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| **Lesson Title : The big “why” in data collection.** | **Unit #:1** | **Lesson #:1** | **Activity #:1** |
| **Activity Title: Introduction to Optimization** |

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| **Estimated Lesson Duration:** | **3 days** |
| **Estimated Activity Duration:** | **1 day** |

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| **Setting:** | **Middle school classroom, 8th grade students in an urban setting.** |

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| **Activity Objectives: (Students will spend the vast majority of the class time working through the hook challenge. They will be choosing the best items to purchase toward meeting the goal of the task. Their decisions will be made informally as they will need materials for starting the task. Their success or failure will be used in the concluding discussion to bring in suggestions for a challenge.** |

**The students will as a group:**

1. **Evaluate the cost effectiveness of basic items needed to complete a task.**
2. **Select the best items to purchase toward meeting the goal of the task.**
3. **Evaluate their success or failure during the concluding discussion**
4. **Suggest a challenge**

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| **Activity Guiding Questions:**  **Why do I need to consider cost when working on a design project?**  **How do I know which items are the most important to purchase?**  **How do I work with in a group to meet a common task on time?**  **What costs do businesses need to consider when establishing a price for a newly developed product?** |

| **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 New Learning Standards for Science (ONLS)** |
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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)** |

| **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, ONLS and/or CCSS):**  **8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data,** **interpreting the slope and intercept. *(For example, in a linear model for a biology experiment, interpret a slope of*** ***1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in*** ***mature plant height.)*** |

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies)  1. Physical materials for task: eggs, golf balls, paper, tape, paper clips, straws,  2. Handout with task instructions  3. Tube with mounting bracket to ensure consistency drop.  4.Group work assignment sheet  5. Linear equations comparison homework. |

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| **Teacher Advance Preparation:**  **Materials for the hook activity must be pulled. Students need to be given some type of money to use as currency to purchase the needed items for the egg drop challenge. The teacher needs to have a reasonable plan for selling items to students while walking through the room monitoring group progress.**  **Egg drop tube built and attached to a drop location.** |

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| **Activity Procedures:**   1. **Unit introduction** 2. **Find out what students know about optimization. What is the overriding goal of any business that provides a product or service? How does this relate to them?** 3. **Develop Essential Questions for the Unit.** 4. **Hook Activity** 5. **Assign the students to groups based on student ability. Group’s members should vary in abilities and strengths.** 6. **Give an overview of the task at hand. What is the goal for each group? Define the parameters and the constraints of the activity. Pass out handout.** 7. **Outline any special procedures for the day to include; how much money each group gets and how do they go about purchasing items for construction of their protection device.** 8. **Hand out needed assignments. Students will need to prove that they have engaged in a group discussion focused on a plan to successfully fulfill the task. The assignment sheet ask students to describe their role in what would become the final outcome.** 9. **Assuming it appears that all groups reasonably understand the task, begin to sell items to groups. Keep a watchful eye on materials used to ensure the fairness of the challenge.** 10. **Student work time. Quickly sell the items to the groups and give them time to work on construction of their device. Monitor student materials to ensure that they are only using items purchased from the teacher. The materials constraint is important to the learning of the idea “optimization”.** 11. **Formatively evaluate each group’s device. Document their final device with a photo.** 12. **Test each group’s ability to protect an egg sized object.** 13. **After all groups have gotten a chance to drop their egg hold a debriefing session. What strategies seemed to work well and which did not? Where the items appropriately priced? Which items seemed to be the most valuable? The groups that had a cracked egg, how confident are they that give new materials and time them could meet the task? Would it be easy to complete the task given infinite materials? Did planning and communication play and important role in being successful?** 14. **Introduce selling salt app.** <http://forio.com/simulation/mit-sloan-salt/index.htm>   **Use this activity to further engage the students in discussion of general optimization. It potentially could be used as additional support for helping the students develop ideas for the challenge. Introduce the big idea optimization. (Pose these to students) Can you put optimization in your own words? What if we were to sell something? What are the things you have to think about to stay in business?**   1. **Ask students for their input on the unit challenge. What could we “optimize”? Students will be asked if we were to pursue a business venture as a class what would you want to sell? (Exit slip) What are some of the most important things you use on the daily bases? They will be given the opportunity to generate ideas and submit them to the teacher. I will then use their input to generate the challenge and introduce it on the following days instruction.** 2. **Assign comparing linear equation problem for homework.** |

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

The assessment “Gather information” will be incorporated in to activity and used in a formative way. Students will do some self-assessment at the conclusion of the activity. The document will ask them to describe their part in the activity, and also ask about their new found understand of optimization and how it will apply to us as a class. (The challenge)

**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.

None for this activity.

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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.  Most of the differentiation is addressed with in the structure of the groups. Each group should have all different types of learners with varying abilities. Responsibilities assigned with in the groups all for all students to apply value toward the completion of the assignment. |

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson.  I was relatively pleased with the flow and learning of the hook lesson. The students enjoyed the hook activity of engineering an egg protection device. The students were definitely able to grasp the concept of managing materials to meet constraint requirements. I wanted the students to understand that this is a basic operation in most businesses. Any design or prototype has to be financially practical when hoping to sell that item or service for a profit. This is a basic balancing act that is at the heart of any business. Understanding this principle will allow students to develop a business context to apply to many word problems given to secondary students.  A shortcoming of the lesson was related to the student grouping assignments, and honestly this is a regular issue in my school building. The task requires students to work cooperatively together, a skill that most middle school students do not have. This being the first time this unit has been taught, I had some pacing issues with regards to allowing every group the opportunity to practice and modify their device before final evaluation. It simply was a lot to squeeze into a single class period.  Overall the students really enjoyed the lesson and it cultivated a certain level of excitement for the coming unit of instruction. |