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| **Lesson Title :** Manager of the Water | **Unit #:**  1 | **Lesson #:**  2 | **Activity #:**  4 |
| **Activity Title:** Rain Harvest |

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| **Estimated Lesson Duration:** | 7 Class Periods |
| **Estimated Activity Duration:** | 5 Class Periods |

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| **Setting:** | Classroom |

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| **Activity Objectives:** |

1. I can analyze the pros and cons for different possible water sources for their use in the water transportation system, eventually selecting one.
2. I can research and take into consideration the cost of the water transportation system’s parts and upkeep, staying within my allotted budget.
3. I can synthesize my understanding to determine the water needed to saturate the garden soil to the optimal soil saturation level for the specific plants in the garden, and select a method to control this variable.
4. I can design and build a water transportation system that can be tested on a “model” of the garden (constructed by the teacher) that can transport enough water to water the new community garden and ensure plant growth.
5. I can test, evaluate, and redesign my water transportation system to improve efficiency.
6. I can create and present a final PowerPoint for presentation to the PTA Garden Committee and / or School Board of the final proposed solution for a watering system for the community garden.

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| **Activity Guiding Questions:** |

1. What is the water demand of the community garden space?
2. What is the average rainfall for the designated time period?
3. What water resources are located nearby and how can they be utilized as sources of water?
4. What properties of water allow / prevent the water’s transport?
5. Where does our local water come from?
6. Does the water need to be filtered / purified at all from pollution (such as acid rain)?
7. How can we decide the purity or pollution level of rain water (if we decide to use this source)?
8. How much do different sources of water cost?
9. What are the components of transporting water / what is needed?
10. What is the estimated cost of the supplies and implementation for your group’s proposed water implementation system?

| **Next Generation Science Standards (NGSS)** | |
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| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☒ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☒ Developing and using models | ☐ Cause and effect |
| ☒ 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 |  |

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

| **Ohio’s Learning Standards for Math (OLS) and/or**  **Common Core State Standards -- Mathematics (CCSS)** | |
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| **Standards for Mathematical Practice (Check all that apply)** | |
| ☐ Make sense of problems and persevere in solving them | ☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☐ 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, OLS and/or CCSS):** |

**Ohio Learning Standards**

* Scientific Inquiry and Application
  + Identify question and concepts that guide scientific investigations;
  + Design and conduct scientific investigations;
  + Use technology and mathematics to improve investigations and communications;
  + Formulate and revise explanations and models using logic and evidence (critical thinking);
  + Recognize and analyze explanations and models; and
  + Communicate and support a scientific argument.
* **Global Environmental Problems and Issues** 
  + Potable water quality, use and availability
  + Sustainability
  + Food production and availability
* **Earth’s Resources** 
  + Water and water pollution
  + Potable water and water quality
  + Point source and non-point source contamination
* **Soil and Land** 
  + Mass wasting and erosion
  + Land use and land management (including food production, agriculture and zoning)

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

1. Various supplies for water transportation system model construction
2. Garden “model” for students to use to test their water transportation systems
3. Water supply (for use during testing on the garden “model”)
4. Laptops / computer lab
5. Metric measuring devices

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| **Teacher Advance Preparation:** |

1. Gathering supplies and tools needed for water transportation system construction
2. Construction of garden “model” to use for testing student-designed watering systems
3. Research school policies on safety / grounds limitations that may affect the challenge
4. Arrange to attend a Board Meeting for students to present their proposals and / or arrange for the PTA Garden Committee to visit the class and hear the proposals
5. Secure laptops / computer lab for student PowerPoint / Google Slides proposal construction

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| **Activity Procedures:** |

**Day 1 –** (50 minutes):

1. Instruct the students to get into their Challenge groups (these should be the same groups that the students have been working in since the beginning of the unit). Remind them of the challenge (it is a good idea to have the challenge posted clearly on the board).

**Challenge:** Design and possibly build a way to transport enough water to water the new community garden to ensure plant growth. The system designed and built by the students will be tested on a “model” of the garden, constructed by the teacher. Students will test, evaluate, and redesign their systems to improve efficiency. A final PowerPoint will be created for presentation to the PTA Garden Committee and / or School Board of their proposed solution for a watering system for the community garden.

1. Students will brainstorm within their groups all of the different pieces of data that they need to collect from the garden area to accurately plan for and build a water transportation system for the school garden. As students brainstorm, one student from each group should record the list in a notebook or on a scrap piece of paper. Allow students about 10 minutes for this step (or until the groups seem to begin to run out of ideas).
2. Take the class outside to the garden area and allow the groups about 15-20 minutes to collect any / all data that they think they will need to assist them with their proposal. (Please stress that the students will be free to revisit the garden area throughout the Challenge, on their own time. However, this is the only class time that will be devoted to visiting the garden).
3. Bringing their gathered data back into the classroom, each group will use their research findings from Activity 3 to brainstorm ideas for their proposal. Important components that they will need to focus on include the efficiency, the necessary design to allow proper function, and cost.
4. Each student will sketch out one design for their group’s proposal, complete with dimensions, details, and special instructions. Students may use a digital program (such as SketchUp) or pencil and paper.
5. After each student has completed a design, the other group members will write a pro and a con for each of their group members’ designs. At this point in the Challenge, the teacher needs to sign off on the group’s individual sketches before allowing the groups to progress forward.
6. After the teacher checkpoint, each group must combine the best ideas from each of their sketches and construct one final sketch to use to build their first prototype.
7. By the end of the class period, the students in each group need to have a complete list of the different supplies needed to construct their prototype. Cost of supplies is a major factor in the student proposals, so it is essential for each group to research and find as many donated supplies as possible (a lot of non-profit organizations and / or local businesses are willing to make donations to students for school projects).
8. Various supplies will be made available by the teacher for building the in-class prototypes, however students may bring in additional supplies and / or submit a list of requested supplies to build their prototype / model to the teacher. The teacher maintains the right to deny any requests due to safety or cost reasons. (Based on teacher discretion).

**Day 2 –** (50 minutes):

1. Students will continue to work on their challenges.
2. Depending on both the pacing of the unit and the level of the students, each group will build their prototype and test it on the teacher-made garden “model,” making iterations to improve efficiency. ALL iterations made must be recorded. As an alternative, students may use the materials provided to test out ideas and kinesthetically explore different possibilities for the components of their proposals.

**Day 3 –** (50 minutes):

1. Students will continue to work on their challenges.
2. Each group will build their prototype and test it on the teacher-made garden “model,” making iterations to improve efficiency. ALL iterations made must be recorded.
3. As students finalize their system designs, encourage students to begin their proposal presentations, using PowerPoint and / or Google Slides. Encourage them to work on their proposals outside of class as well, because class time alone might not be enough time to produce a sound proposal.

**Day 4 –** (50 minutes):

1. Students will continue to work on their challenges.
2. About 15 minutes into the class, pause all of the groups and have them pair up with another group for their half-way checkpoint.
   1. Students will share their progress thus far with another group (they will use this as a “dress rehearsal” for their final presentation) for feedback.
   2. The teacher should also observe these presentations and use it as a formative assessment, providing feedback to help groups improve their proposals.
3. From both self-reflection and this feedback, the groups will each rebuild / alter their water filtration system prototype and proposal. (This is the iterative portion of the EDP).

**Day 5 –** (50 minutes):

1. Arrange to have the school’s PTA Garden Committee come to visit the class and allow the students 5-10 minutes for each group to present. Encourage the groups to be open to answering any questions that committee members may have at the end of their presentation.
2. When students are not presenting, they will observe closely and record the title of each other group’s proposal, one suggestion for improvement, one positive comment, and one question. (It may be helpful to write these requirements on the board).
3. Administer the post-test and collect it for assessment.

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

1. Individual sketches, with pros and cons for each, and final group sketch of prototype
2. Prototype of water transportation system
3. Water transportation system prototype refinements after initial testing to improve efficiency
4. Half-way checkpoint of peer practice presentations (teacher observations)
5. Presentation improvements after checkpoint

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

1. Evaluation of the water transportation system proposal, with proof of iterations
2. Evaluation of the water transportation model, with proof of iterations

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.  Refer to Activity Template for details. |

* Student ability levels were taken into account when grouping students (I paired highs with mediums, and mediums with lows), which successfully allowed the higher of the two in each group to help guide and bring the lower to a higher level of understanding and mastery.
* Visual learners’ needs were met through writing the Challenge on the board, and auditory learners’ needs were met through verbally discussing it. Additional class discussions took place as further support for auditory learners. Kinesthetic learners’ needs were addressed through the hands-on construction of small portions of each group’s proposal, to test for functionality.
* More teacher modeling, assistance, and “leading” was provided for lower-achieving students, ensuring that all groups were progressing through the Challenge at a good pace.
* For the lower-achieving students (during the peer-feedback portion), model suggestions, questions, and feedback will be provided to help them get started.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

* Successes:
  + Grouping my students by academic ability level and social / behavioral tendencies successfully allowed the higher of the two in each group to help guide and bring the lower to a higher level of understanding and mastery. I intentionally provided more assistance for medium / low groups, to additionally scaffold the learning.
  + One of the most successful portions of this activity was the peer-feedback portion. The students were very honest and real with each other, evaluating other groups’ proposals with careful attention to detail. The feedback was also received very well by all of the groups, which was honestly one of my greatest worries. All groups were energized to make improvements to their proposals, using the feedback from their peers.
  + The previously described iterative portion (peer-feedback) was instrumental in the final proposals submitted by each group.
* Shortcomings:
  + Due to losing a Special Education teacher a few days after starting this unit (and a lack of funds at the district level to replace her), my Environmental Science class gained six special education students, drastically changing the student ability level that I originally catered this Challenge to while writing the unit. In the course of this transition, significant teaching time was lost and to compensate for that time, the student groups did not build complete prototypes of their proposals to test on a model of the garden. Rather, the materials ordered and supplied were used to test out ideas and kinesthetically explore different possibilities for their proposals. In future implementations of this Challenge, I would include the original plans to implement the unit with the building of the prototypes, it just was not possible in this situation.
  + The lack of structure, characteristic of the open-ended Challenge, was a great struggle for many of the lower students. Even with my assistance, getting started and knowing where to head next with their proposals was very difficult.
  + The part that the groups struggled with the most was the determination and persistence to each design / create their own prototype or idea for a system, rather than just using the first idea provided by a member of the group. They were more geared toward finding a single solution, rather than finding the BEST solution.
  + I was also unable to get the school district’s PTA Garden Committee to come visit the classroom and assess the proposals (mostly due to a change in Principal), but I will still attempt to include this portion of the Challenge in future implementations. Rather, other teachers and school staff were used as judges.
  + Most of the groups needed assistance with the creation of their proposals, due to a lack of computer program skills. This could also be addressed by attempting a cross-curricular project with the English teacher prior to implementing this unit. I would also strongly suggest that more rigid requirements / guidelines be provided to the students in future implementation relating to proposal / presentation formatting requirements.