LAUSD Elementary Engineering

DESIGN A TOY THAT MOVES FROM HERE TO THERE CHALENGE

Third Grade - Physical Science

PURPOSE

IN THE <u>DESIGN A TOY THAT MOVES FROM HERE TO THERE CHALLENGE</u>, STUDENTS WILL:

- Plan, design, and create a toy that wobbles
- Exhibit understanding of relevant science content/concepts
- Construct relevant questions
- Use appropriate materials provided to complete their task
- Determine effectiveness of their design
- Answer the Focus Question: <u>How can we design a toy that wobbles when it moves?</u>

NEXT GENERATION SCIENCE STANDARDS (NGSS)

3-5-ETS1 Engineering Design

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Students who demonstrate understanding can:

3-5-ETS1-1. **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**

3-5-ETS1-2. **Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.**

3-5-ETS1-3. **Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. ▪ Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) ▪ At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) ▪ Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) **ETS1.C: Optimizing the Design Solution** ▪ Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	**Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1) ▪ Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Connections to 3-5-ETS1.A: Defining and Delimiting Engineering Problems include:
Fourth Grade: 4-PS3-4
Connections to 3-5-ETS1.B: Designing Solutions to Engineering Problems include:
Fourth Grade: 4-ESS3-2
Connections to 3-5-ETS1.C: Optimizing the Design Solution include:
Fourth Grade: 4-PS4-3

Articulation of DCIs across grade-bands: **K-2.ETS1.A** (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3); **K-2.ETS1.B** (3-5-ETS1-2); **K-2.ETS1.C** (3-5-ETS1-2),(3-5-ETS1-3); **MS.ETS1.A** (3-5-ETS1-1); **MS.ETS1.B** (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3); **MS.ETS1.C** (3-5-ETS1-2),(3-5-ETS1-3)

Common Core State Standards Connections:

ELA/Literacy –

RI.5.1	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(3-5-ETS1-2)*
RI.5.7	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(3-5-ETS1-2)*
RI.5.9	Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)
W.5.7	Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1),(3-5-ETS1-3)
W.5.8	Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. *(3-5-ETS1-1),(3-5-ETS1-3)*
W.5.9	Draw evidence from literary or informational texts to support analysis, reflection, and research. *(3-5-ETS1-1),(3-5-ETS1-3)*

Mathematics –

MP.2	Reason abstractly and quantitatively. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*
MP.4	Model with mathematics. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*
MP.5	Use appropriate tools strategically. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*
3-5.OA	Operations and Algebraic Thinking *(3-5-ETS1-1),(3-5-ETS1-2)*

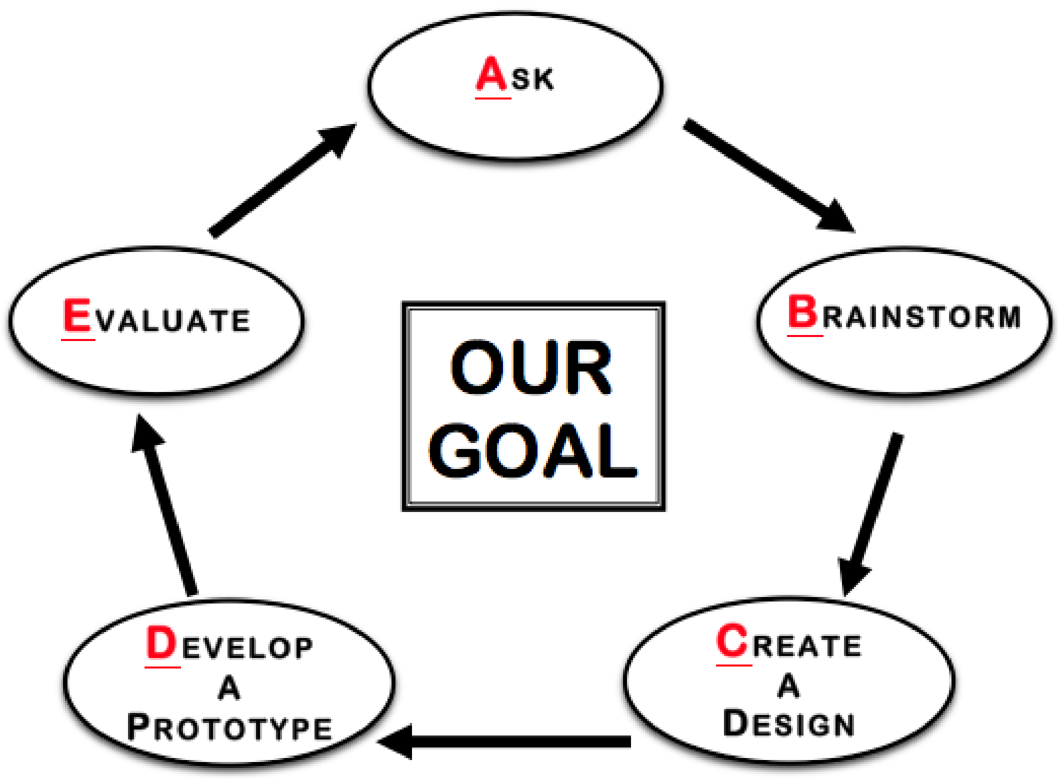
CA ENGLISH LANGUAGE DEVELOPMENT CONNECTIONS

- **P1.3.A.1** Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics
- **P1.3.A.2** Interacting with others in written English in various communicative forms (print, communicative technology, and multimedia)
- **P1.3.A.3** Offering and supporting opinions and negotiating with others in communicative exchange

SPECIAL EDUCATION (SPED):

To make accommodations or modifications for students with special needs, provide simple directions, instructions, provide multiple opportunities for repetition, make frequent checks for understanding, use visuals to accompany all vocabulary, simplify questions, be specific with sequence and steps, provide opportunity for paraphrasing, and adjust time and pacing.

The Engineering Design Process (EDP)



ENGINEERING DESIGN PROCESS (EDP)

ASK

- What is the **problem** or **need**?
- What is already out there?
- What are the **requirements (criteria)** and **restrictions (constraints)**?

BRAINSTORM

- What are possible **solutions**?
- Choose your two best solutions.

CREATE - A - DESIGN

- **Draw** a diagram with labels.
- Have a critical design review (peer review & input).
- What materials are available?

DEVELOP - A - PROTOTYPE

- Follow your best diagram and **build** a prototype.
- **Test** the prototype!

EVALUATE

- **Improve** your prototype!
- Conduct more compatibility tests.

BACKGROUND FOR THE TEACHER

You may teach this lesson once students have completed:

FOSS CA – MATTER AND ENERGY

- **Investigation 1, Parts 1-3**

Additional information can be found in the Matter and Energy FOSS Teacher's Guide.

MATERIALS

FOR EACH TEAM

- Found Objects From Around The School Campus
  - Milk / Juice Cartons
  - Breakfast / Lunch Trays
- Warehouse Catalog/School Supply Items
  - Yarn / Roving
  - Construction Paper
  - Large Index Cards
  - Pipe Cleaners
  - Tape (Scotch/Masking/Bookbinding)
  - Scissors
  - Drawing Supplies (Color Pencils, Markers, etc. for decorating)
  - Rubber Bands
- FOSS Materials
  - Disks (Large and Small)
  - Straws- Regular and Jumbo
  - Craft Sticks
  - Tongue Depressors
  - Motors
  - AA-Cells

FOR THE LESSON

- Individual student engineering notebooks
- Open Floor Space (1sq. foot tiled floor works best)
- Cardboard ramp using clothespins supports (see Investigation 1, part 3)

GETTING READY

1. **Schedule the Engineering Challenge**
   The challenge will take three 45-minute sessions: one for planning, one for testing and evaluation, and one for redesigning.

2. **Gather / Obtain Materials**
   Be sure to allot time for milk/juice carton and tray collections.

3. **Prepare Materials Station**

4. **Plan Partners/Teams**

GUIDING THE ACTIVITY

Students will engage in the Engineering Design Process (EDP)

1. ASK

Setting Up the Context

- Begin by telling the students that the biggest toy manufacturer of the city has a need for a new toy for the upcoming Christmas season. They have heard of a low-cost toy that wobbles. In addition, they are offering a large award of $1,000,000 for the team of engineers that can design a prototype toy. There are some restrictions, in that, there are specific materials needed to build the prototype. While students are gathered, explain or demonstrate to them how energy transfers from one object to another. Tell students that today they will be working with a partner(s) to use their scientific knowledge about energy in order to create the toy.

Present Problem or Need

- The challenge is to design a toy that wobbles when it moves using a type of energy. The group goal is to have their toy travel the farthest.

- Have students record the Focus Question in their engineering notebooks - <u>How can we design a toy that wobbles when it moves?</u>

- Encourage students to come up with their OWN questions about materials, criteria, and constraints. (Sample questions: How long do we get to create the toy? What materials can we use? Are there any pictures of examples? Where will we test our toy? Does it have to go in a straight line? What do you mean, "using a type of energy?")

Present Requirements and Restrictions

- **Requirements** (Criteria) *standards that must be met; rules/directions that must be followed)*:
    - Teams consist of 2 - 4 members.
    - The toy must wobble.
    - The toy must remain stable and intact.
    - The toy must be self-propelled with the materials available.
- **Restrictions (Constraints)** that keep something from being the best it could be; may be problems that arise or issues that come up:
    - Teams may only use materials provided by the teacher.
    - Teams must complete the prototype within the time allotted and be ready to test their toy.
    - Toy must be self-propelled. Students may not push or pull their toy.

2. BRAINSTORM

- Teams may handle materials at the material station but are not allowed to modify them or take materials back to their own table.

- Teams evaluate the available materials and determine their usefulness based on their properties.

- Teams may research other wobble toys that exist.

3. CREATE - A - DESIGN

- Each member must draw a design individually, without team member input, into his/her science notebook.
  - Title the page "My design"
  - Students should label the parts of their design (i.e. carton, round balloon, tape, etc.) Also, include on your model things that cannot be seen such as wind, gravity, etc. Indicate the movement with arrows.
  - Include a materials list with your design.

- Team members share designs with one another, compromise, and collaborate in order to create into a "team design."
  - Title the page "Team design"
  - Team members should label the parts of their design

4. DEVELOP - A - PROTOTYPE

- Getters go to the material table with their list and gather materials.

- Teams build toys according to their collaborative designs.

- Teams test their design 3 times. Each team member records the outcomes in their Notebooks. (Teacher does the distance measuring. Teacher decides if students should use the best result of the three or an average.)

5. EVALUATE

- Teams will test the success of their toys one at a time.
- After testing their prototypes, group members discuss, come to consensus, and draw an improved toy in their Notebooks. Test again. (3 tries—record in Notebook)
- Teams compare the outcomes of the revised prototype to the original prototype. "What observations did you make?" Record observations in Notebook.
- Teacher facilitates discussion about student successes and challenges.
- Successes are determined by distance traveled (across the floor or table).
- Students will answer the Focus Question in their notebooks.
    - Sentence frames can be used for scaffolding. For example: *"We got our toy to safely wobble across the floor by__________."*
    - Encourage students to include information about both their successes and failures.