THE EDUCATION FUND

FOR EXCELLENCE IN MIAMI-DADE PUBLIC SCHOOLS

2019-2020

Ideas with IMPACT

idea packet

sponsored by:

FPL

STEAM-y Robotics

2019-2020

STEAM-y Robotics

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FOR INFORMATION CONCERNING IDEAS WITH IMPACT OPPORTUNITIES INCLUDING ADAPTER AND DISSEMINATOR GRANTS, PLEASE CONTACT:

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www.educationfund.org

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GOALS AND OBJECTIVES

The goal of this project is to help students answer the question "When will I ever use this?" and to support them in understanding the relationships between different disciplines and their connection to how real-world problems are solved using interdisciplinary skills and the collaboration of different ideas. This project champions project-based learning and is fully adaptable to different grade levels, abilities, and time constraints. Originally the project was completed as a pilot program and had a total of eight students varying from fifth to seventh grade and three robots. The group met every Thursday after school for two hours, although there were also many unofficial meetings during lunch. As the project's complexity and students' excitement increased, I added meetings to our calendar on Saturdays, especially when students were preparing for competitions. The project can be easily adapted and scaled to meet the needs of different grade levels and group sizes. As part of this project, students will meet various behavioral and academic objectives.

Behavioral Objectives

- Learn how to research, acquire knowledge, and assimilate new information for practical use
- Develop creative-problem solving and perseverance
- Improve ability to work collaboratively
- Have a greater understanding of how different disciplines come together in practical, real-world situations

Academic Objectives

- Meet various Florida standards from different core and content areas in a single integrated project
- Articulate how a solution was collaboratively chosen to solve a particular challenge
- Learn basic engineering principles
- Learn basic coding skills in ROBOTC or EV3 Programming

FLORIDA STANDARDS

MAFS.7.G.1.1 - Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

MAFS.7.G.2.6 - Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

LAFS.68.RST.1.3 - Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

SC.68.CS-CS.4.4 - Identify and describe the use of sensors, actuators, and control systems in an embodied system (e.g., a robot, an e-textile, installation art, and a smart room).

SC.68.CS-CS.4.5 - Evaluate a hardware or software problem and construct the steps involved in diagnosing and solving the problem (e.g., power, connections, application window or toolbar, cables, ports, network resources, video, and sound).

SC.7.P.11.2 - Investigate and describe the transformation of energy from one form to another.

COURSE OUTLINE/OVERVIEW

This project is simple in design and goals. The instructor acts as a facilitator, introducing the basics and encouraging innovative problem-solving techniques and higher-order thinking by presenting students with increasingly difficult challenges. The students begin by building a generic Clawbot build. This build will introduce students to the basics of robot construction. Inevitably, this process will become a race to see who can finish first. However, it is vital to contain and focus students' excitement so they can explain what each section of the build does and how it contributes to the overall robot. A journal will help with this; however, if students struggle with extensive journaling, they can also verbally explain what different modules and parts do in relation to each other or use drawings to assist their explanations. The facilitator should encourage student usage of proper terms, such as motor, axel, bearing, and gear. Once the robot is built, the teacher is to provide different challenges to students. The typical challenge is the Vex robotics game that allows students the opportunity to participate in various levels of competition, including international competition. You can access a list of these competitions from robotevents.org. However, students do not have to participate in these games in order to learn and hone their skills in robotics, higher-order thinking, problem-solving, and project-based learning.

The objective is to build up the robot to make it taller, stronger, and better-able to traverse different terrain and overcome increasingly difficult challenges. My students were expected to come up with their own solutions, such as large-diameter wheels, longer wheelbases, or even tank tracks to facilitate robot mobility. In the process, they learned about friction, as well as the equation that used a friction coefficient. Additionally, they also had to work together to solve problems dealing with weight distribution. In turn, they learned the power of leveraging by using gear ratios to multiply their power. Furthermore, my students learned to balance weight and power; in other words, they learned to balance adding more weight and the requisite power until the point at which their effects would be neutralized, thereby yielding a diminishing return on investment. These areas are useful real-world principles that are applicable and transferable far beyond their robot challenge.

Lesson Plans:

These lesson plans are purposely broad as they need to be tailored to your individual needs and student population.

General recommendation for Elementary students grades 3 to 5

Materials:

- 1:4 ratio of robots to students in each class
- Vex or LEGO Mindstorm robot
- 1 composition notebook per group
- Tables are preferred; however, you can also use the classroom floor as it makes it harder to lose parts
- Ziplock bags for parts storage

Instructions:

Students at these grade levels have some difficulty grasping the abstract. Therefore, it is imperative to build up their excitement by first showing them a working robot. I recommend teachers with little experience to choose a build from the vex robotics schematics site at https://www.vexrobotics.com/vexiq/resources/robot-builds. A working robot shows students that the task they are about to undertake can actually be accomplished, and it also highlights the fun they will have with their finished product! For example, the humble Clawbot, which I recommend as a first build, can be used to pick up a small pencil box and move it from one side of the classroom to another. Naming the robot also adds to students' excitement; it makes the project come alive. Once enough excitement has been built up, go over the specific challenge you would like students to complete. Make sure to create a list of steps to guide them, but allow them to act as independently as possible. Below is a sample list.

Sample instructions list:

Good morning class. Today we begin our robotics program; we will learn the basics of building and controlling a robot as well as documenting our learning from start to finish. Follow the instructions below and keep this sheet for your records.

1. With your group, read the team role explanation sheet. Assign the following team roles: Driver, Coder/Architect, Journalist, Strategist.
2. One member of each team must journal findings and document your progression with pictures if possible.
3. Follow instructions to build your basic bot.
4. Test your robot in a challenge.
5. Improve your robot to defeat other teams'.

TEAM NAME

____

Assigned Roles:

Driver: ________________________

Coder/Architect: ____________________________

Journalist:___________________________

Strategist: __________________________________

Role explanations:

Driver: The driver is the pilot of the robot; their job is to familiarize themselves with the robot's controls. The basic build only uses the analog controllers/thumbsticks. However, as the robot gains motors and new abilities, more buttons will need to be mapped. This requires the driver to learn how to best use these abilities smoothly to be able to effectively maneuver the robot.

Coder: If coding is used in the project, the coder will familiarize themselves with either RobotC or EV3 programmer applications. The Carnegie Mellon Robotics Academy is an excellent place to learn how to code. They provide free classes and even certificates for students learning either program. Visit https://www.cs2n.org/ and create a teacher account to explore!

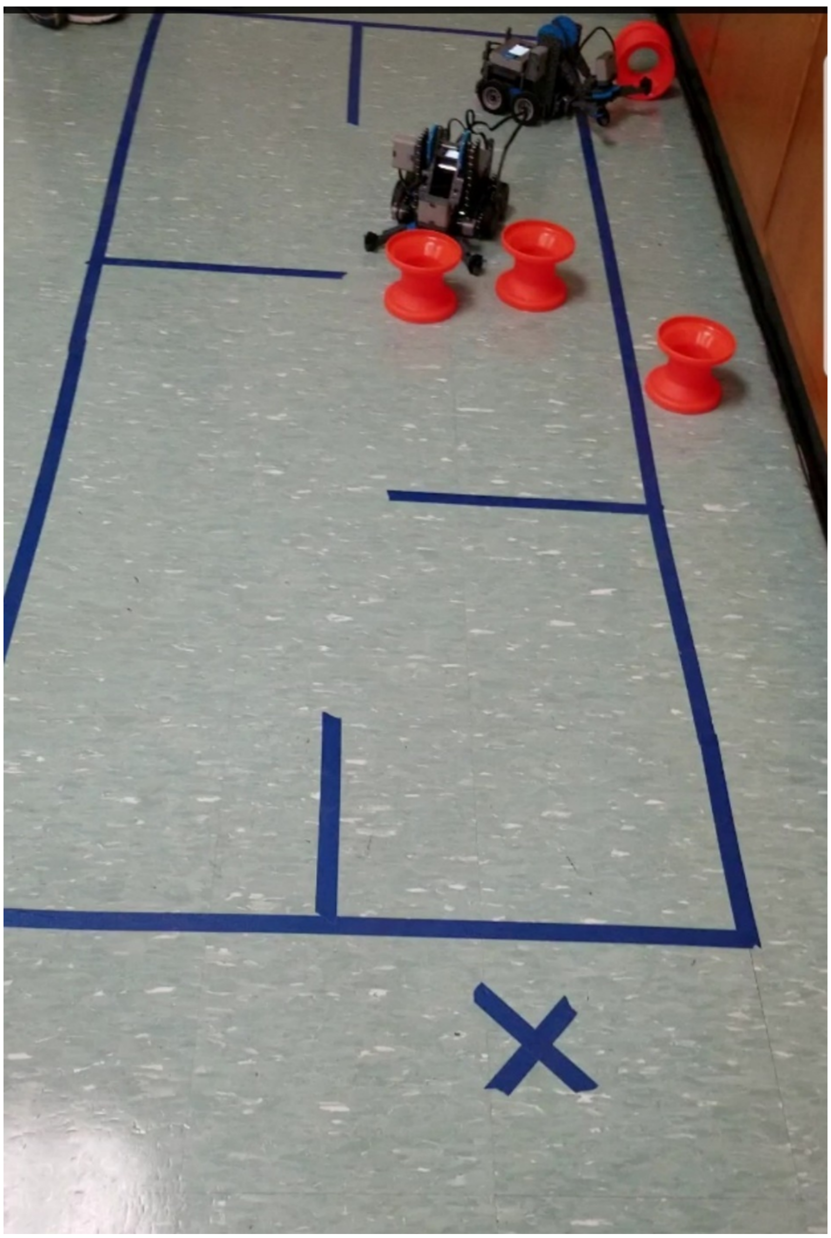
Architect: If coding is not used, an architect can take the coder's place. The architect works closely with the journalist and strategist to design robot add-ons that will give the team robot an advantage in specific challenges. It is essential to take the driver's input into account when designing add-ons as a driver may not feel comfortable with complicated ones.

Journalist: The journalist's role is to record all the team's designs, failures, and thought processes. They take pictures and write down what they learned from their mistakes; they also write down any newfound knowledge or specific useful websites they found while researching ideas. The journalist works closely with the strategist who researches problems and challenges to come up with ways of gaining an edge.

Strategist: The strategist is the researcher of the group; they focus on different challenges and how their robot could gain an advantage against the other groups. Strategists will scour the internet for build schematics, ideas, and may even work together with other strategists to determine their best course of action. The strategist works closely with all other team members to determine what is possible and the best way to achieve their goal.

If you do not have a challenge in mind, I recommend creating a maze using blue painters' tape. The goal is to create a robot that can be driven through the maze. This maze can be used to play multiple games, including:

- Quickest time through the maze without touching any edges. Single robot.
- Quickest time through the maze without touching any edges. Two robots. Friendly interaction allowed.
- Quickest time through the maze without touching edges. Two robots. Competitive interaction allowed.
- Overcoming obstacles placed in the maze that require pickups or pushes.



Additional options:

I do not recommend Vex Robotics RobotC coding at this grade level as it can require some teacher familiarity and its complexity could warrant a course just on coding itself. However, if you are using LEGO Mindstorms, the coding is much simpler and intuitive. It is mostly illustrated and utilizes a drag and drop method as opposed to actual command writing. If you like, you can add a coding challenge to the maze, which forces students to use only codes to program the robot to get through the maze without touching any blue tape.

Challenges:

Students may run into the following challenges:

- They may have trouble discerning part size differences. Many of them do not read instructions and will begin building and will not be able to progress, do not correct them until they come to you. When they do, redirect them to the instructions and encourage them to pay attention to part numbers and names.
- Students may have disagreements about roles within their team. Observe the development of their roles and assist students in their social needs. For example:
    - Natural leaders may become bossy. Speak to these students individually and ask how each team member is contributing.
    - More than one leader may emerge. If this occurs, mediate between them to see who will lead each aspect of the project.
    - Students may not want to journal. If this is the case you can rotate roles each period.
    - For ESE or ESOL students: You can allow students to verbally answer your questions. Engage them first with a few sample questions.

General recommendation for Secondary students grades 6 to 12

Materials:

- 1:4 ratio of robots to students in each class.
- Vex IQ or VEX robotics
- 1 composition notebook per group
- Tables are preferred; however, you can also use the classroom floor as it makes it harder to lose parts.
- Ziplock bags for parts storage

Instructions:

Students at these grade levels have less difficulty grasping the abstract. Therefore, it is imperative to build up their excitement by first showing them a working robot. I recommend teachers with little experience to choose a build from the vex robotics schematics site at https://www.vexrobotics.com/vexiq/resources/robot-builds. A working robot shows students that the task they are about to undertake can actually be accomplished, and it also highlights the fun they will have with their finished product! For example, the humble Clawbot, which I recommend as a first build, can be used to pick up a small pencil box and move it from one side of the classroom to another. Naming the robot also adds to students' excitement; it makes the project come alive. Once enough excitement has been built up, go over the specific challenge you would like students to complete. Make sure to create a list of steps to guide them, but allow them to act as independently as possible. Below is a sample list.

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TEAM NAME

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Strategist: ___________________________________

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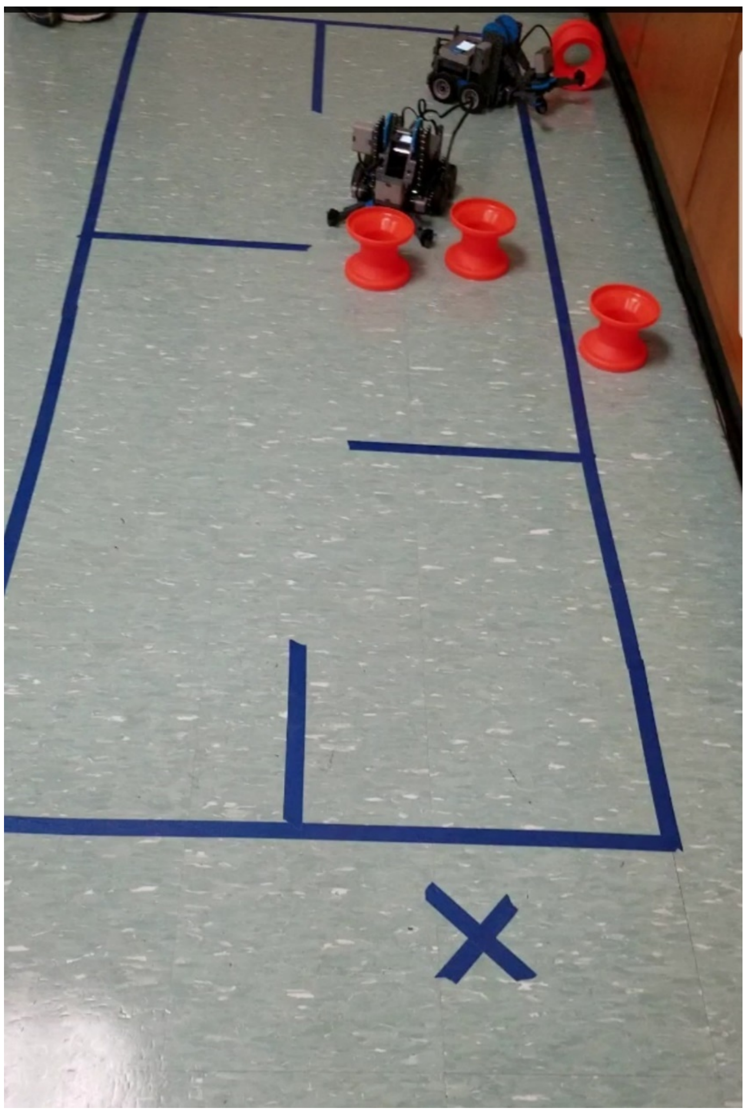

Additional options:

1. Basic programming should be used for the initial game. However, encourage your strategists and coders to use their sensors package. The sensors package will allow the team's robot to automatically detect and avoid the blue tape. Some students may feel that this is cheating. However, the discovery of how to properly program the color sensor and the motors to do avoid the tape will take more than a few hours and will help the team develop strong research and implementation skills.
2. Take part in the Vex Robotics competitions. Competitions take place every year, and each year the game is different. You can find out more at www.robotevents.com. Last year's VEX IQ game was the Next Level IQ challenge. The game board can be seen below. Students had to prepare a coding and a driving component for the competition.

Challenges:

Students may run into the following challenges:

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  - Students may not want to journal. If this is the case you can rotate roles each period.
  - For ESE or ESOL students: You can allow students to verbally answer your questions. Engage them first with a few sample questions.

RESOURCE LIST

Carnegie Mellon University Robotics Academy: Robotics coding curriculum. Learn to code specifically for VEX and Lego EV3.
https://www.cs2n.org/

REC Foundation: Vex and VEX-IQ Robot Competitions.
https://www.robotevents.com/robot-competitions/vex-iq-challenge

Vex IQ: Build schematics and robot/part purchases.
https://www.vexrobotics.com/vexiq/resources/robot-builds

RobotC for Vex robotics: VEX and VEX-IQ coding program.
http://www.robotc.net/download/vexrobotics/

Lego Mindstorm: EV3 coding program for Lego EV3 robot.
https://www.lego.com/en-us/mindstorms/downloads/download-software