**Lesson 5: Product Completion -**

**Design/Test, Gallery Walk & Class Consensus Discussion**

**Problem statement:** The City of \_\_\_\_\_\_\_\_\_ is advertising a Request for Proposal (RFP) from Engineering Firms to develop the area of land next to \_\_\_\_\_\_\_\_\_\_\_\_\_ to encourage physical activity and outdoor fitness, as well accessibility for all in the community.The RFP’s scope would include additional energy resources to supplement the community’s energy needs as well as provide energy back into the development. The RFP would require the developed land to provide the community with sustainable attractions for all ages and abilities. There is an open space next to the \_\_\_\_\_\_\_\_\_\_\_\_ Middle School that has opportunities for potential energy (see attached topography map). Bids for the project are being solicited.

This lesson fits into the Problem Statement as a core lesson. Using the engineering process, students will prepare their SPPA design for feedback and participate in giving feedback with other groups. With this feedback, students will then complete their RFP by including improvement plans for their SPPA design. These will be shared by each group in a class consensus discussion that will include knowledge, ideas and evidence on how the group’s SPPA design can be improved for a final product that meets the criteria of the project.

**Learning objectives:**

* Students will evaluate their SPPA design using an Evaluation Matrix on the RFP criteria.
  + I can evaluate how our group prototype meets the RFP criteria.
* Students groups will complete a Prototype Design Checklist on energy transformations, energy types and energy transfers for their SPPA design to display in a class Gallery Walk.
  + Students can evaluate others’ solution using the Pugh Matrix
* Students evaluate & provide feedback to other groups’ proposals & prototypes.
  + I can evaluate others’ proposals & prototype providing detailed feedback.
* Students will use a Class Consensus Scoring Guide to organize main ideas used for meeting RFP criteria, evidence supporting these ideas in the building and testing of the prototype and to show understanding of energy system transformations and used in the prototype (including energy efficiency) based on the Law: Conservation of Energy.
  + Students discuss feedback for others’ prototypes

**Lesson refinements to observe selected student learning traits:**

* All students engage intellectually in important science and engineering content.
* All students participate in science discourse with peers (equitable, accountable talk).
* All students use evidence to demonstrate conceptual understanding.

**Lesson standards (NGSS, CCSS, CTE):**

**NGSS MS PS3-2** Develop a model to describe that when the arrangement of the objects interacting at distance different amounts of potentials energy are stored in the system.

**NGSS MS PS3-3** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

**NGSS MS PS3-5** Construct, use, and present arguments to support the claims that when the kinetic energy of an object changes, energy is transferred to or from the object.

**NGSS MS ETS1-2** Evaluate completing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

**NGSS MS ETS1.C:** Optimizing the Design Solution  
Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3)  
The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)

**NGSS Crosscutting Concepts:**  
Structures can be designed to serve particular functions. (MS-PS4-3)  
  
**NGSS Science and Engineering Practices:**  
Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS4-1)

[CCSS.ELA-LITERACY.SL.7.1](http://www.corestandards.org/ELA-Literacy/SL/7/1/)

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.

**Soft skills:**

Communicate clearly

**Locally and/or personally relevant for students:**

Middle school students learn best in collaboration with their peers/team. Sharing ideas to develop a stronger design.

**Connections to career and educational pathways:**

In this lesson, students will present their proposals and review the proposals from other students. While this lesson doesn’t directly connect to a career path, it serves to reinforce the connections from the prior lessons.

**Target Grade Level(s)**: Middle School (6th, 7th, 8th)

**Subject(s)**: Physical Science (Energy)

**Author(s)**: Kathleen DuCharme, Meghan Palmer, Heather Smith, Shelley Garr, Devin Knowles, Emily Prewett

**Materials:**

* Prototype Design Matrix (brief description of prototype)
* Gallery Walk: Pugh Matrix for Gallery Walk
* Energy Park Self Reflection Questions
* Piece of “Pie”: Teamwork broken down
* SWOT - Group Work
* Extension - Class Consensus Scoring Guide

**Time required:**

* 2 days 55-60 period (depending on scaffolds needed or used to complete SPPA prototype Evaluation Matrix and Prototype Design Checklist).

|  |
| --- |
| ***Focused Step in Engineering Process*: (Engineering Design Process Poster)** |
| **Ask: What RFP criteria has been met with my prototype? Assess the level of prototype completion and exactness in meeting constraints using the Evaluation Matrix.**  **Prepare to receive and get FEEDBACK.**  **Prototype “gallery walk” > Get ideas to improve from other student feedback. Talk with members of your group about ideas to improve your engineering product - prototype.**  **Make a PLAN on prototype design improvements to communicate.**  **Use structure to improve function of prototype to complete product by using the Class Consensus Scoring Guide. Base future changes for your prototype on science understanding and engineering evidence which supports your ideas.** |

**Lesson preparation:**

* Provide class with an example of a completed Evaluation Matrix for a hypothetical SPPA prototype.
* Teacher should have students “share” their Google Doc of the completed Prototype Design Checklist. This can be put on the overhead for the prototype completion discussion to be used during the Class Consensus. Changes students make to improve their SPPA prototype on the Class Consensus Scoring Guide may be juxtaposed with the current “gallery walk” prototype.

**Considerations**:

* Access to computers/internet
* Time for students to make adjustments to prototype after the Evaluation Matrix and before the Prototype Design Checklist is completed.

**Grouping of students for instruction:**

Students should be grouped by teams (of 3-4) at this stage (either by interest, random, social needs etc.).

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

***Resolve the Problem:*** *Students should be able to provide an argument for each of the possible solutions and be given an opportunity to share and critique arguments. How will students reflect upon and share what they’ve learned? How will students synthesize their learning? If there are presentations involved with this PBL, how do you plan to help the non-presenters learn from presentations?*

* *Determine Best Fit solution*
* *Present the Solution*
* *Debrief the Problem*

**Best Fit -** First, determine the prototype’s fidelity with the SPPA criteria and constraints. **Present the Solution -** Next, display prototype with details for on meeting the RFP. Use the Engineering Design Cycle to look for additional ideas and listen to specific feedback given by other groups about the current prototype from “gallery walk” to choose which areas require additional possible solutions to maximize stored or transformed energy. Finally, determine one area to focus on for a plan of optimization of the SPPA prototype. In other words, make one plan of improvement for the prototype. **Debrief** with the Class Consensus.

|  |  |
| --- | --- |
| **Teacher** | **Student** |
| **Day 1:** *Student groups will evaluate another group’s prototype and reflect on their group’s engineering.* | |
| Unit - Day 9  Learning Target:   * Students can evaluate their own group prototype * Students collaborate using sentence starters to choose criteria when using the Pugh Matrix   Warm-Up   1. Pugh Matrix 2. Prototype Design Specifications (gallery walk prototype description) 3. Place prototype & printed copy of proposal on your group table.   Teacher begins class with handouts for students that will allow them to check their SPPA prototype and draft of Proposal.  Students complete Prototype Design Specifications as a “fact sheet” for their prototype (model) display.  *Teacher reviews questions on the handout with students to elicit student understanding.*  Model the Pugh Matrix which is based on qualitative weights on criteria. Have the class identify which criteria should be weighted at 1 vs 2. (There will be variation amongst students.)  Teacher models:  How to group rotation procedure to facilitate all group participation in giving feedback. e.g.: “All group members gather around the proposal & checklist 1 person reads aloud the proposal, stopping to take breaks to us the checklist.”  How to provide appropriate feedback (write sentence starters on the board):  “We are unclear about…”  “Could you further explain..”  “We think you are missing…”  Direct students to begin “gallery walk”. Teacher dismisses groups to rotate to another table to provide feedback using the checklist. (5-10 min), assists students with completing matrix and engages students in conversation about criteria in the matrix. Instructs students that each group, move to another group to evaluate the proposal & prototype.  Ask one person from the group to stay behind to answer questions as each group uses the pugh Matrix.  (This evaluation may may take about 5-8 minutes per group).  Teacher asks students to return to their table to take a closer look at the engineering reflection on the handout and to make adjustments/improvements to their prototype & proposal  HW:   * Final Draft of Proposal * Start Reflection   Wrap-Up: Collect the Pugh Matrix, proposals & prototype.  Criteria for Success: Completed Prototype Design Matrix and also completed Pugh Matrix for another group (complete/incomplete grades). | Students, sitting with their teams/group, look over their prototype, set out draft of proposal; using the Prototype Design Matrix.  Students complete the Prototype Design Specifications worksheet to make sure they have met criteria and constraints on their prototype as well as to self-reflect on their engineering design and building experience. Some groups may want to add to this worksheet after the “gallery walk”.  Students read through the prompts of the “Self-Reflection/Pugh Matrix”  Students discuss each prompt about the process. Each group shares 1 strength & 1 challenge.  Students discuss in small groups which criteria should be weighted more. Then share out in participate in whole class discussion. Students select which criteria is more important to them and which is less important, by assigning 1 vs 2.  Students listen to modeling.  Student provide feedback to other groups’ proposal & prototype. Students alternate person stays at their table to answer clarifying questions. Whole class participates in “gallery walk”, using pugh matrix (either the Gallery Walk - Pugh Matrix  One person stays behind at their table to answer clarifying questions.Whole class participates in “gallery walk”, using pugh matrix (either the Gallery Walk - Pugh Matrix  Groups of 3 move to another table, using the Pugh Matrix and evaluate the project. Groups work together to read over another’s proposal.  Students return to groups, and edit proposal or adjust prototype. (~30 min)  Students work until the end of class.    Students clean-up. |
| **Day 2:** *Student groups will evaluate another group’s prototype and reflect on their group’s engineering.* | |
| Day 10:  Learning Target:   * Students review others’ evaluate Pugh Matrix on their group’s prototype. * Students metacognitively think through the PBL engineering design cycle with their group’s prototype to write a reflection of their learning.   Warm-Up   1. Pick up Pugh Matrix worksheets from other groups 2. Pick up “Self-Reflection Sheet”   Teacher hands out “Self-Reflection” sheet. Asks students to reflect on the engineering process (e.g. challenges, successes etc). *How does the Pugh Matrix from other groups on their prototype inform their written self-reflection worksheet?*  Inform students that each student take a turn writing in the groups’ response. (~10-15 min). Ask each group to share 1 success and 1 challenge.  Criteria for Success: Completed Energy Park Self Reflection Questions (grade) | Students, sitting with their teams/group, look over the Pugh Matrix from other groups on their group prototype.  Students collaboratively discuss the reflection worksheet and take turns writing to complete.  Students brainstorm which success and which challenge to share as well as how they wish to do their “mini”-presenting.  Student groups participate in the 1 success and 1 challenge share outs.  Students complete their own Energy Park Self Reflection Questions. |

**Accommodations:**

* No specific accommodations required.

**Extensions:** An additional ½ -1 ½ days > Part 3 extension provides a space for students to do additional critical thinking on the science of energy transfer embedded within their prototype (model).

|  |  |
| --- | --- |
| **Extension Option #1: Students review their teamwork skills and collaborating problem solving** | |
| Learning Target:   * Students reflect on individual effort. (PIE) * Students reflect and present on group strengths, weaknesses, opportunities, threats (SWOT)   Warm-Up   1. Pick up “Piece of the Pie: Teamwork” 2. Place prototype & printed copy of proposal on your group table.   Model and explain the purpose of the “Piece of the pie: Teamwork.” Students list what they worked on, then use that evidence to “divide” up the pie in parts that reflect the amount of effort put forth by each individual. (~15 min)  Introduce the engineering tool/student worksheet: SWOT: Group Work. *Teacher reviews questions on the handout with students to elicit student understanding.*  Criteria for Success: Completed checklist for another group. | In groups, students list what they worked in during the project, then discuss how to “divide” up the pie - students submit their own final decisions with group feedback (grade).  In groups, students collaborate to answer the SWOT questions about their group prototype work - students submit their group SWOT (grade). |
| **Extension Option #2: Students complete a class review of science used in group prototype** | |
| Learning Target:   * Students brainstorm and present one optimization to prototype * Students reflect and think critically on the science of energy transfer and how this informed their prototype decisions.   Warm-Up   1. Students review norms of using the Class Consensus Discussion Rubric to use in whole class discussion. 2. Students review types of energy transfer in Discussion Notes to prepare to use whole class discussion time to score rubrics and take individual energy transfer notes.   *Teacher reviews questions on the handout with students to elicit student understanding.*  Instruct students to complete page one of the handout. Elicit a student understanding of the norms listed on page one. Read and review the rubric on page two with students.  Teacher puts display of each group’s Prototype Design Matrix (specs - label) as they take their turn at the group discussion on their prototype.  *Teacher facilitates ongoing discussion of energy transfer* (during group discussions) eliciting student thinking to answer the reflection question for “one specific way you would make your design even better? Why would you make that change?”  Criteria for Success: Completed Class Consensus Scoring Guide with Consensus Discussion Notes. | Students write their one design change plan with why they would make that optimization.  Students individually review outline on participating in a Class Consensus; then review in whole class with teacher.  A student group in whole class gives a brief discussion of their prototype change while other students complete the rubric on the Class Consensus Scoring Guide. This is repeated multiple times until all groups have had their discussion. Checklists are shared with groups reviewed.  Students write energy transfer ideas and evidence using the Consensus Discussion Notes section of the Class Consensus Scoring Guide (grade). |

**Assessment:** *See Handouts.*

**References/Resources:** *See Handouts.*