STEM (Science, Technology, Engineering, Math) and ROBOTICS!

Background

The FRC 3925 Robotics Champion Project: RoboRunner relies on the voice of teens as leaders and mentors for younger students, working in non-competitive, hands-on informal educational settings encouraging spatial awareness and collaboration. Spatial skills in particular were chosen based on research into the reasons for reduced participation in STEM and Robotics. Lack of exposure to spatial skills appears to be the most significant reason students are choosing to participate in Robotics.

Research demonstrates that over the next decade the world will need a large talented diverse workforce in the STEM fields (Science, Technology, Engineering and Math); women and minorities remain very underrepresented in science classes and STEM fields. Experience supports the research that many STEM programs are happening too late. Earlier exposure in elementary school or middle school will benefit student confidence and excitement.

The State of California Department of Education's INNOVATE State Blueprint for STEM (2014) emphasizes that "STEM is Everywhere" and "every learning ecosystem" should be used. Robotics Champion Curriculum is a Teen Mentor learning ecosystem that other FRC teams can incorporate into the business plan.

One of the persistent gaps in cognitive skills is in spatial skills, specifically on measures of mental rotation (example Purdue Spatial Visualization Test) – which correlates with three stations included for RoboRunner. Other curriculum elements/stations address additional recommendations. The Robotics Champion program has been designed using PDSA rapid cycles for best outcome (PDSA—Plan, Do, Study, Act). The FRC Teen Mentors have built on small successes and now are expanding widely into the community.

Research Recommendations

1. Spatial skills are developed, so give lots of opportunities and exposure
2. Encourage use of construction toys, fitting items together, following complex instructions and diagrams
3. Use handheld models

This is the basis for this project. We provide an opportunity for hands-on learning in a fun environment—using shapeology, tangrams, nuts, bolts and screws, aerodynamics of airplanes and robot paper plane launcher, smart robot, paper rockets, spaghetti construction towers, dynamo generator car, aerodynamic drone and tin can cable car. In addition we teach construction and interpreting diagrams, and working on a tin can robot (basic foundations and skills are built upon in successive sessions). The curriculum builds spatial concepts and adds problem solving in working on the robot which establishes success and confidence in a supportive learning environment. (The goal is confidence with spatial problem solving). STEM is really in every field and every career as innovation, technology and communication advances.

The Curriculum

The curriculum is designed for 12+ sessions or can be presented in a Discovery Day format involving all or some of the activities. Additionally the curriculum is now in trial development for one-week summer camps for local enrichment programs. (See photo examples of after school enrichment programs, school programs, Boys and Girls Clubs, Boy and Girl Scouting events and a pilot for summer camps). Additionally, birthday parties are led by Robotics Teen Mentors.

A big part of learning a skill set and building a foundation, is understanding what parts are available, what they are called, what they are used for and how they can be used in different ways in construction and machine design. Each station is designed for 2-4 maximum students which encourages hands-on interaction. The activities encourage teamwork, collaboration and communication with peers and the teen mentors who model the desired behaviors. The small number of students at each station allows for individual discovery plus evaluation of differing strategies.

Nuts and Bolts

- Learning the basics, knowledge and discrimination
- Learning head markings, grade and material, nominal size range, mechanical properties and working with multiple nuts matching the screws and to the specific function, working with screws with self-drilling point, threads, bolts, cap, wing

ShapeOmetry and Spatial Rotation

- Build from picture/instructions, reasoning
- Tangrams for older students, discrimination, dimensional, abstract and quantitative reasoning

Building Spaghetti Towers

- Supplies and creative problem solving as a team
- Manipulative skills and basic mechanical engineering skills
- Working out solutions, changing the approach

Aerodynamics

- Paper planes, paper plane robot launcher, paper rockets—addressing construction of launch device, different composition and supplies
- Complexity—folding planes based on diagrams, understanding aerodynamics and design and how that impacts on drag and lift—certain creases, folds that must be firm and sharp to allow plane to cut through the air
- Achieving greater distances; differences in materials – indirectly gravity, point of balance, weight distribution. The robot plane launcher teaches concepts of mechanical wheel and axle, pulley and gear with design of the plane central as well

Brain Teasers and Puzzles

- Problem solving, perseverance, abstract and quantitative reasoning skills, students are encouraged to talk openly while working to share their reasoning and strategy. Research demonstrates that talking through a problem and listening to others verbally discuss will help students become more intentional about thinking and increase understanding of concepts

Construction Challenge

- Manipulation and part-to-whole concepts

Smart Robot

- Learning algorithms, loops and conditionals, beginning code concepts

T-shirt Launch Full-Size Robot

- Concepts connecting to learning robotics, driving the robot
- Demonstrates the capability of the FRC students

Tin Can Robot Cable Cars

- Pulley system, Reverse switch, energy, gears

Dynamo Generator Car

- Generator and electricity, DC current

Tin Can Robots

- Putting it all together, working together as a team, problem solving over several sessions, interacting with peers and teen mentors

#1 RoboRunner: STEM Project--Design/Pilot 3-4 months Plan, Do, Study, Act (PDSA)

Plan: Research STEM, spatial skills are the focus of the project in support of girls joining robotics as example of STEM--robotics discovery Junior First Lego League (JrFLL), First Lego League (FLL), First Robotics Competition (FRC). Ideas reviewed with Robotics mentors and math/science teachers. Plan promotional banners for community sites, for events and for Robotics team to use at competitions. Build project for sustainability—collaborate with Robotics Team 3925, Girls STEM Club and Girl Scout Ambassadors. Specifically Robotics team officers will be engaged to continue the project for community hours and to support the Robotics alliances. Design and test skills in a box—RoboRunner Spatial Skills in a box "Robotics on the Run"

Do: Participate with Robotics Mentors and Students, work in small groups on concepts of aerodynamics with paper planes and introduction of tin can robots. Used primarily at Boys and Girls Clubs in 5th graders (trial group), added community groups. Successfully completed tin can robots, students worked in groups of 4 due to cost of the robot supplies. Learned design and graphics to significantly reduce costs of banner stands (two purchased) for project and Robotics team (donation to the team). Purchased supplies, donated to Robotics Team 3925 for ongoing community service. Some robot kits to be used for outreach and event.

Study: Students with varying abilities to serve as a leader and mentor of younger students, better serve the students with a more organized curriculum (instructions, contents of box and specific concepts to be shared for each meeting or station), 5th graders really enjoyed working on the tin can robots and were successful. Also able to engage the younger students with basic spatial hands-on discovery and they are already very excited to participate next year. The goal of the project was to create excitement for STEM related activity. Activities are valuable but need to add summary of concepts and why each station is important. Supply costs—the tin can robots are expensive. Can they be purchased in bulk? Tin Can Robots require a soda can but the student mentors should not be "promoting" sodas which is unhealthy. Add more activities or curriculum stations. Reduce number of students at each station to maximize hands-on and interaction with the teen mentors.

Act: Finalize curriculum boxes including overall background design, research recommendations, skills for each box, contents (for each presentation and for restocking) and teen mentor instructions. Design an event that takes what we have learned over 3-4 months at Community Centers. The event will be focused on girls (Girl Scouts) and will combine all spatial skills boxes and activities as stations plus additional fun demonstrations. Evaluate the event stations to guide RoboRunner and Robotics team. This will help in future collaboration with Boys and Girls clubs and Scouting during the 2015-2016 school year.

#2 RoboRunner: STEM Project--Discovery Day

Plan, Do, Study, Act (PDSA)

Plan: Set up 3 hour event for Girl Scouts with teen mentors from Robotics Team, Girls STEM club and Ambassador Girls Scouts. Set up at Arnaz Program Center to allow for demonstration of small scale and large scale robots. Unlike pilot at community centers with 4 students to 1 teen mentor the event will alter the ratio to 2 students per station and each student will work on their own robot. Stations: Hour of Coding, Smart Robot demonstration and interaction, Nuts and Bolts, ShapeOmetry Challenge, Aerodynamics of paper plane and robot plane launcher, Brain Teasers and Spatial Rotation, Construction Zone, Robot Launcher for T-shirts, Demonstration of Tin Can Cable Cars across the room, Dynamo Generator Car and each Girl Scout to build their own Tin Can Robot.

Do: Volunteers and volunteer training for spatial skill stations, acrylic painting and sealing 100 soda cans for event and future community sessions. Evaluate timing for building tin can robots all in one session (trial with more than one session and 4 students working on one robot), set up event schedule, T-shirts for launching "ToGetHerThere" and patch/pin "Year of the Girl". Build and test the additional demonstration robots. Add Dreams to Reality session for Girl Scouts. Plan evaluation for the event including girls, adult leaders and teen mentors with suggestions for ongoing spatial skills sessions. Make building Tin Can Robots the highlight of a series of sessions or single day.

Study: Observation during the event. Most of the girls were in 4th and 5th grades. Each Girl Scout was provided her own robot to build from start to finish. During the pilot 4 students worked together to collaborate, interpret instructions and problem solve with one teen mentor. When confronted with their own robot the Girl Scouts needed more teen mentor support. This event demonstrated that the emphasis on the group approach is best and teaches the skills necessary to work successfully as a team and especially working with each other's strengths. Evaluations overall very positive. Supports the plan to focus on Tin Can Robots—none of the girls had any experience with nuts and bolts or robots. 68% of the Girl Scouts would consider Robotics in the future and 96% rated the event as awesome.

Act: The RoboRunner spatial skills boxes and Tin Can Robots will be used for Robotics outreach to Boys and Girls clubs, Community Centers and Boy and Girl Scouts based on the project experience. The background research and materials for each skill set plus instructions for the mentor are ready to go. All Banner Stands (2), all spatial skill boxes containing the games and materials, painted tin cans and 60 Tin Can Robot kits for teams of 4 are donated to Robotics Team 3925 as part of the design for sustainability. FIRST Robotics has a national alliance with organizations including Boys and Girls clubs, and Boy /Girl Scouts so this is a national and local connection. Teen mentors are key and come from Robotics Team 3925, Girls STEM Club and Ambassador Girl Scouts.


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S.T.E.M. Education
STEM
Science E=MC²
Technology
Engineering
Math
Girl Scouts of USA - Gold Award Project
Caitlyn Fastenau
Girl Scouts House


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STEM
Science E=MC²
Technology
Engineering
Math
CIRCUIT OF LIFE
VENTURA, CALIFORNIA


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STEM
CIRCUIT OF LIFE


BUFFALO


TIN CAN
ROBOT


GAP


SMART ROBOT
SMART ROBOT
Smart Robot
Coding (Instructions)
Conditionals
Loops


RoboRunner
S.T.E.M. Education
STEM
Science
Technology
Engineering
Math
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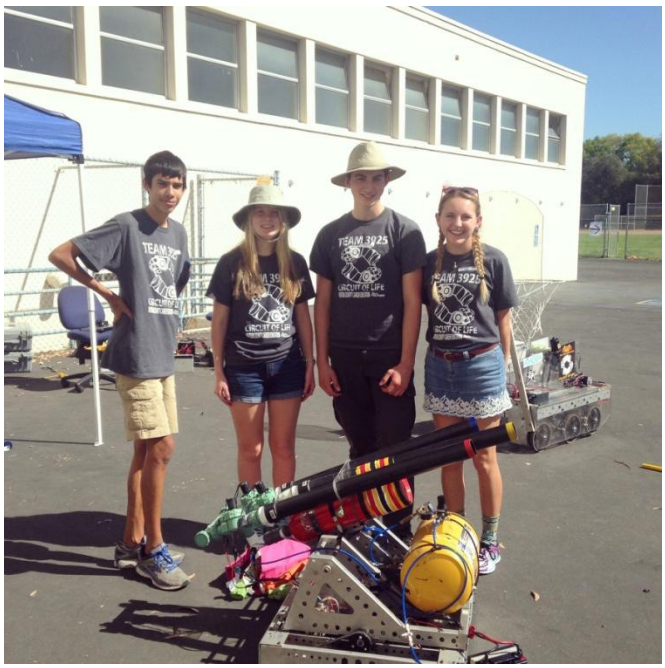


Discovery Day


Discovery Day