Standards/Objectives

Detailed plan for communicating these standards and objectives to students with sample materials

The standards and objectives will be communicated to students through various avenues including a rubric, a checklist of skills to be mastered, verbal cues throughout the unit, and checkpoint skills quizzes. Students will also partake in daily reflections in order to ensure they are understanding the standards/objectives appropriately- and then reactive supplemental activities or scaffolding can help clarify any misconceptions of the standards/objectives.

Detailed plan for ensuring students are able to explain what and how they are learning.

A variety of methods will be used to ensure students are able to explain what and how they are learning. This will include posting daily essential questions and learning objectives in the classroom, creating a culture of partnering in the classroom, maintaining an activity log, and providing opportunities for reflection through debrief sessions and exit slips. In addition, students will be asked to read, write, speak, and listen everyday to give chances for the teacher to make formative assessments that the students are learning what is expected.

Math Content Standards

The following is a list of Indiana State Standards that will be addressed with our PBL. The focus of our PBL will be in a Geometry classroom comprised primarily of freshman students. The PBL will primarily focus on solving real world problems involving volume and surface area to create and solve a design problem.
GEOMETRY

The Mathematics standards for Geometry are supplemented by the Process Standards for Mathematics.

The Mathematics standards for Geometry are made up of 5 strands: Logic and Proofs; Points, Lines, Angles, and Planes; Triangles; Quadrilaterals and Other Polygons; Circles; Transformations; and Three-dimensional Solids. The skills listed in each strand indicate what students should know and be able to do in Geometry.

Quadrilaterals and Other Polygons

G.QP.5: Deduce formulas relating lengths and sides, perimeters, and areas of regular polygons. Understand how limiting cases of such formulas lead to expressions for the circumference and the area of a circle.

- Learners will explore the relationship between the dimensions of a polygon and the resulting surface area and volume through an activity like "Shape and Surface Area/Volume".

Three Dimensional Solids

G.TS.1: Describe relationships between the faces, edges, and vertices of three-dimensional solids. Create a net for a given three-dimensional solid. Describe the three-dimensional solid that can be made from a given net (or pattern).
- Learners will apply their knowledge of nets to develop a three-dimensional scaled model of their final device.

G.TS.5: Solve real-world and other mathematical problems involving volume and surface area of prisms, cylinders, cones, spheres, and pyramids, including problems that involve algebraic expressions.
- Learners will research real-world industry standards relating to the design and development of various technological devices.
- Learners will analyze the results of their research and apply it to their understanding of surface area and volume relationships when evaluating the materials and product costs.

G.TS.6: Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).
- Learners will design the "Next Big Thing" to satisfy project criteria, which may include cost, functionality, size, and/or marketability.

Nanotechnology Objectives

The following is a list of the four nanoscience skills that we will focus on including how the higher order thinking skills (HOTS) will be addressed in our unit.

Size and Scale

1) Learners will be able to relate the size of nano-sized objects to objects encountered in daily life (macro scale).
- Learners will investigate the relationships between nanometers and real-world objects through an activity similar to "How big is it?".

2) Learners will be able to apply dimensional analysis in conversion problems.
- Learners will utilize their knowledge of dimensional analysis to convert between nanometers and meters through a scaling activity similar to "Nanometer Activity".

Structure of Matter

3) Learners will compare surface-area-to-volume ratios of different sized objects and explain that surface-area-to-volume ratios play a role in the unique properties of objects at the nanoscale.
- Learners will use their mathematical understanding of surface area and volume to develop a comparison between the surface area to volume ratio and the size of objects through an activity similar to "The Painted Cube".

Forces and Interactions

4) Learners will be able to explain why (intensive) properties of matter can change at the nanoscale (for example: properties like boiling point, reactivity, malleability, fluorescence, magnetism).

- Learners will write reflections reporting their findings during a comparison of gravitational and electromagnetic forces given an electron and a proton (similar to the "Gravitational vs Electromagnetic" activity).

21st Century Skills

This PBL will address several 21st Century Skills, but the primary Skills that will practiced are Critical Thinking and Problem Solving, Creativity and Innovation, and Communication and Collaboration.

Critical Thinking and Problem Solving

1. Students will perform market and product research in order to determine characteristics of desirable products. They will also synthesize and analyze the data the information they collect to apply this information to their own designs.
2. Students will need to determine necessary questions and then research the intricate details to learn of the technological components that will lead to better advances in their products

Creativity and Innovation

1. Students will work together in their groups to determine their desired product based upon their brainstorming sessions, market analysis among their peers, or any other creation technique that seems appropriate
2. Students will implement their imagination and creativity to design their product to outshine the other products in the class
3. Students will hone their communication skills within their own groups when designing their product, also when delivering their elevator pitch to potential consumers
4. Students will apply the comments and suggestions from their peers to learn more about improving their product, and then implementing those suggestions based upon the mass preferences

Communication and Collaboration

1. Students will articulate their product ideas through verbal presentation, and also written report in order to properly communicate the details of their product
2. Students will work in a team of diverse individuals, and demonstrate their cohesiveness as a single unit by presenting a final product that was built together