EPICS and Service-Learning

Lesson 11- Redesign of the Proof of Concept Prototype

Essential Question: After evaluating the testing data and the information gained by interviewing the stakeholder after using the prototype, what changes and modifications need to be made to the prototype to make it more efficient and useful?

Note to teacher: In this activity, the students will be evaluating the idea of how the prototype will meet the needs of the underserved stakeholder rather than the actual prototype. The students will be communicating the concept of the prototype through graphic illustrations, photographs along with a written description. This type of testing is used to evaluate a new product idea.

Standards

NGSS HS. Engineering Design
Students who demonstrate understanding can:
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
ETS1.b: Developing Possible Solutions When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

Common Core State Standards Connections:
ELA/Literacy – SL.11-12.1c - Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on *grade 8 topics, texts, and issues,* building on others' ideas and expressing their own clearly. Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
ELA/Literacy –SL.11-12.1d. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on *grade 8 topics, texts, and issues,* building on others' ideas and expressing their own clearly. Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.

Materials

- Proof of Concept Prototype
- Proof of Concept Testing Plan results
- Student notebooks
- Student Exit Slips

Activities			
Activity	**Name of the Activity**	**Photocopies**	**Materials**
1	Preparation for Class - 1.3 and 1.8- Teacher Toolbox. Assigning Team rolls- 1.13 Teacher Toolbox- Roles and Responsibilities.		Student page
2	Standards Statement (Option: Unpacking the standards Teacher toolbox 1.12- Unpacking the standards)	11 Student Sheet	PowerPoint Presentation Proof of Concept Testing Plan
3	Evaluate the Prototype through the interview and the testing plan	11 Student Sheet	PowerPoint Student Sheet

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4	Develop a redesign procedure	Proof of Concept Testing	PowerPoint Presentation Student Sheet
5	Test the Prototype with the testing procedure. Record findings	Prototype Testing	
6	Reflection and Formative Assessment	Exit Slips	PowerPoint Presentation Notebook Formative Assessment Sheet

Overview

In this activity, the students will be taking the information that they have gathered from the stakeholders about the prototype, the data from their project testing and develop a redesign plan for their prototype. Through thoughtful evaluation of their data, they will be able to draw conclusions about the viability and usefulness of the proposal.

Major Concepts

- Prototyping used in Engineering
- Engineering design process
- Testing protocol
- Evaluating data to drive design

Objectives

Students will:

- Identify how engineers use prototypes as a way to examine a possible solution to a need in the community.
- Identify the phases of the engineering design process.
- Develop a testing protocol based on the project specifications
- Evaluate the testing measurements to determine the viability and usefulness of the product.

Lesson Preparation

Preparation

- **Lesson Preparation**: For specific directions on preparing lesson materials, see 1.3 and 1.8 documents in the Teacher Toolbox.
- **Instructional Resource:** Make sure that you have the *PowerPoint presentation* ready for class viewing.
- **Materials:** It will be important for the students to get a materials list identified so that they will have the necessary resources to build their redesign.

Procedure

Activity 1: Preparation for the Class

Multimedia Presentation: This lesson will have a multimedia presentation that will help to get the students thinking about the lesson and walking them through the information. Download the presentation in the folder.
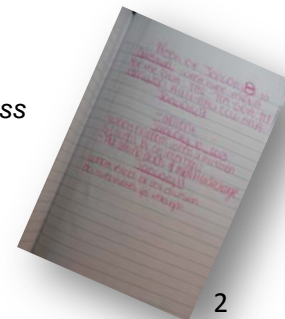
Preparing the notebooks- see document 1.3 in the Teacher Toolbox for specific instructions concerning notebooking.

Line of Learning # 11. Have the students reflect on the following question.
Proof of Concept
Question: what is the most important data I have collected about the usefulness of my prototype and how best to improve the design?

Team Roles and Responsibilities- For more detailed information about team roles; use 1.13 Teacher Toolbox Team Roles and Responsibilities.

Activity 2: Unpacking the Standards

Class Explanation: The students will be exploring how engineering and technology are deeply connected. They will need to be able to look at different sources of information and synthesize that information into statements that demonstrate their understandings.

Note to Teacher: Look above to see the standards that will be addressed through this lesson. The students need to understand the focus of the lesson, so an examination of the standards is a way of addressing this lesson essential.

Here is a possible Standard Statement which incorporates the standards used in this lesson:

> *Students will experience how speaking and listening skills is an important way of gathering important information to evaluate a solution to an engineering problem by creating a prototype and listening to feedback from peers to get initial feedback. They will use that information to redesign their prototype.*

Optional Lesson Component: As an additional component for this lesson, you may use Teacher toolbox 1.12- *Unpacking the standards in a Student Centered Classroom*. This gives procedures to help your students create their own standards statement.

- Pass out the student sheet

Activity 3: *Evaluate Prototype Information from Stakeholders*

Note to teachers: Students will need to have the information from their notebooks that they gathered by interviewing the stakeholders about the use of the prototype. They will need that information to create the *Proof of Concept* for their project and the testing that they did with that.

1. **Engaging prior knowledge- When** you shared the prototype with your stakeholder, what did you discover about the design?

In Design Groups:

Discussion: Be sure to answer the questions in your notebook so you have an accurate record of your project development.

Note to Teacher: there are many questions here to answer. It might be well to have the students divide the questions within their groups to get the most concise information about their prototypes and how it should be redesigned. A suggestion would be to give each student a different aspect of the prototype to analyze and evaluate. Then as they develop their redesign protocol, they will have "experts" on each part of their design.

- **Prototype Successes**: What were the successes of the prototype?
    - What were the parts of your prototype that were most useful for the stakeholder?
    - Should these parts be modified? If so what modifications can you make to those parts to improve their function?
    - If there are modifications, how will they be modified, size, shape, direction, color?
- **Prototype Issues:** Did the stakeholder encounter problems with the prototype?
    - Describe the problem.
    - What is your plan to modify the prototype to minimize or eliminate the problem?
- **Questions with Prototype Use:** Did the stakeholder have to ask you questions about the prototype and its function?

    If Yes

    - What was confusing to the stakeholder about your design?

- o What part of the solution will need more explanation?
- o In most situations, you will not be there to answer questions for the stakeholders so how will you address these questions?
  - o User's manual or guide?
- o Are there modifications to the prototype that will eliminate any confusion?
- **Observation of the Stakeholder** using the Prototype.
  - o Did the stakeholder use the prototype as you had designed it to work?
    - If not, what modifications will you make to make it more "user friendly"
    - What design issues are making the stakeholder use the prototype differently?
    - How are you going to modify the prototype?
  - o What did you learn from watching the stakeholder interact with the prototype?
  - o Did they use it in a way that would make it more accessible? How does that information impact your redesign?
  - o What design or instructional issues caused the stakeholder to use the prototype differently than intended?
  - o If the stakeholder's modification is an improvement to design, how are you going to use that information to improve the design?
- **Measurable Targets** (From Testing Document)
  - o What were your testing items that you worked with after you initially gave the stakeholders the prototype?
  - o How will you use that information in your redesign?
  - o If you know that your prototype solution needs to be improved, more cost effective or perform faster, what measurements will you be including in your redesign based on the data from your initial testing?

Record information: As the groups go through this iteration process, each student in the group should be answering the questions on their student sheet which will go in their notebooks. This will be invaluable as they are working to document the redesign process.

Note to teacher: Circulate around the room and throughout the groups to determine that the students understand the iteration process and discussing solutions to any problems that were encountered with the prototype. Also make sure that the students as they are exploring the redesign process that they discuss the measurement of the changes to the prototype.

Whole Group: Share out: Have each of the groups share out one of their most important issues that will need to be addressed in the redesign.

Activity 4: *Creating a Redesign Procedure*

Note to teachers: The students will be using the information that they have gathered and the data they have recorded in their notebooks to create a redesign plan for their project and prototype.
They will also be using the document 5.10 Proof of Concept Testing Plan as a starting place.

Note to Teacher: Students will use the documents for testing and 5.10 proof of concept testing plan as a way of organizing their redesign based on the original information. A suggestion is that they students use different colored ink or colored pencils to make changes to their document. They can keep a key with the color and date noted on the document. The notebooks are not supposed to be pristine; they are to give an accurate timeline of the development of the project.

In Groups: Look back over the documents that you have created your 5.10 proof of concept testing plan and the Excel testing document.

- Are there any changes that you need to make to the document concerning the basics of the project?
- Make those changes in a different colored ink and date the changes.

Students will use their specifications for the prototype and with the document 5.10 Proof of Concept Testing Plan, to create a protocol that can be used to evaluate their prototype and its viability and usefulness. Here are the basics.

1) Reexamine the basic requirements- Has any of this information changed after your observation and interview with the stakeholders and the initial testing?

- Product including the **dimension**s, a photograph or diagram, Specifications and important characteristics.
- **Purpose of the product** including the goals and objectives.
- **Success Criteria**
- **List of materials:** what are their uses and the limitations of said materials and their tolerances.
- **Goals** of the proof of concept prototype- probably this will change with the new information you have gathered.
- **Benefits of the Prototype**- This may be another part that has changed from the original document.

2) Prioritize the issues for the redesign- Determine which of the issues with the initial prototype are of highest priorities and identify how you will measure the results of the redesign.

Decide on what changes you will be making to your prototype and how you are going to measure the success of that change. Record that information on your student sheets in your notebook.

3) What is your redesign?

- Sketch your redesign
- What materials do you need?
- What is the duration of the redesign?
- What are the features of the redesigned prototype that will be tested and who is responsible? (This will relate back to your specifications. These may include but may not be limited to: safety, durability, power, weight, accessibility, physical dimensions.)
- What are the measureable criteria that you will use in this testing protocol?
- Record your testing procedure in your notebook.

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5) Summary:

- Discuss the redesign protocol as a group to ensure that it is a solid plan for redesign. This iteration is essential for the group to meticulously plan for the redesign. This will help to ensure that there are no unforeseen issues that could have been avoided through proper planning.

The group will complete the documentation and be ready to redesign their prototype.

Activity 5: Redesign *Using Criteria from Observations, Interviews and Testing Data*

Note to Teacher: In the redesign phase, the students have created a redesign protocol determined by the importance of the issues that need to be addressed.

Redesign Preparation
Materials: Make sure that the students have secured the materials that they will need for the project and the redesign.

Instructions:
Students will:
- Review the design sketches they have created in their notebooks.
- Determine if the original prototype can be modified or will it have to be rebuilt.
- Build their prototype based on the sketches and the modifications that have been suggested through the observations, interviews with stakeholders and data from the testing.
- Students will record in their notebook the modification and how that modification will make the prototype more usable for the stakeholder.

Note to Teacher: Circulate among the teams as they go through the redesign of the prototype. Make sure that the students have explored the most important specifications for the project as a testing emphasis.

Activity 6: Wrap-Up: *Reflection and Formative Assessment*

1) **Back to the Standards:**
Go back to the original class document about the standards.
Ask the students did the students:
   - Use the information from the stakeholders and the testing to redesign their prototype?
   - Can the students defend their prototype redesign as an improved project and give important insights into the viability and usability of their project.

2) **Formative Assessment and student reflection**: Last 5 minutes of class
- Pass out the *Exit slips*. This will give you an idea of what they have learned in the lesson.
- Make sure that they students have their *notebooks open* with their design documents in their books.
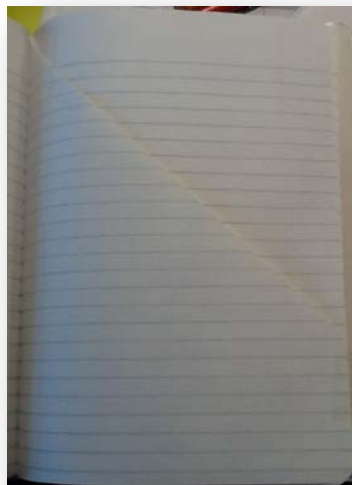
Because this document is good sized, you may want to create a pocket in your notebook which is pictured here.
How to create a pocket:
- Have the students open their notebook to the next available page
- Take that page and fold it diagonally backward into the next page
- Tape the sides and bottom to create a pocket.
- Students will then be able to label the pocket as their prototype design and insert the folded document in the pocket.

Notebook check:
As the students are filling out the slips, walk around the room and check to make sure that the student have the following information in their notebook:
- ✓ Completed the redesign information in their notebooks as an artifact for the project.
- ✓ Sketches of their redesign and the issue that it should eliminate or modify.
- ✓ Determine the measurable criteria for each modification to the redesigned prototype.
- ✓ Have the students turn in the exit slip.

3) Teacher Reflection: Look at the student's exit slips and the student notebook.
Questions:

- ✓ Have the students expressed an understanding of the correlation between measurement and modification to the prototype?
- ✓ Developed a list of modifications that need to be implemented with the prototype?
- ✓ How are the students reflecting in their notebook?
- ✓ Are the students showing self-efficacy when reflecting on their own learning in the class?

Resources:

- Cumming, A., (2014) EPICS Test Plan Template- EPICS Program, Purdue University
- Catalign Innovation consulting- http://www.catalign.in/2008/11/prototyping-foundational-competency-of.html
- Gearfuse- http://www.gearfuse.com/the-original-prototypes-of-iconic-gadgets/
- Institute of Design at Stanford http://dschool.stanford.edu/dgift/#gear-up
- http://www.johnsonrd.com/ie/lj/ljprofile.html
- NGSS Lead States. (2013). Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press. For more information see http://www.nap.edu/NGSS/
- National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for English language arts and literacy in history/social studies, science, and technical subjects*. Washington, DC: Authors.
- Oakes, W., Zoltowski, C., (2013). Presentation for Online Teacher Training*,* EPICS Program, Purdue University.
- United States Government National Archives- http://www.archives.gov/records-mgmt/policy/pilot-guidance.html