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| **Line Tracking** | |
| Teacher: Dr. Jeffrey McCullough | |
| Subject/Grade: Middle School Science and Mathematics | |
| Lesson Title: Program an ActivityBot Robot to follow a path based on input from light sensors | |
| **STANDARDS** | Tennessee State Standards effective fall 2018 |
| **Science**  6.ETS1.2 Design and test different solutions that impact energy transfer  8.PS2.1 Design and conduct investigations depicting the relationship between magnetism and electricity in electromagnets, generators, and electrical motors, emphasizing the factors that increase or diminish the electric current and the magnetic field strength.  8.PS2.4 Plan and conduct an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.  8.PS4.3 Evaluate the role that waves play in different communication systems.  PSCI.PS3.3 Design, build, and refine a device within design constraints that has a series of simple machines to transfer energy and/or do mechanical work.  **Mathematics**  6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.  6.RP.A.3Use ratio and rate reasoning to solve real-world and mathematical problems (e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations).  7.RP.A.2(b) Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.  7.G.A.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.  8.EE.B.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. *For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.*  G.GPE.B.4 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.  G.GPE.B.5 Know and use coordinates to compute perimeters of polygons and areas of triangles and rectangles. | |
| **OBJECTIVE(s)/Sub-Objectives** | **Connect prior learning to new learning.** Clear, Specific, Observable, Demanding, High Quality, Measurable, Aligned to Standard(s), and Integrated with other subjects, build on prior student knowledge  Student-Friendly (I Can Statement) |
| I can access on-line programming instructions for an ActivityBot.  I can mount a QTI sensor to an ActivityBot  I can build QTI sensing circuits on an ActivityBot  I can program and troubleshoot an ActivityBot to have it move along a path defined by a black line on a white background | |
| **MATERIALS AND RESOURCES** | **Content-related:** Clearly supports lesson objective(s); rigorous & relevant; Incorporates multimedia & resources beyond the textbook. |
| **Activities & Materials**   1. Smartboard / screen to display instructions 2. Laptop/computer to access instructions and program robot. If each group of students has a computer, then each group can move at its own pace. With one computer, the class can move at the same pace, reading instructions from a classroom display screen. 3. Internet Resource [**http://learn.parallax.com/tutorials/robot/activitybot/activitybot/mechanical-assembly**](http://learn.parallax.com/tutorials/robot/activitybot/activitybot/mechanical-assembly) and <https://www.parallax.com/sites/default/files/downloads/28108-QTI-Line-Follower-Guide-v3.0_0.pdf> 4. Assembled ActivityBot robot 5. 5xAA batteries.   **What if the technology is not working?**  It is possible to print the instruction manual to use if a classroom computer is unavailable. Assembling the robot requires no more technology than a wrench and a screwdriver.  After assembly, if the robot is not working, move on to other tasks. Allow interested students to troubleshoot the robot during independent or small group study time.  **Routine for distributing materials**  Before the lesson, place an assembled robot, computer, a QTI line follower AppKit, electrical tape, and 5 AA batteries at a center for each group. | |
| **ACCOMMODATIONS/ADAPTATIONS** | **Learning styles and interests.** Anticipate learning difficulties, regularly incorporate student interests & cultural heritage; differentiate instructional methods. |
| **Modifications/Plans for Diverse Learners**  **Differentiation**  **Content.** Students must remember names of parts and understand assembly instructions. Higher order thinking will result from questions calling for analysis and evaluation during the assembly.  **Process.** There are several levels of skill involved in assembling the robot. Visual learners might read the instructions while auditory learners listen and sort parts. Kinesthetic learners may connect wires to the appropriate ports and lay out a course with electrical tape.  **Product.** The product is having a robot follow a path defined with electrical tape. Some group members may also provide a written lab report describing their actions to program the robot. Other students may make an oral presentation describing what the robot is doing and how its sensors work. Students may also be asked to keep a journal of the process followed by the group, including difficulties encountered; the journal may focus on issues of group dynamics instead of having the technical focus of a lab report.  **Accommodations**  **\_\_\_ Small Group** In this small group setting, there should be a group role suited to almost anyone.  **\_\_\_ Peer Tutoring** Students will help each other through the assembly process. Assign each student a role that he or she can perform.    **Early Finishers**: Have students experiment with other media to define a path. Can the robot follow a path drawn with a black marker? A pencil? A blue marker? A piece of string? | |

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| **MOTIVATING STUDENTS/ANTICIPATORY SET** | **“Hook”: Engage students’ attention and focus on learning.** Personally meaningful and relevant. |
| Place the teachers’ preassembled and programmed robot at the front of the classroom. Have it follow a path. Tell students that they are going to assemble and program a robot to do similar tasks. | |
| **INSTRUCTIONAL PROCEDURES** | **Step-by-Step Procedures-Lesson Sequence: Basic to Complex.** Lesson includes visuals, modeling, logical sequencing and segmenting (beginning, middle, ending); essential information; concise communication; grouping strategies; differentiated instructional strategies to provide intervention & extension; seamless routines; varied instructional strategies; key concepts & ideas highlighted regularly. |
| ***Introduction***  We have assembled an ActivityBot, and we have seen how to make it follow a path that we define in the robot’s program. Today we will attach sensors to the robot and program it to follow a path based not on its program, but on the input the robot receives from the sensors.  As you work, think about the advantages of programming the robot to respond to input from sensors.  In each group, lets identify some group roles:  Timekeeper/Group leader  Instruction Reader/Computer operator  Parts manager (sorts and manages the parts from the QTI AppKit)  Parts handler attaches sensors and wires (students should take turns)  Course creator (creates a path out of electrical tape for the robot to follow)  Quality Controller (ensures that each wiring step is correctly completed before the group moves to the next step)  Open the instruction manuasl at : [**http://learn.parallax.com/tutorials/robot/activitybot/activitybot/mechanical-assembly**](http://learn.parallax.com/tutorials/robot/activitybot/activitybot/mechanical-assembly) and <https://www.parallax.com/sites/default/files/downloads/28108-QTI-Line-Follower-Guide-v3.0_0.pdf>  Begin by going through the QTI AppKit parts list. Ensure that you know the names of each part, and make sure that you have all of the parts. You should lay them out in the order that they are listed.  Once you have the parts sorted, follow the instructions to attach the QTI sensor and sensing circuits  **Motivating Students**  Verbal Reinforcement. The teacher will continuously provide praise for accomplishment of intermediate steps.  Relate to Real World. Questioning throughout the assembly will relate skills used during assembly to real world tasks. The teacher will remind students of the effectiveness of robots in real world tasks such as search and rescue.  **Presenting Instructional Content**  Hands-On. Students will attach sensors to a robot and program it to follow a path based on sensor input. They will have to read and interpret the instruction manual to follow steps to complete the assembly.  ***Instructional strategies:***  ***Input -* Hook (Set)** Follow the instruction manual.  **Modeling and Guided Practice *–*** Place the teachers’ preassembled and programmed robot at the front of the classroom. Have it follow a path. Tell students that they are going to assemble and program a robot to do similar tasks.  **Check for Understanding (CFU) –**  ***What am I doing for students that progress at different rates?***  Ensure that all students in each group are participating. Do not let group members exclude one of their partners.  ***What do I do if they get it?***  Have students create more complicated paths to follow (curves, T-intersections, four-way intersections, railroad switch-style intersections)  ***What do I do if they don’t get it?***  Encourage students to read the instructions carefully. If they are stuck, have them consult with students in another group. As a last resort, point out a mistake made in a single step and have them start over from that point. | |
| **QUESTIONING/THINKING/PROBLEM SOLVING (embedded throughout)** | **Balanced mix of question types.** Utilizes Blooms Taxonomy/Webb’s Depth of Knowledge; high frequency; purposeful & coherent; require active responses; balance based on volunteers/non-volunteers, ability, & gender; lead to further inquiry & self-directed learning.  **Implement four types of thinking (Analytical, Practical, Creative, & Research-based) & Teach/Reinforce problem-solving types**. Provide opportunities for students to generate ideas & alternatives; analyze, evaluate & explain information from multiple perspectives& viewpoints. |
| **Questioning**  **Knowledge:**  How many sensors are there?  **Comprehension:**  Explain what the sensors actually detect.  **Application:**  Draw a diagram on paper to show a situation which would cause the robot to turn to the right.  **Analysis:**  How many times per second does the robot need to check input from its sensors to stay on the path? Does the answer to this question depend on how fast the robot is moving?  **Synthesis:**  What is the minimum number of infrared emitter/receiver pairs required to sense enough information to follow a path? Why?  **Evaluation:**  **Thinking**    \_\_ **Practical** –Troubleshooting the robot to make it follow the path requires practical thinking.  \_\_ **Creative**– Students design their own path for the robot to follow.  \_\_ **Analytical** – Wiring the circuit board usually results in troubleshooting. Troubleshooting is analytic.  \_\_ **Research-based** – Students will study the online instructions and will use trial and error (hypothesis – experiment – conclusion) to get the robot to follow the path.  **\*What am I going to do to give Students the opportunity to:**  **1. Generate variety of ideas:** Create multiple paths for the robot to follow. Try to follow paths defined by smaller contrast than the tape/poster board setup.  **2. Analyze problems from multiple viewpoints:**  **Problem Solving**  **\_\_\_ Categorization:** Which sensor is which (far right, mid right, mid left, far left), and which gets plugged in to which port?  **\_\_\_ Drawing conclusions/Justifying Solutions:**  **\_\_\_ Predicting Outcomes :** What will the robot do if it encounters a T intersection? What will the robot do if it comes to a four-way intersection? What will the robot do if it comes to a fork in the path (Y-intersection)? | |

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| **GROUPING** | **Maximize student understanding & learning** Varied group composition (race, gender, ability, & age); clearly understood roles, responsibilities & group work expectations; accountability for group & individual work; student opportunities for goal setting, reflection & evaluation of learning. |
| * Use a number of groups equal to the available number of unassembled robots * Use heterogeneous groups * Group roles are: Timekeeper/Group leader, Instruction Reader/Computer operator, Parts manager, Parts handler(s), Course creator, and Quality controller. For large groups, students may take turns being the parts handler * The teacher will assign roles and describe the duties of each role as part of the lesson introduction. * The room will be arranged for group work as the students enter. The day before the lesson, the teacher will instruct students to enter the room and join groups in preparation for the robot assembly lesson. Each group will need at least 6 square feet of clear floor/table space on which to place their poster board with the course for their robot to follow. * Students will produce a robot which can follow a simple curve. | |
| **ASSESSMENT** | **Formative and/or summative assessment.** A variety of assessments, including rubrics, measure achievement of objectives and informs instruction. |
| ***Assessments:***  **\_\_\_ Exit Ticket**  The exit ticket for the group is a robot following a simple curve defined by electrical tape on a poster board.  **\_\_\_ Questions/Answers** Keep students’ names on a clipboard and record satisfactory/unsatisfactory based on responses to questions asked during assembly.  **\_\_\_ Presentation** Have a group member describe parts of the QTI sensor and explain what they do. Have a group member explain the process that the group used to assemble the sensor attachment and program the robot. | |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| * ***Review/Summary:*** Robots are important in industry. Give an example of a robot used in industry that needs to follow a path. * ***Preview for next lesson:***. * ***Upcoming assignments:*** None   ***Let’s review our I Can statements……***  **Follow-up Activities/Extension** Students may explore the instruction manual online to see other types of sensors and how to use them to help the robot navigate.  ***Reflection: You must reflect on every lesson you teach.*** | |

**NOTES:**

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