting and enjoying STEM curriculum as they advance through school and into college and careers. What's more, students working hands-on with robots have the opportunity to experience a team-based learning environment, as well as get an introduction to authentic engineering processes through problem-based learning.

At Florida Advanced Technology Center's (FLATE's) robotics camps, we aim to accomplish these goals: giving participants as authentic an experience as possible, while fostering their interest in STEM. The beginner camps introduce students to robotics, and our intermediate and advanced robotics camps give students with previous robotics experience an opportunity to advance their skills. High school camps and camps offered to special populations (e.g., all-girls camps) extend the reach of the traditional summer robotics camp for increased community impact.

Since 2005, FLATE's robotics summer camps have provided a unique experience in advanced technology education for 970 campers in 47 summer camps. These camps serve as a model and provide resources for other Florida high-tech camps. A signature feature of FLATE's robotics camps for all levels are the "Made in Florida" tours, which have an emphasis on advanced manufacturing. These high-tech industry tours include presentations and activities, have provided a national model for Manufacturing Day,[1] and are a best practice for introducing students to technical careers (Cox & Pierce, 2014).

Introductory Robotics Camps

FLATE's summer robotics camps, which start at the middle school level, are often participants' first exposure to robotics. Other introductory-level participants may come to camp having had some interaction with robots through informal experiences, older siblings or through school or after-school programs.

In order to effectively hook students and engage their interest in STEM using robots, it's important to make the camp experience fun, varied and relevant. Our philosophy is simple:

> Technology is more fun when you actually know what is going on. FLATE's emphasis on the technology and engineering (T&E) side of sTEm is revealed in the components of the camp's STEM activities: The camp's "tool" is robotics, its "toy" is the LEGO® MINDSTORMS® robot, and its "trick" is to dissolve the robots into an environment where the technology is the star, and seeing the results of their own engineering decisions is the reason campers are having fun (Barger, Gilbert, & Boyette, 2011).

The reach and scope of robotics summer camps, as well as robotics after-school clubs and competitions, are growing. Why? Because kids love robots! And when students ask to be a part of an activity that teaches not only STEM curriculum, but also emphasizes learning and teamwork, parents love robots too. Over the past five years, of the more than 200 parents who took FLATE's satisfaction surveys administered at the end of each camp, 96.2 percent were "very satisfied" or "extremely satisfied" with the camp and would recommend the experience to others.

Exposure to robotics and high-tech careers at an early age has the potential benefit of helping to prepare a highly skilled workforce for advanced manufacturing industries. In many cases, students are unaware of the interesting high-tech and well-paid jobs in fields like advanced manufacturing. And when they go on the industry tours and see the robots in action in a high-tech environment, their awareness of and their interest in the options grows. In a post-camp survey, participants' awareness of advanced manufacturing career options saw a +108% positive change (Table 1).

Seeing robots in action in a modern advanced manufacturing facility is an important aspect of an effective and impactful robotics camp.

Intermediate and Advanced Robotics Camps

Beyond the introductory level, early experiences in robotics camps can also exert a positive influence on students' academic pursuit of STEM and technical career pathways. Additionally, these experiences

TABLE 1. 2012–14 PRE- AND POST-CAMP SURVEY RESPONSES

n=510 (Pre-camp Survey), n=488 (Post-camp Survey)

General Scale for Surveys (Response terms may vary slightly among questions):
1=Not at All 2=A Little 3=Somewhat 4=Very 5=Extremely

PRE-CAMP SURVEY QUESTIONS	1	2	3	4	5	TOTAL
1. Please rate your awareness of career options in advanced manufacturing.	53	130	173	114	40	510
2. Please rate your interest in a career in advanced manufacturing.	37	131	163	123	56	510
3. Please rate how realistic you feel careers in advanced manufacturing are for women.	15	43	190	142	120	510
4. Please rate your familiarity with STEM courses needed in middle and high school in order to prepare for careers in engineering and advanced technology college programs.	56	109	146	129	70	510
5. How likely are you to take a course in engineering, technology or robotics in school next year?	38	78	99	129	166	510
6. I've been considering a career in advanced manufacturing or related technical industries.	21	52	212	135	90	510

POST-CAMP SURVEY QUESTIONS	1	2	3	4	5	TOTAL
1. Please rate your awareness of career options in advanced manufacturing.	11	23	133	190	131	488
2. Please rate your interest in a career in advanced manufacturing.	28	88	182	102	88	488
3. Please rate how realistic you feel careers in advanced manufacturing are for women.	8	21	144	140	175	488
4. Please rate your familiarity with STEM courses needed in middle and high school in order to prepare for careers in engineering and advanced technology college programs.	28	39	120	145	156	488
5. How likely are you to take a course in engineering, technology or robotics in school next year?	26	49	97	106	210	488
6. I am now considering a career in advanced manufacturing or related technical industries.	21	48	162	155	102	488
7. The camp helped me better understand how STEM concepts are used in industry.	1	9	51	197	230	488
8. The field trip helped me make the connection between the camp activities and real-world applications.	5	9	88	219	167	488
9. Learning to program the robot by thinking logically will help me when solving other problems in STEM subjects in school.	4	14	89	216	165	488

promote interest in postsecondary education in technical subjects like automation and advanced manufacturing. While robotics activities may provide a hook for students and encourage enrollment in STEM subjects, FLATE has gathered data from parents indicating that these activities and the associated high-tech curriculum options are often not offered as part of traditional middle and secondary school curriculum outside of STEM magnet schools and engineering career academies.

Therefore, early exposure to robotics through activities such as summer camps can help secondary students explore next steps in regard to careers in high-tech industries. Learning, coupled with hands-on activities and applications with robots, helps put practical meaning behind STEM school curriculum. In post-camp surveys collected from 488 students, the camp experience helped 87.5 percent of surveyed students better understand how STEM concepts are used in industry, and 78 percent of students surveyed expressed that learning to program the robot by thinking logically will be "very" or "extremely" helpful when solving other problems in STEM subjects in school (Table 1).

Also shown in Table 1 are the positive gains made in the following areas:

- perceptions of how realistic students feel careers in advanced manufacturing are for women (64.5 percent)
- likelihood of taking a course in engineering, technology or robotics in school next year (64.8 percent)
- interest in a career in advanced manufacturing (38.9 percent)

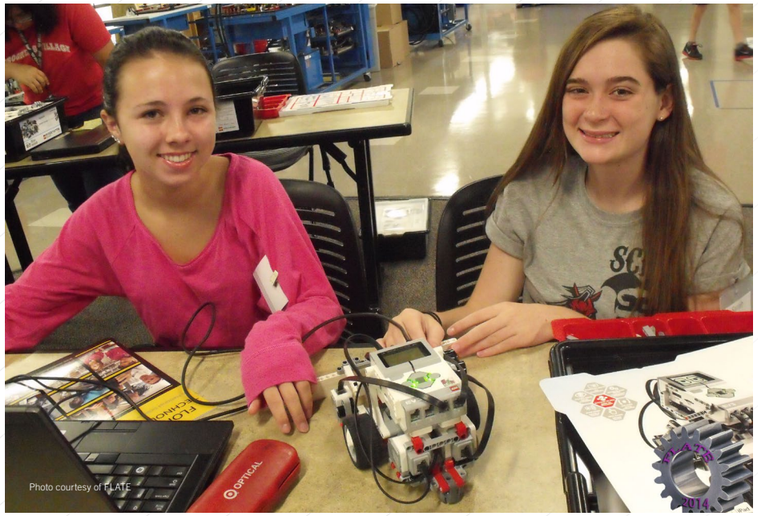
High School and Special Camp Initiatives

To help in postsecondary recruitment, high school-level camps include, in addition to robotics, an introduction to local colleges' Engineering Technology (ET) high-tech labs, deeper exploration of advanced manufacturing careers and student activities that introduce equipment used in high-tech industries, such as programmable logic controllers and industrial robotic arms.

Inspired by the interest in advanced manufacturing expressed by students at high school week-long summer robotics camps, in 2014 FLATE developed a one-day summer camp-style student event which can take place during the school year or during the summer.

Like FLATE's summer camp model, the one-day camp experience is easily duplicated by other community and state colleges with high-tech labs to help raise awareness about advanced manufacturing postsecondary and career options. And just as with the week-long camps, students visiting high-tech college lab facilities during the one-day camps receive information about advanced manufacturing college and career programs, and are given the opportunity to become acquainted with the equipment used in automated processes in advanced manufacturing.

Another special camp initiative is the all-girls camps. By making a place for girls to learn in a same-sex environment, as well as through the generous scholarship support of local donors, the percentage of girls attending FLATE summer robotics camps is currently 28.7 percent of total camp attendees. This is significantly higher than the 15–16 percent of girls enrolled in Florida high school career academies and technical programs.



Programming robots in summer camps promotes STEM activities and learning for girls.

Girls test their robotics programming skills at FLATE's all-girls robotics camp.

FLATE, as part of its National Science Foundation Advanced Technical Education Center (NSF-ATE) mission, has developed a range of services in support of high-tech summer camp initiatives across the state (Barger, Boyette, & Gula, 2013). Partner camps have been offered by Dream It. Do It., Institute for Human and Machine Cognition, CareerSource Pinellas, Florida Gateway College, College of Central Florida and Palm Beach State College, along with Citrus, Duval, Escambia and Sarasota County schools. In 2014 alone, FLATE's summer camp model inspired 15 advanced manufacturing and STEM robotics and high-tech camps across the state, with strong positive feedback from camp directors.

Conclusion

Extending the summer camp experience by including robotics in technical programs during the school year can mean ongoing STEM applications, increased awareness and integrated learning experiences for students. For this to happen, teachers themselves should be introduced to robotics experiences and curriculum, as well as have access to hands-on technical learning opportunities.

Robotics summer camps equip students with direct technology and engineering applications for math and science curriculum, as well as the opportunity to put theory into practice through hands-on learning. They provide an effective jump start down a pathway toward STEM courses in college and careers. Awareness of and a commitment to advanced technology education is critical to building education programs that will supply tomorrow's high-tech workforce. We must all be committed—education providers, parents and community partners. Tech

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REFERENCES

Barger, M., Gilbert, R., & Boyette, M. (2011). Proceedings from the American Society of Engineering Education Annual Conference: *Best practices for student robotics camps.* Vancouver, B.C., Canada: Authors.

Barger, M., Boyette, M., & Gula, D. (2013). *Robotics camp survival guide: A FLATE best practices guide.* Retrieved from **http://fl-ate.org/wp-content/uploads/2015/02/Robotics-Camp-Guide-082213-EW.pdf**

Cox, E. D., & Pierce, K. B. (2014). Presentation handout at the Florida Association for Career and Technical Education (FACTE) 48th Annual Conference: *How does participation in middle school technology education and STEM-related career and technical education (CTE) courses impact student achievement in science, mathematics, and reading?* Wesley Chapel, FL: Authors.

ENDNOTE

1. Manufacturing Day℠ is a celebration of modern manufacturing meant to inspire the next generation of manufacturers. Although Manufacturing Day officially occurs on the first Friday in October … any day can be a Manufacturing Day. Retrieved from http://www.mfgday.com/