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| **Robot Assembly** | |
| Teacher: Dr. Jeffrey McCullough | |
| Subject/Grade: Middle School Science and Mathematics | |
| Lesson Title: Assemble an ActivityBot Robot | |
| **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.PS2.3 Create a demonstration of an object in motion and describe the position, force, and direction of the object.  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.PS4.2 Compare and contrast mechanical waves and electromagnetic waves based on refraction, reflection, transmission, absorption, and their behavior through a vacuum and/or various media.  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.  PSCI.PS4.3. Develop and use mathematical models to represent the properties of waves including frequency, amplitude, wavelength, and speed.  **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.  **Language Arts**  6.RI.CS.4 (Informational Text) Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.  6.RI.CS.5 Analyze how a particular sentence, paragraph, chapter, or section fits into the overall structure of a text and contributes to the development of the ideas.  7.RI.CS.6 Determine an author’s point of view or purpose in a text and analyze how an author distinguishes his or her position from that of others.  8.RI.IKI.7 Evaluate the advantages and disadvantages of using different mediums to present a particular topic or idea. | |
| **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 assembly instructions for an ActivityBot.  I can make sure that I have all the parts of an ActivityBot using the parts list in the instructions.  I can assemble an ActivityBot.  I can explain why the materials used to construct the ActivityBot are suitable  I can follow written assembly instructions | |
| **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 to access instructions. 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) Contains parts list and step-by-step assembly instructions. 4. Robot kit. 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. Trust them to figure it out. They can.  **Routine for distributing materials**  Give each group of students a robot kit in its original package or in another suitable container. Distribute batteries to each group after the robots are assembled. | |
| **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 should actually turn the screws.  **Product.** While the product is obviously the robot, there are opportunities to give oral or written answers to questions the teacher raises during assembly. Read and write learners may be asked to keep a journal of the process followed by the group, including difficulties encountered, as an additional product.  **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**: Ensure that software is loaded to program robots. If a group finishes early, then they may begin programming the robot. Get them stopped in time for the closure activities. | |

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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 drive, blink, play a song. Tell students that they are going to assemble and program a robot to do similar tasks.  Show a video of manufacturing robots.  <https://www.youtube.com/watch?v=sjAZGUcjrP8> | |
| **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 seen what robots can do. We have seen what an ActivityBot can do. Today, each group will assemble an ActivityBot. At the end, we will insert the batteries and make sure that the robot works.  During a later lesson, we will program the robot to get it to perform tasks.  Along the way, I will ask questions about the instructions, about the materials used, and about the assembly process. I want to see how well you understand an instruction manual. I want you to analyze and discuss why certain materials are used. I want you to think about the order in which you put the robot together.  In each group, lets identify some group roles:  Timekeeper/Group leader  Instruction Reader/Computer operator  Parts manager (manages the entire pile of parts)  Parts handler (moves parts from the big pile to the robot and back)  Wrench turner  Screwdriver turner  Quality Controller (ensures that each step is correctly completed before the group moves to the next step)  Open the instruction manual at : [**http://learn.parallax.com/tutorials/robot/activitybot/activitybot/mechanical-assembly**](http://learn.parallax.com/tutorials/robot/activitybot/activitybot/mechanical-assembly)  Begin by going through the 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 all of the parts, begin putting the robot together.  **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 manufacturing.  **Presenting Instructional Content**  Hands-On. This is a hands-on activity where student groups will work to assemble a robot. 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 *–*** Provide an assembled robot for students to look at. The purpose is to let them know that the assembly is possible. They mostly should observe the robot from a distance. The instruction manual should be their guide. However, if students are stuck and cannot find a solution by consulting with another group, then they can look at the assembled robot to see how to continue with the assembly.  **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?***  Allow robot assembly to continue, but ask continuously more difficult questions about the assembly.  ***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:**  **6.ETS.1.2** How many batteries will the battery pack hold?  **6.RI.CS.4** What is the verb in the instruction (refer to the assembly instruction on whichever page the students are currently viewing.)  What are the wheels made out of? What are the tires made out of?  **Comprehension:**  **6.ETS.1.2/8.EE.B.5** What voltage will the batteries supply to the robot?  **6.ETS.1.2** Are there magnets involved in the robot? What do these do? (magnets are in the motors)  **6.RI.CS.4** What is the mood of the verb in the instruction? (refer to the assembly instruction on whichever page the students are currently viewing.)  **7.RI.CS.6** What point of view does the author use to write the instruction manual? (The author is using second person imperative verbs, with an implied “you” as the subject.)  **8.RI.IKI.7** What medium does the author use to present the instructions? (text and pictures)  Why are the wheels made out of a rigid material? Why are the tires made out of a flexible material?  **Application:**  **6.ETS.1.2/8.EE.B.5**  If the battery pack had places for 6 batteries, what would the voltage be?  **Analysis:**  **6.ETS.1.2** Why does the robot use AA batteries rather than C-cells or D-cells?  **6.RI.CS.4/8.RI.IKI.7** Why does the author use imperative verbs in the instructions? (refer to the assembly instruction on whichever page the students are currently viewing.)  **8.RI.IKI.7** Without the pictures, would the author need more or less text to describe the robot assembly?  How would you build wheels built out of just hard plastic with no flexible tires? (look at pictures of old, steel-wheeled tractors). Are there surfaces for the robot to drive on for which such tireless wheels would be suitable?  **Synthesis:**  **6.RI.CS.4/8.RI.IKI.7** Re-write the instruction using a declarative sentence. (refer to the assembly instruction on whichever page the students are currently viewing.)  **8.RI.IKI.7** Write a set of instructions for the steps on this page, but use no pictures. (refer to the assembly instruction on whichever page the students are currently viewing. This is a difficult task. )  If we could obtain more materials, are there other ways to power the robot? (adapter with long cord to plug into wall. Attach solar panel to top of robot). What are the advantages/disadvantages of these ways? Are batteries a good power solution?  **Evaluation:**  **Thinking**    \_\_ **Practical** –Does the robot power up when batteries are in and switch is turned on?  \_\_ **Creative**– Did students identify alternative power sources? Did students name their robot?  \_\_ **Analytical** – Did students understand that the imperative verbs in the manual allowed for fewer words to convey the instructions than declarative sentences? Did students explain the value of pictures in the instructions?  \_\_ **Research-based** – (programming the robot will better address research based thinking).  **\*What am I going to do to give Students the opportunity to:**  **1. Generate variety of ideas:** Re-write instructions with declarative sentences. Re-write instructions without pictures. Determine another order in which to attach parts to the chassis.  **2. Analyze problems from multiple viewpoints:** Ask about multiple power sources. Ask about the impact of robots on jobs in the economy. What are the advantages of robots in manufacturing? What are the disadvantages?  **Problem Solving**  **\_\_\_ Categorization:** Which parts support the robot? Which parts control the robot? Which parts move the robot (notice that wheels support and move the robot). Which parts allow the robot to sense the environment? Which parts allow the robot to communicate?  **\_\_\_ Drawing conclusions/Justifying Solutions:** Why did the instructions call for mounting the servos before the wheels? Why did we mount the battery pack before the activity board?  **\_\_\_ Predicting Outcomes** If we connect the left servo cables to the right servo ports and vice-versa, what would happen? What if we swapped the encoder cables? What would happen?  What if we connected the left servo cables to the right servo ports AND connected the left encoder cables to the right encoder ports. Would that make everything work out OK? | |

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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, Wrench turner, Screwdriver turner, Quality controller. For large groups, students may take turns being the wrench/screwdriver turner. * 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. * Students will produce a robot with power ready to respond to computer commands. | |
| **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 functioning robot.  **\_\_\_ Questions/Answers** Keep students’ names on a clipboard and record satisfactory/unsatisfactory based on responses to questions asked during assembly.  **\_\_\_ Presentation** Have group describe parts of the completed robot and explain their function. After a group member correctly describes a part/function, then another group member can describe another part and its function. | |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| * ***Review/Summary:*** Robots are important in industry. When we assemble a robot, we should attach parts in a certain order. Pictures and imperative verbs are useful in an instruction manual. We have created a working robot. What are your questions? * ***Preview for next lesson:*** Now that we have robots, next time we will program the robot to conduct activities. We will make it drive forward, turn, and drive backward. Ultimately, we will get the robot to follow a track that we make for it on the floor. * ***Upcoming assignments:*** None   ***Let’s review our I Can statements……***  **Follow-up Activities/Extension** If time is left, students may begin programming the robot to drive forward.  ***Reflection: You must reflect on every lesson you teach.*** | |

**NOTES:**

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