Using Robotics as a Tool to Engage Students in Technical Curriculum

Presented by
Deshjuana Bagley
FLATE Outreach Manager

NSF-ATE Center of Excellence at
Hillsborough Community College

Impact Florida. Lead Nationally.

FLATE

www.fl-ate.org
www.madeinflorida.org

NSF Advanced Technological Education

ATE CENTERS

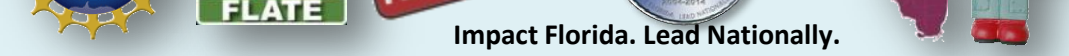
www.atecenters.org

Partners with Industry for a new American Workforce

FLATE VISION

FLATE will be Florida's leading resource for education and training expertise, leadership, projects, and services to promote and support the workforce in the high performance production and manufacturing community.

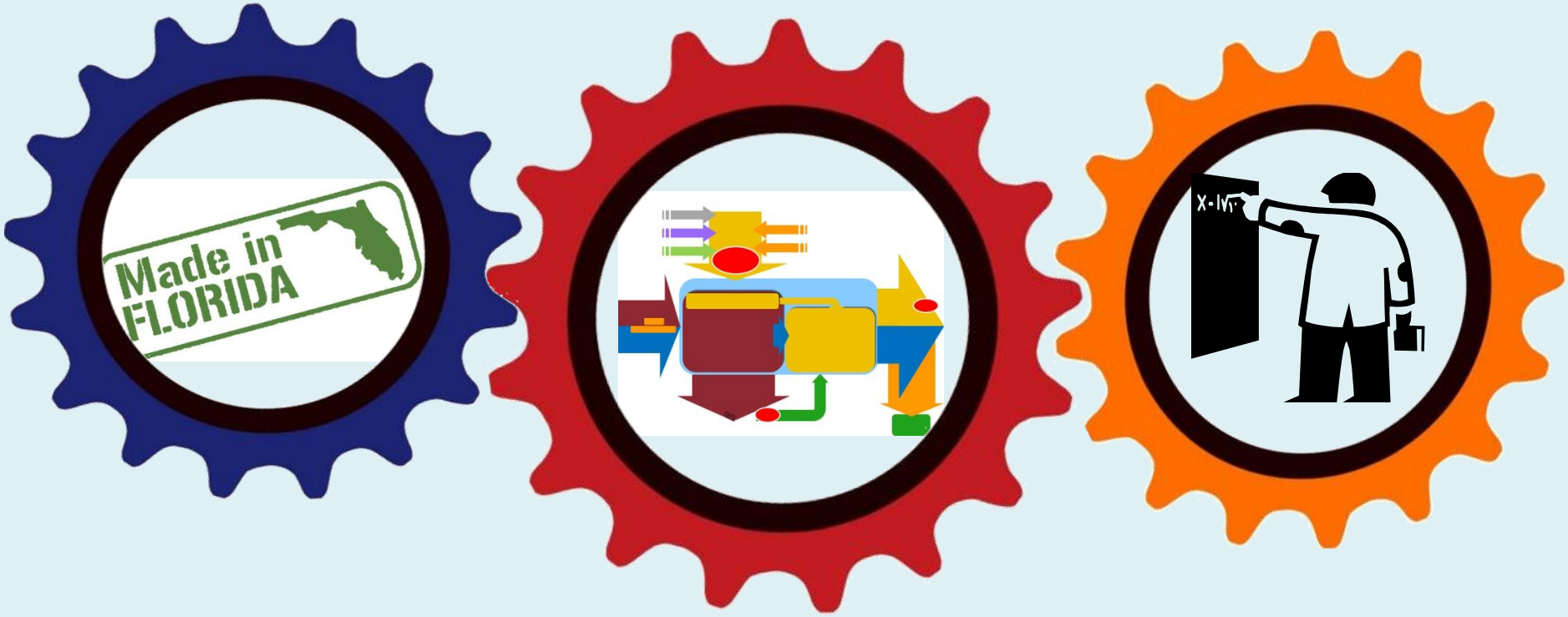
Impact locally. Lead nationally.



FLATE

www.fl-ate.org
www.madeinflorida.org

Outreach ◆ Curriculum ◆ Professional Development



Tell | **Teach** | **Train**

Advancing Excellence in Engineering Technologies

Impact Florida. Lead Nationally.

FLATE

www.fl-ate.org
www.madeinflorida.org

Using Robotics as a Tool to Engage Students in Technical Curriculum

This session will:

- give alarming data regarding the diminishing retention rate of high school students and undergraduates in STEM majors and careers
- demonstrate curriculum integration strategies that educators can implement using robotics “as a hook” which will encourage students to confidently pursue STEM majors and technical career pathways
- explain how “hands-on” project based learning activities using robotics can provide direct applications of math and science which positively influence students’ retention in STEM academic and career pursuits
- explore the role of robotics extracurricular activities, camps, and competitions to go one step further in influencing students to choose STEM majors and careers

FLATE

www.fl-ate.org
www.madeinflorida.org

STEM Career-Pathway Needs

United States will have 8,654,000 U.S. STEM jobs in 2018 and will need highly skilled workers to remain globally competitive

Students need exposure to STEM majors and careers through curriculum integration and mentoring

Educators need professional development to deliver transformative , project-based STEM lessons

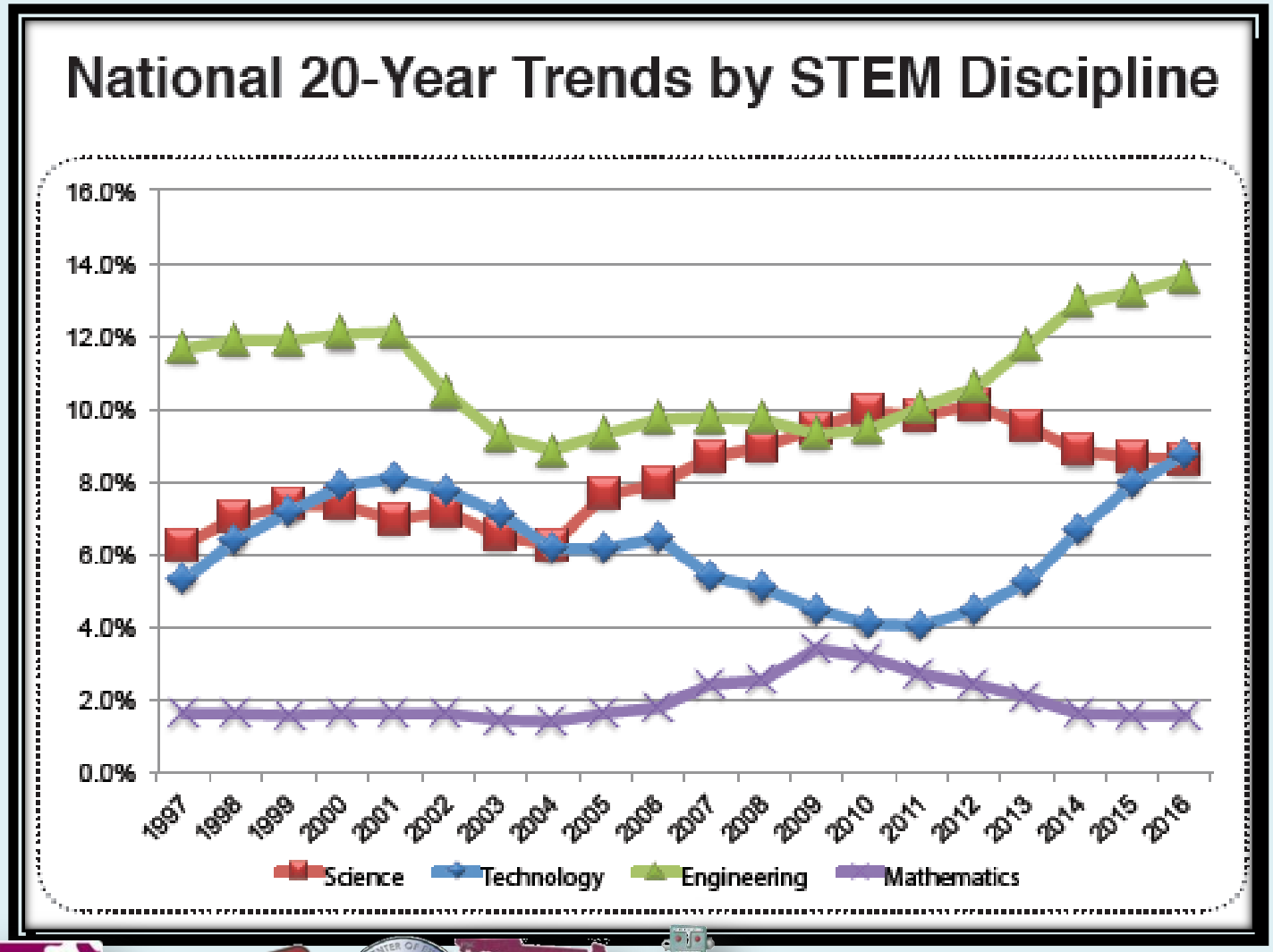
Students need interactive and relevant learning experiences which provide hands-on application to real-world problems

Impact Florida. Lead Nationally.

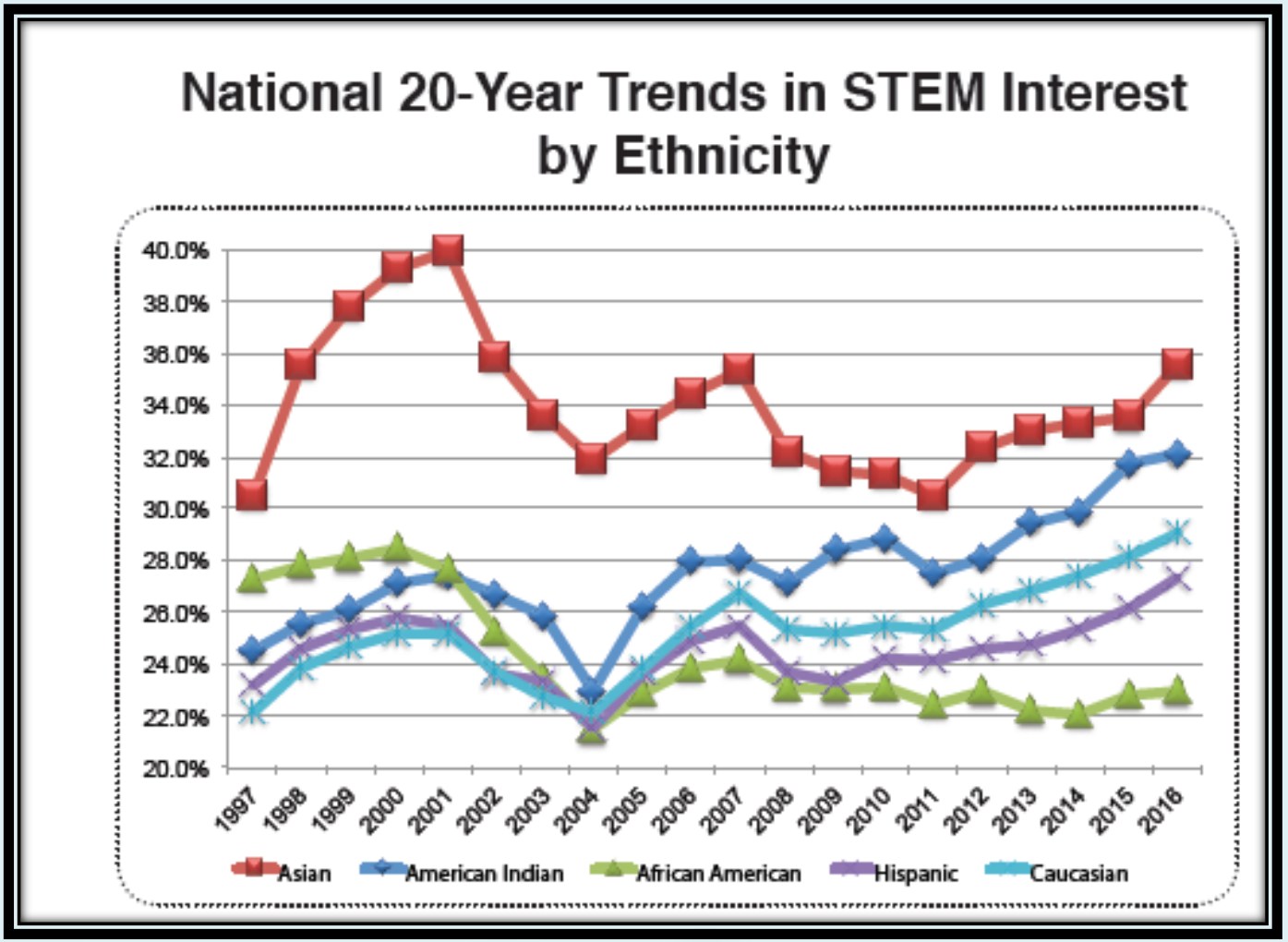
FLATE

www.fl-ate.org
www.madeinflorida.org

Good News – Bad News for STEM



Good News – Bad News for STEM



Impact Florida. Lead Nationally.

FLATE

www.fl-ate.org
www.madeinflorida.org

STEM Students – STEM Jobs

Manufacturing employers continue to need high skilled technicians

By 2016,

40% of all new jobs will require STEM education or training

To remain globally competitive, the United States must educate or train employees to fill the STEM jobs

28% of all high school freshman declare an interest in STEM majors and careers

57% of those students change their minds by the time they graduate from high school

Mentors provide real experience for students outside of the realm classroom time

Dual enrollment among high school CTE programs increasing

40% of Engineering majors will change majors or drop out of college

Transforming the freshman college experience from lecture-based to project-based increases retention among engineering college students

MyCollegeOptions and STEMconnector

How do robots lead students to STEM Career Pathways

- Ability to integrate robotics activities into curriculum
- Creative thinking, situation analysis, critical thinking and problem solving applied to real-world problems
- Teamwork and communication skills are enhanced
- Students learn to make mistakes and then find solutions
- Use logical thinking to learn computer programming
- Robots can be used to demonstrate complex concepts
- Robots are FUN!!

Types of Robots used in Education

BoeBot
(Parallax®)

Baxter

Arduino®

PLCs &
Robotic Arms
(Industrial)

LEGO®
Mindstorms®

NAO

VEX®

Using Robotics as a Hook for STEM Career Pathways

Increase students general **interest** in STEM

Pre-K – 3rd

Increase students **confidence** in STEM

4th – 7th

Increase students **pursuit** of STEM majors or certificates

8th – 12th

Increase students ability to apply theoretical **knowledge** to practical career needs

Postsecondary

Impact Florida. Lead Nationally.

FLATE

www.fl-ate.org
www.madeinflorida.org

Robotics for Pre-K thru 3rd Grade

- Early exposure to robotics
- Guest speakers
- Classroom robotics activities
- Robotics camps and workshops
- Increases interest and confidence

Video Link:
https://www.youtube.com/watch?v=9W5EA5vN6ik

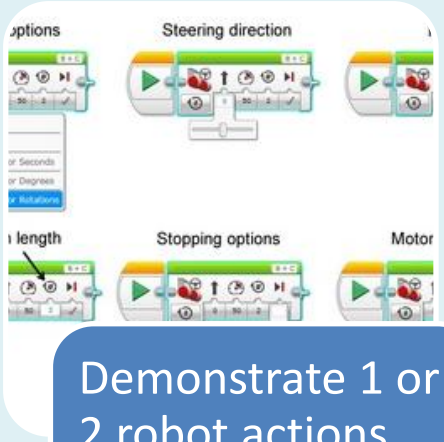
Classroom Robotics for 4th – 7th Grade

- Alignment with state standards and frameworks
- Introduction to planning, designing, and testing
- Learn to use motors, sensors, and programming languages
- Develop challenges for testing, troubleshooting, and refining

Classroom Integration of Robotics Example: Day 1 of Two Days

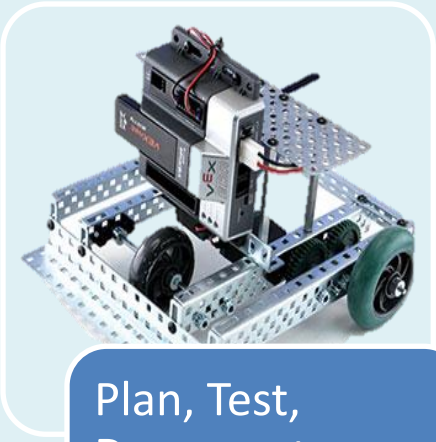
Bell Work

- Build a simple robot
- Follow the instructions
- Communicate and collaborate with your partner



Demonstrate 1 or 2 robot actions

- You show a step
- Have the students repeat the step
- Follow the leader type of lesson



Plan, Test, Document

- Make a plan
- Test the plan
- Document the results

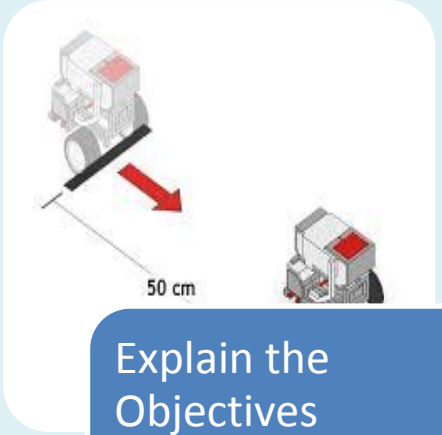
Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org

Classroom Integration of Robotics Example: Day 2 of Two Days

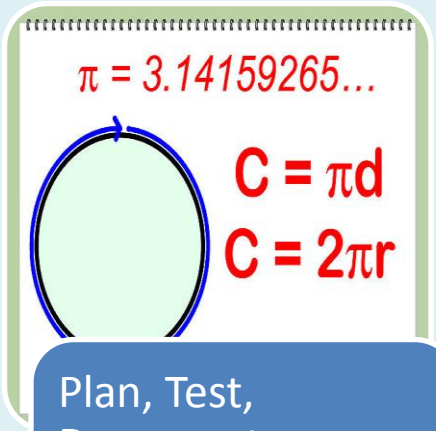
Bell Work

- How will the tires spin?
- How far will they go?
- How can I measure it?



Explain the Objectives

- Understand the relationship between wheels and motors
- Learn how to measure distance travelled



Plan, Test, Document

- After the testing students should document their efforts
- Introduce the math or science principles

Align Robotics Activities to Standards/Frameworks

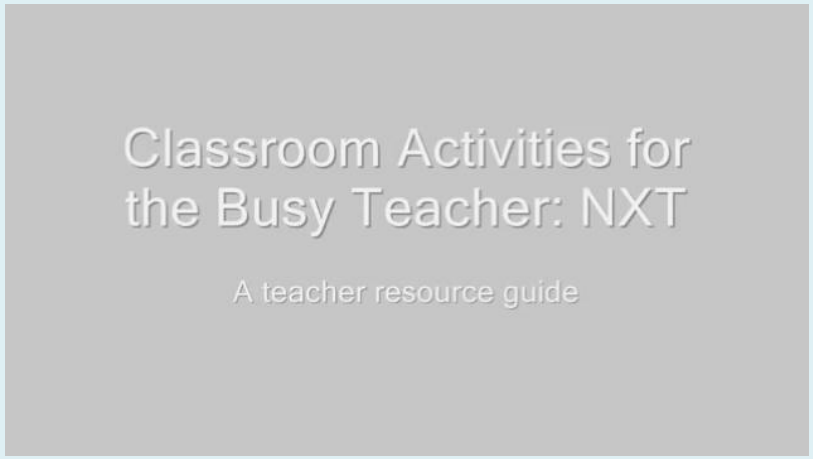
Math	Science	Technology	Communication & Writing
• Diameter • Circumference • Angles • Graphs and tables • Linear relationships • Scaling and models • Ratios & proportions • Unit conversions • Averages • Boolean logic • Spatial reasoning • Patterns	• Hypothesis & evidence • Experimental design • Observations & predictions • Data analysis & acquisition • Measurement • Error analysis • Amplitude and frequency • Light and reflectivity • Color and perception • Spatial graph model • Ultrasonic waves • Speed, distance & power	• Purpose of technology • Technology relationships • Systems • Design tradeoffs • Troubleshooting • Sensors • Performance • Boundaries • Mechanical elements • Controls • Computer Programming	• Brainstorming solutions • Reasoning with evidence • Explanatory composition • Documenting processes

Great FREE Resources for VEX® and LEGO® Mindstorms ®

- http://www.education.rec.ri.cmu.edu/products/teaching_robotc_cortex/
- http://www.youtube.com/watch?v=MOJ7lppnEiA
- http://www.stemcentric.com/
- http://www.nxtprograms.com/
- http://www.legoengineering.com/
- http://drgraeme.net/
- http://www.damienkee.com

Examples of Robotics Integration for 4th – 7th grade students

- Use open ended projects that fit academic standards
- Review various solutions at the end of the project
- Reflect on the math and science involved



Video Link:
https://www.youtube.com/watch?feature=player_embedded&v=HnTh5haK7ZU

Robotics Integration for 8th – 12th grade students

- Introduce connections between science and math theory with industry application through field trips and relevant robotics projects
- Introduce tools, resources, and vocabulary used in industry
- Ask industry professionals to speak to your class or to mentor a robots club or team

Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org

Industry Connections Using Robotics

Robotics Language	Industry Language
Motors, Lights, Speakers	Actuators
Sensors	Feedback Control
Variables	System Monitoring
Graphical / Icon-based Languages	Object Oriented Languages

LEGO mindstorms education EV3

2014 ROBOTICS CAMPS

All NEW EV3 Robots!

Middle School & High School Camps
Monday – Friday 8am to 4pm
Weekly Camp Costs: $175
T-Shirt, Curriculum, & Supplies provided

Jun 16-20	Intro EV3 Robotics Camp – Middle School - GIRLS **ONLY**
Jun 23-27	Intro EV3 Robotics Camp – Middle School
Jul 7-11	Intro EV3 Robotics Camp – Middle School
Jul 14-18	Intermediate* EV3 Robotics Camp (A) – Middle School
Jul 21-25	Intermediate * EV3 Robotics Camp (B) – Middle School
July 28-Aug. 1	Robotics and Engineering Camp - High School **ONLY**

FLATE Robotics Camp Location:
Hillsborough Community College - Brandon Campus
10414 E. Columbus Drive; Tampa, FL 33619
Student Services Building 2nd Floor

For More Information Contact:
FLATE Outreach Manager, Desh Bagley
Email: camps@fl-ate.org
Phone: (813) 253.7838
Web: www.fl-ate.org/projects/camps.html

The Summer Robotics Camps are being conducted through a partnership between the Florida Advanced Technological Education Center and Hillsborough Community College.

INTRO CAMP
no experience required

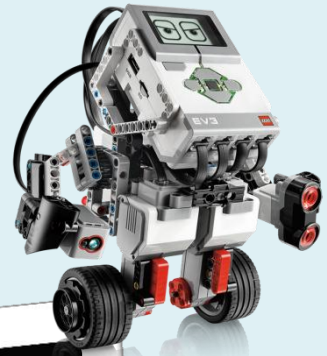
INTERMEDIATE*
Sessions A & B
requires experience

- Build and program the all new Lego® EV3 Mindstorms® Robot system
- Participate in team challenges
- Tour an Advanced Manufacturing Facility
- Learn about the science, technology, engineering & math used in today's high-tech industries

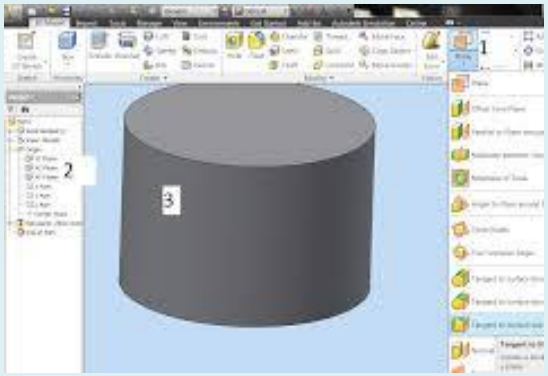
HIGH SCHOOL ROBOTICS & ENGINEERING CAMP
no experience required

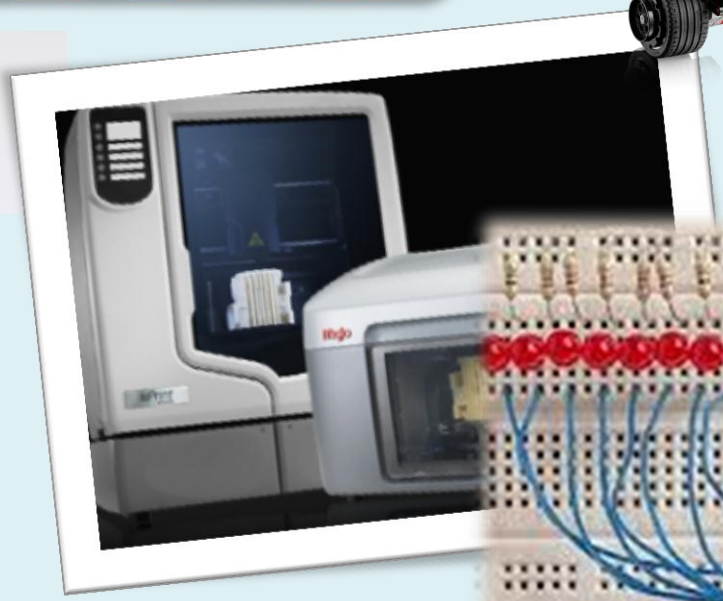
- Solve Lego® Mindstorms® EV3 Robotics challenges through original robot design, construction and programming
- Tour an Advanced Manufacturing Facility
- Hands on CAD Design and demonstration of 3D Printing
- Program NAO Humanoid Robot

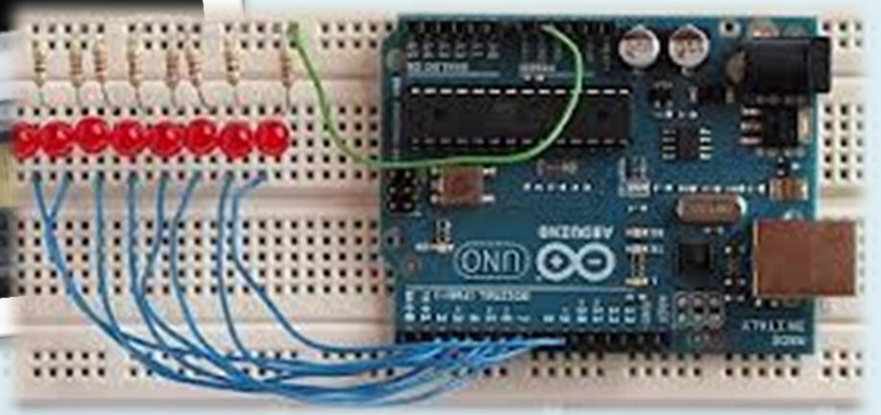
FLATE High School Robotics and Engineering Summer Camp



AUTODESK INVENTOR



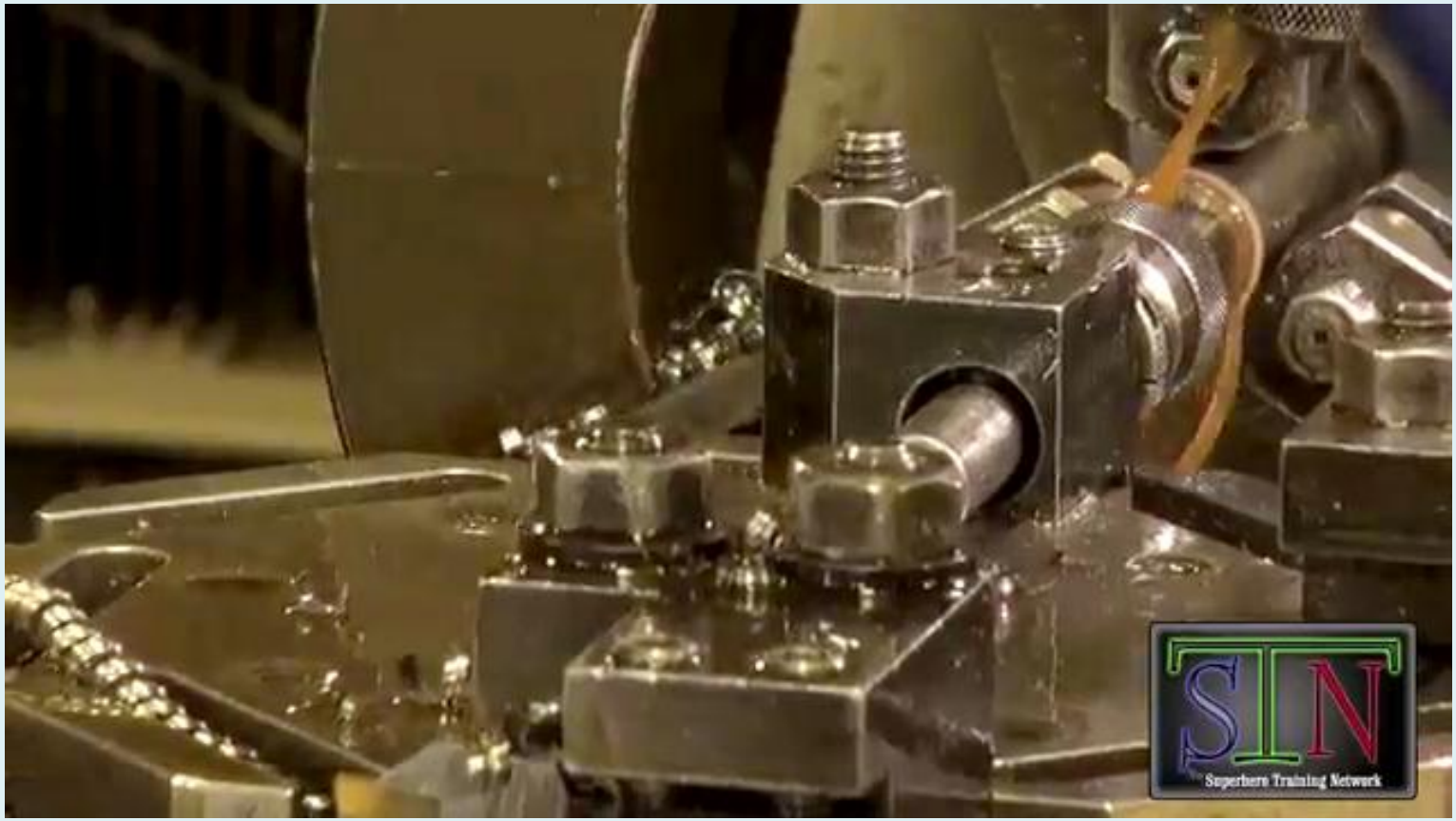




Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org

FLATE Robotics Camps Video



https://www.youtube.com/watch?feature=player_embedded&v=HnTh5haK7ZU

Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org

FLATE Robotics Camps Survey for 9th – 12th grade students

FLATE High School Robotics and Engineering 2014 Camp		
Survey Questions	Pre-Camp	Post-Camp
Please rate your awareness of career options in advanced manufacturing	2.9	4.4
Please rank you interest in a career in advanced manufacturing	2.9	3.6
Please rate how realistic you feel careers in advanced manufacturing are for women	4.0	4.4
Please rate your familiarity with the Engineering Technology A.S. degree	2.2	3.5

Responses Range from 1 to 5 with **1 being Not** Aware at all and 5 being **Extremely Aware**

Total number of campers: 28

Total number of surveys: 22

Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org

Robotics Competitions Impact Technical Career Pathways

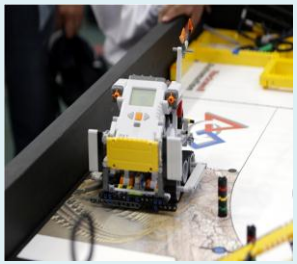
FIRST® LEGO® League

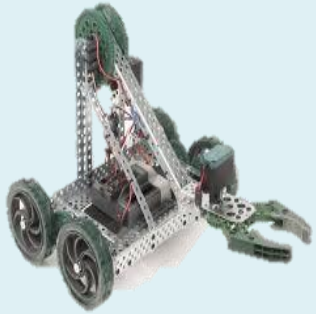
Grades 3 - 8

- Mentoring Relationships
- Real Life Experiences
- Internships & Apprenticeships

FIRST® Tech Challenge

Grades 7 - 12





FIRST® Robotics Competition

Grades 9 -12

MATE

Grades 9 -12

RoboCup

Grades 9 -12

VEX ROBOTICS COMPETITION

Grades 6 -12

NATIONAL ROBOTICS LEAGUE

NW ALABAMA BEST Boosting Engineering, Science & Technology Robotics Competition

RoboFEST

VEX Robotics Comparison of STEM Interest by Gender

Table 6. Student Comparisons on STEM Interest Items by Gender

Participating in the VEX Robotics Competition has made me		Strongly Agree	Agree
more interested in taking additional math or science classes in high school	Males	41.6%	33.3%
		74.9%	
	Females	45.6%	32.9%
		78.5%	
more interested in taking math or science classes in college	Males	44.7%	35.2%
		79.9%	
	Females	39.2%	36.7%
		75.9%	
more interested in taking engineering classes in college	Males	60.6%	25.7%
		86.3%	
	Females	44.3%	29.1%
		73.4%	
more interested in having a job in a STEM or computer field	Males	65.1%	25.7%
		90.8%	
	Females	54.4%	24.1%
		78.5%	

Example of Robotics Team Mentorship and Teamwork

Video Link: https://www.youtube.com/watch?v=DdSlXz1Ddbo

Impact Florida. Lead Nationally.

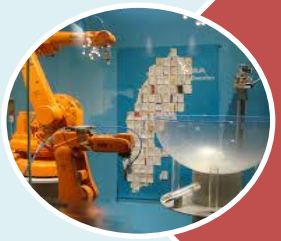
www.fl-ate.org
www.madeinflorida.org

FIRST® Robotics Impacts STEM Career Pathways

74% of the FRC alumni continued pursuing STEM either in college, working internships, or working full time

For the 89% of respondents who went on to college, 51% reported taking at least one engineering course

60% said they had at least one work experience that was science or technology related



46% of African-American and 53% of Hispanic respondents took engineering courses

Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org

SCANS Workforce Competencies

Competencies				
Resources	Interpersonal	Information	Systems	Technology

Foundation / Fundamentals		
Personal Qualities	Thinking Skills	Basic Skills

Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org

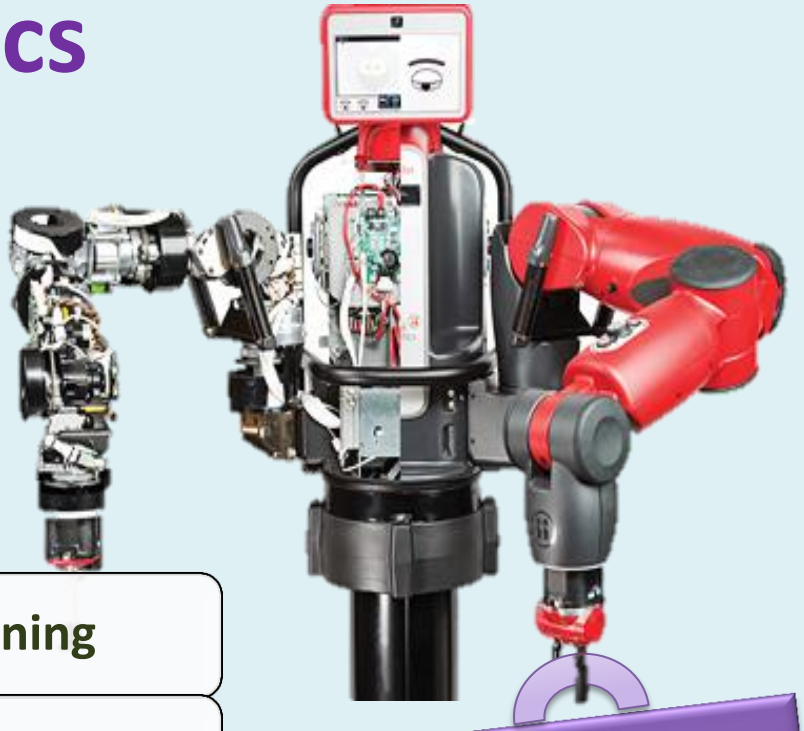
Undergraduates Leave STEM Majors

- Many STEM freshmen **wash out** as they wade through a blizzard of calculus, physics and chemistry in lecture halls with hundreds of other students

- 40 percent of students planning engineering and science majors **end up switching** to other subjects or failing to get any degree at all

- In September 2011, the Association of American Universities encouraged faculty members in the STEM fields to **use more interactive teaching techniques**.

Collegiate Use of Robotics for Retention in STEM & Technical Career Pathways



- Project Based Learning
- Dual Enrollment
- Internships / Apprenticeships
- Real-world Applications
- Creative Problem-solving

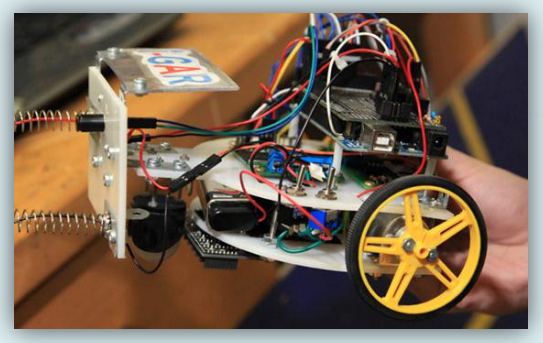
2-year degree + certifications in technical career

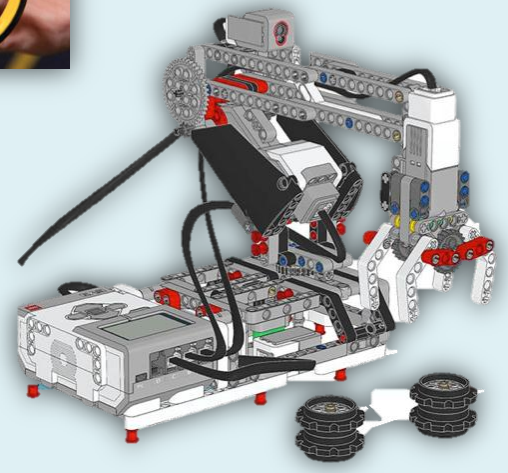
Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org

Robotics Topics Featured in Undergraduate STEM Courses

- Robot Manipulators
- Mobile Manipulators
- Controllers
- Vision Systems
- Programmable Logic Controllers
- Mechatronics





Undergraduate Recommendations for Retaining STEM Students

- Encourage high school seniors (of all interests) to enroll in **dual-enrollment** robotics courses
- Organize **2+2 year STEM programs** to retain STEM majors
- Use robotics to **demonstrate complex theoretical topics** during freshman and sophomore years
- Use robotics to **introduce students to industry problems** involving real-time systems, feedback control, and data acquisition
- Robotics **open house** public events at local college

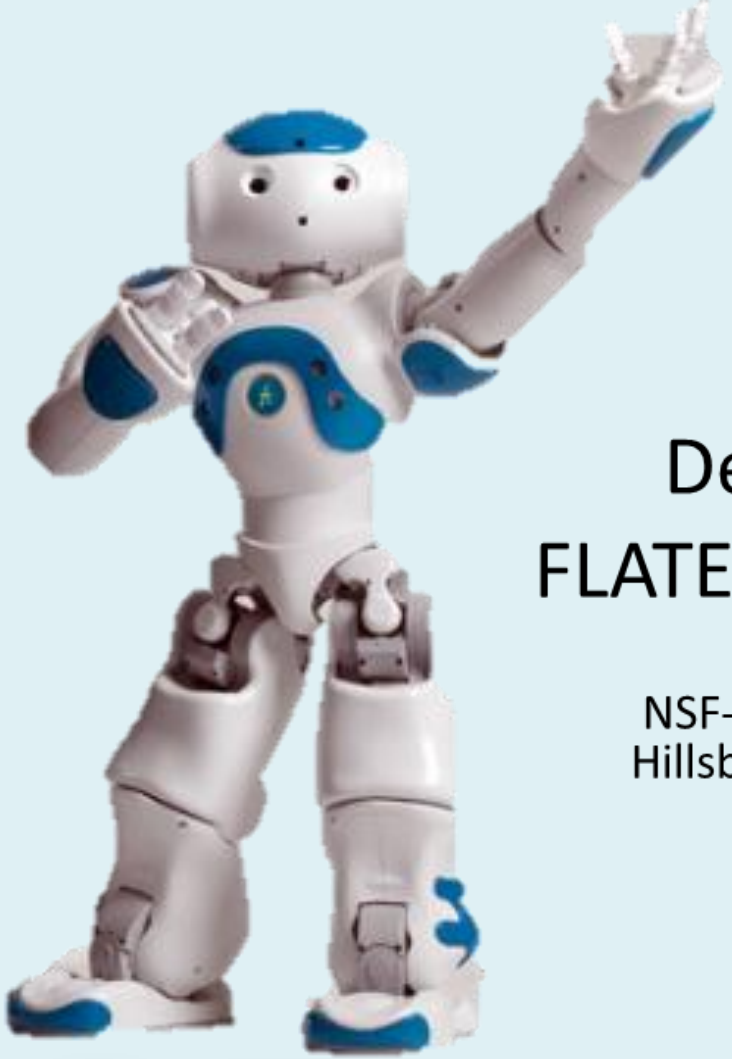
Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org

FLATE Robotics Open House at Hillsborough Community College

Video Link:
https://www.youtube.com/watch?v=9W5EA5vN6ik

Thank you



Presented by
Deshjuana Bagley
FLATE Outreach Manager

NSF-ATE Center of Excellence at
Hillsborough Community College

dbagley5@hccfl.edu
(813) 453.8612

Impact Florida. Lead Nationally.

www.fl-ate.org
www.madeinflorida.org