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| **Lesson Title : The Challenge and the Engineering Design Process** | **Unit #: 1** | **Lesson #:****2** | **Activity #:****4** |
| **Activity Title: Robot Simulation**  |

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| **Estimated Lesson Duration:** | **11 days** |
| **Estimated Activity Duration:** | **8 days** |

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| **Setting:** | **9th Grade Integrated Science Classroom** |

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| **Activity Objectives:** |

Work with a team to build and program NXT robots to simulate a disaster relief plan for UAVs.

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| **Activity Guiding Questions:** |

How do I build an NXT robot and make it work?

How do I program a robot to travel a specific distance?

How do I program a robot to turn directions?

How do I figure out how far and in what direction the robot needs to go?

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| **Next Generation Science Standards (NGSS)**  |
| **Science and Engineering Practices (Check all that apply)**  | **Crosscutting Concepts (Check all that apply)** |
| ☐ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| X☐ Developing and using models | ☐ Cause and effect |
| X☐ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☐ Analyzing and interpreting data | ☐ Systems and system models |
| ☐ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☐ Constructing explanations (for science) and designing solutions (for engineering) | ☐ Structure and function.  |
| ☐ Engaging in argument from evidence | ☐ Stability and change.  |
| ☐ Obtaining, evaluating, and communicating information  |  |

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| **Ohio’s New Learning Standards for Science (ONLS)** |
| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| X☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☐ Demonstrating Science Knowledge **(D)** |
| ☐ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

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| **Common Core State Standards -- Mathematics (CCSS)** |
| **Standards for Mathematical Practice (Check all that apply)** |
| X☐ Make sense of problems and persevere in solving them | X☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | X☐ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☐ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

NXT Robotics Instructions (links)

1.2.3e Power Point Handouts (from Activity 3)

1.2.3f Engineering Design Process Handout (from Activity 3)

1.2.4g Data Collection Sheet

From Activity 3: 1.2.3e Power Point with Map (with coordinates) of disaster area

Probability spinners

Handout 1.2.4h: Evaluation and Rubric

NXT Robotics kits: 1 per 2 students

Computers loaded with NXT Robotics software: 1 per 2 students

Floor space marked with a map of the disaster area

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| **Teacher Advance Preparation:** |

Mark the floor space with a map of the disaster area. I used a 10x10 foot square on the floor so that 2 km on the coordinate map = 1 foot on the floor map. I used electrical tape to mark the center location and a circle around the center to indicate safe ‘landing area’.

Gather NXT Robotics kits and make sure all the parts are present for each kit.

Set out probability spinners for each group.

Set up computers with NXT software in a convenient location (ideally with work tables for building robots)

Copy handouts 1.2.4g Data Collection Sheet and 1.2.4h Evaluation Rubric for students.

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| **Activity Procedures:** |

Day 1-2: Students will work with partners to assemble the NXT Robots. (see directions)

Day 3: Students will learn the basics of NXT programming code. Using a computer, projector, and the online tutorial video (see link), students should view the NXT Introduction (skip sensors and Editor Introduction), Move Blocks, then students can practice some programming

Day 4-6: Pass out and go over the Evaluation Rubric. Pass out the data collection sheet.

Students will work in teams to program their robots to travel the disaster relief plan they created. Students should record results on their Data Collection handouts as they modify their programs. Once the students have correctly programmed a robot to travel to a location city, the teacher can sign off. Expect a lot of trial and error as students are learning to program the robots’ movements. Point out how this also is part of the Engineering Design Process: testing, evaluating, refining, communicating. Since NXT Robots can be programmed to travel distances in inches, you may want to to have the students discuss measuring or calculating circumference of wheels on the robots, to compute how many inches of travel are needed.

Day 7: Evaluating / Final Refining and Revising

Students will return to their Engineering Design Process handouts to complete steps 6 and 7: Evaluate plan, make suggested revisions to improve the plan. This packet will be collected and graded once the students have completed it.

Day 8: Communicating the Results

On the board, each group will provide and explain:

-drawing of the map of their plan (visual)

-description of plan (verbal)

-summary data (total people helped, saved, total distance traveled, total time spent)

-suggestions for future improvement.

After each group has presented, the class will spend a few minutes evaluating their results and suggesting revisions.

1.2.4h Evaluation Rubric can be used to assess the students on these presentations.

Assignment: Final Writing Reflection: What did you learn about the EDP? CBL?  What was most challenging?  What would you recommend for next year?

**Formative Assessments**.

Students will be formatively assessed using informal teacher check-ins during group work throughout Days 1-6.

**Summative Assessments**

Data Collection Handout – Document 1.2.4g

Engineering Design Process Handout – Document 1.2.3f

Final Rubric: Disaster Relief and UAVs- Document 1.2.4h

Unit Post-Test – Document 1.1.1a

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| **Differentiation:** |

This hands-on task lends itself extremely well to engaging students who typically struggle with pencil-paper tasks. Groups can be assigned either heterogeneously or homogeneously to assist in differentiation. Since this task is open-ended, it will allow for students to expand their plans and visit multiple cities, or visit fewer cities as time permits. During the evaluation and communication stage, questions from the teacher to the students can be adapted depending on the readiness of the students.

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| **Reflection:**  |

The students were actively engaged throughout this activity. There were lots of opportunities for the students to experience frustration and work through difficulties as they built, recognized errors in, and re-built their robots. The same was true for learning to program the robots to travel to their desired locations on the map. It was great to see their enthusiasm when their robots finally traveled their path correctly. Allowing the students to experience the engineering design process without rushing the results was worth the time spent. The lowest-energy day came the day after we finished robot testing, when we came back to the EDP handouts to write down their evaluations and revisions. On the presentation day, we had a good large group discussion about each plan: strengths, disadvantages to not visiting city B (most groups did not), distance traveled (traveling longer distance did not mean saving more people; 2 groups with shorter distances still saved the same amount of people as the groups with longer distances).  We did not break down to see who took pictures of damage vs delivered medical supplies and pros/cons of that because time did not permit.