Exploring Robotics, Photonics and Optics with Ozobots!

Subject/ Grade Level: Computer Science/ 4th Grade
Materials: ● Ozobots Classroom Education Kit (contains 12-18 Evo robots, chargers and markers) ● Plain 8.5” x 11” printer paper ● Colorful markers ● Example “obstacle course” for Evo bot to navigate (tested and works!) ● *May also want to bring:* ○ Lenses/ prisms (to demonstrate properties of light, such as wavelength/ frequency relationship) ○ Model of the human eye (to talk about the ways in which Ozobots’ perception of different frequencies of light is similar to how the human eye perceives light) ○ Googly-eye Color-by-Numbers diagram of the pathway of light through the eye
NGSS Essential Standards and Clarifying Objectives: 4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. 4-PS4-2: Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. 4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information. 3-5-ETS1-1: Define a simple design problem reflecting a need or want that includes specified criteria for success, and constraints on material, time, or cost. 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled or failure points are considered to identify aspects of a model or prototype that can be improved.
Lesson Objective(s): In this lesson, students will: ● Understand the basic principles of photonics and optics that allow Ozobots to sense their surroundings and respond through coordinated (programmed) movements. ● Program an Ozobot to move along a pre-prescribed path, using solid, colored lines on a plain surface. ● Appreciate the practical applications of this kind of robotics technology, including (but not limited to) easily-programmable robots in the workforce and self-driving vehicles of the future.
Differentiation Strategies to meet Diverse Learner Needs: ● Think-pair-share, for students that learn best when engaging with classmates. ● Multisensory learning, to accommodate students that are auditory learners and visual learners, as well as encourage students to engage their senses in the learning process. ● Awareness of social and cultural backgrounds of students, in order to reinforce the real-life application of what they are learning.

ENGAGEMENT:

Start by asking students about what they know about light, and more specifically, *how we as humans perceive light*. Use the following "leading questions" to get students engaged and thinking about this problem of *visual perception*:

- *"How do we see different colors of light?"*
- *"How are our eyes connected to our brain, and thus, the rest of our body?"*
- *"How do we respond to light?"*

Now present students with the following hypothetical scenario: you are walking home from school, and reach an invisible barrier that we are all intimately familiar with: *a crosswalk*. There is a light on the other side of the road, and the light is a symbol of a hand in red. Ask students the following question: *"What do you do when you see this color of light in a crosswalk?"* Then, the light changes from a red hand symbol to an icon of a green person walking. Ask students the same question, and compare students' responses. Have them stop and consider this scenario further: we respond to different colors/ symbols in specific ways (in this case, we either cross or don't cross the street).

Tell students that today they will be observing this kind of light-directed behavior in a small robot named *Evo*. Evo has a programmable, bluetooth sensor on the underside of its spherical body that allows it to sense and respond to specific colors and symbols, in a similar way to how we as humans respond to colors and symbols from our own learning/ experience.

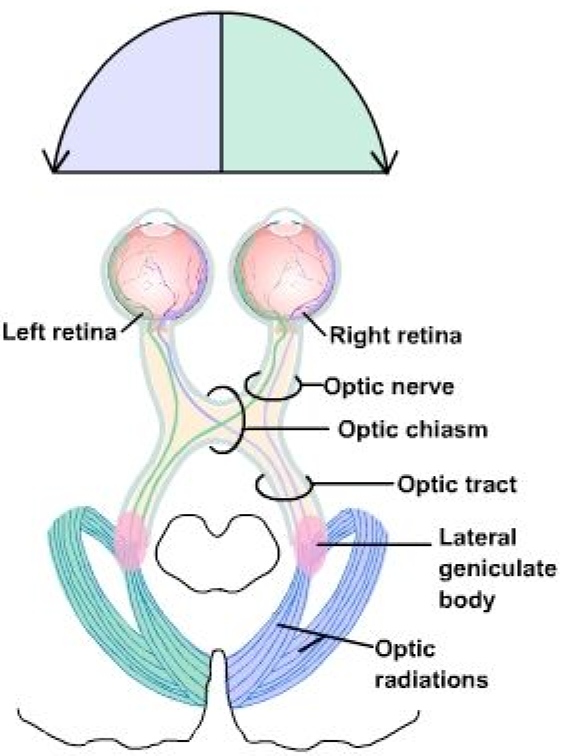

Image Resource: *https://nba.uth.tmc.edu/neuroscience/m/s2/chapter15.html*

Make sure that students understand the following analogies, and ***write these analogies on the board/ on a PowerPoint slide/ on the document camera screen:***

- Our eyes *are equivalent to* the sensors on Evo's body
- Our brain *is equivalent to* the computer chip inside Evo that we as scientists can program, to give Evo "memories"
- Our legs/ muscles *are equivalent to* the motor inside Evo that allows it to move in response to light/ symbols

If there is time, you may also want to the following demonstration(s) for students:

- Have them color in the "Color By Numbers" handout illustrating the pathway light takes through the human eye and the brain to trigger a motor response.
- Pass around the model of the human eye to allow students to examine the anatomy and the way our "sensors" work, compared to the sensors on the Evo Ozobot.
- Use lenses and/ or a prism to demonstrate how white light is actually made up of all the colors on the (visible portion of the) Electromagnetic Spectrum.

EXPLORATION:

Explain the following instructions to students, so that they know what they will be doing with their Evo bots, and how they will be programming them to move along a pre-drawn pathway:

Students will be working in *groups of 2-3* to first sketch out an "obstacle course" for their Evo bot to navigate, with a "prize" at the end of the course. They will need to program their Evo bot to navigate this course (i.e. make sure that they have drawn the correct symbols in the correct colors along the course trajectory). Students will then have an opportunity (approximately 15-20 minutes) to test out their course, and make adjustments as needed. At the very end, students will showcase their unique course as part of class presentations.

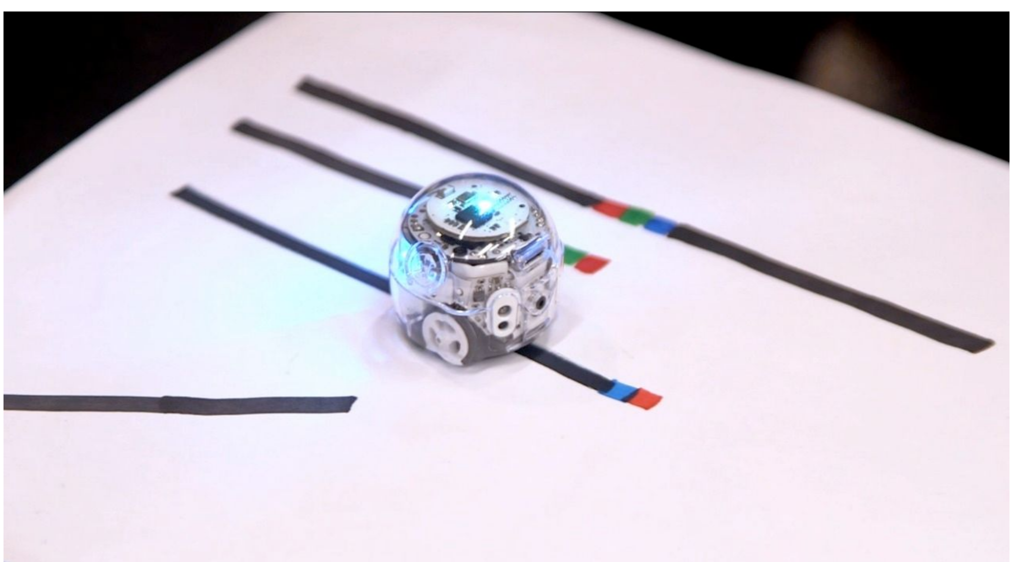

Image Resource: *https://www.youtube.com/watch?v=VBdBG1TSgR8*

Student Procedure:

1. Have a designated "Materials Leader" pick up the materials needed for the activity (one Evo bot, colored markers, plain printer paper).
2. Begin by *deciding as a team* what your unique obstacle course will look like, and what the prize for the Ozobot will be at the end.
3. Sketch your final obstacle course design in your Science Journals (each student must have the design in their journals!), then make sure this design *is approved by your teacher before moving forward with drawing on the printer paper*.
4. Once your obstacle course design has been approved, begin creating the final design and testing it with your Evo bot. Make adjustments as necessary, so that the robot is able to navigate the course successfully.
5. By the end of the "exploration period", be prepared to share your obstacle course with the class.

EXPLANATION:

Reconvene as a class, and go over the following "reflection questions" about the Evo "obstacle course" activity:

- *"How did Evo respond to each of the different colors/ symbols?"*
- *"Did Evo's response depend upon the color?"*
- *"What were the most challenging parts of designing a working obstacle course for Evo?"*
- *"If you could redesign your obstacle course, what would you do differently?"*

Have students either reflect upon these questions out loud as an entire class or in small groups (think-pair-share), and/ or have students record their responses to these questions in their science journals. Also, make sure students have completed the following in their science journals:

- Taken written observations about how the Evo bot responded to the different colors/ symbols in their obstacle course.
- Drawn (and colored) their obstacle course design

ELABORATION:

At the beginning of the lesson (in the "Engagement" portion), we discussed how Evo's sensors are similar to our own eyes, and allow us to respond to our environment in coordinated, pre-planned ways that rely on memory and prior experience. To elaborate upon this activity further, we can discuss the practical implications of the Ozobot technology when it comes to a new, cutting-edge development for the future: *self-driving cars!*

Ask students the following questions to engage them in a discussion about self-driving cars:

- *"What do you know about self-driving car technology?"*
- *"How do you think self-driving cars work?"*
- *"Do you think the kind of sensor installed in the Evo bot would be useful for a self-driving car? If so, what would need to change on our current roads?"*
- *"Do you think we could program a car to learn how to navigate an obstacle course, like Evo did?"*

In addition (and if time permits), you could adjust the activity to have students pretend that the Evo bot is a miniature self-driving car, and they can design and decorate their obstacle course to look more like a road, in which Evo needs to be able to “run errands around town”.  ***Image Resource:*** *https://www.wired.com/2017/01/self-driving-cars-approach-auto-industry-races-rebuild/*
EVALUATION: Students may be evaluated on their performance/ understanding of the lesson in one (or more) of the following ways: ● Student groups will give a short (2-3 minute) presentation to the class explaining how they designed their obstacle course for their Evo bot. ● Students groups will be judged based on the complexity of their obstacle course, and how successful they were at programming their Evo bot to navigate the course. ● Students may be evaluated individually for completeness of their science journals.

Resources:

Next Generation Science Standards (NGSS) 4th Grade

Ozobots Professional Development and Webinars

7 things to know about Ozobots