How to Integrate STEM in Your Classroom with NGSS FOSS

Larry Escalada  
*University of Northern Iowa*

Alison Beharka  
*University of Northern Iowa*

---

**Let us know how access to this document benefits you**

Copyright ©2022 Larry Escalada and Alison Beharka

Follow this and additional works at: [https://scholarworks.uni.edu/sciedconf_documents](https://scholarworks.uni.edu/sciedconf_documents)

Part of the Science and Mathematics Education Commons

---

**Recommended Citation**

Escalada, Larry and Beharka, Alison, "How to Integrate STEM in Your Classroom with NGSS FOSS" (2022).  
*Science Education Update Conference Documents*. 34.  
[https://scholarworks.uni.edu/sciedconf_documents/34](https://scholarworks.uni.edu/sciedconf_documents/34)

This Slideshow is brought to you for free and open access by the Science Education Update Conference at UNI ScholarWorks. It has been accepted for inclusion in Science Education Update Conference Documents by an authorized administrator of UNI ScholarWorks. For more information, please contact scholarworks@uni.edu.
How to Integrate STEM in Your Classroom with NGSS FOSS

Lawrence Escalada and Alison Beharka

Science Education
University of Northern Iowa

April 1, 2022
NGSS FOSS Modules

- **STEM Enrichment**
  - Forces in Action (Grades K-2)
  - Sound & Design (Grades 3–5)
  - Variables and Design (Grades 6-8)

- **Others**
  - Observing Nature (Grade Pre-K)
  - Weather & Seasons (Grade K)
Variables & Design (Grades 6 - 8)

● Investigation 1 Testing Variables
  ○ Phenomena – How can we design a controlled experiment?
● Investigation 2 Testing Designs
  ○ Phenomena – How does engineering design process help us solve problems?
● Investigation 3 Real World Problems
  ○ What are engineers doing to solve real-world problems?
Course anchor phenomenon

Engineers try to solve problems. You will work like an engineer to identify a problem and start to develop possible solutions. Title a new page in your notebook: Possible Engineering Problems. Jot down any ideas on this page.

- What are some problems you can identify that might be solved through clever engineering?
Air trolleys and motion

One of the first things we will explore is the motion of an air trolley. It runs on a line across the classroom. This trolley represents real-life modes of transportation, including a zip line.
What makes a passenger move on the zip line?
Focus question

- How can we describe and measure motion in a system?
Construct air trolleys

Teacher master A, Air-Trolley Construction

Variables and Design Course, 1.1: Air Trolleys
Step 8
DEMO AIR TROLLEYS
Make the trolleys move

Make your trolley move. Thinking like a scientist, observe the motion and be prepared to describe the motion to the class. Think about what affects the air trolley’s movement.
**Cause and effect**

- Did you successfully get the trolley to move?
- What evidence do you have to support the claim that the trolley moved?
- What cause-and-effect relationship explains the motion of the air trolley?
EXPERIMENTAL DESIGN QUESTIONS

Think about the experiment where we tested how the number of winds affects the distance an air trolley travels, and try to answer these questions.

1. What was the independent variable?

2. What was the dependent variable?

3. How did we test the independent variable?

4. How did we control other variables?
AIR-TROLLEY CRITERIA

Engineering problem
Design an air trolley that safely and efficiently moves passengers from one end of a 4-meter line to another.

Criteria, or design requirements, for the air-trolley challenge:
• The line must be 4 meters long and level.
• The trolley carries three passengers (paper clips).
• Safety: The trolley stops at the end of the line (does not bounce back).
• Efficiency: The trolley uses the least amount of fuel (number of winds).
AIR-TROLLEY CONSTRAINTS

Engineering problem
Design an air trolley that safely and efficiently moves passengers from one end of a 4-meter line to another.

Constraints, or design limitations, for the air-trolley challenge:
• Only two periods are available for designing, testing, and redesigning.
• You must use available materials (can bring materials from home).
BRAINSTORMING GUIDELINES

The idea of brainstorming is to generate as many ideas as possible as quickly as possible.

- Choose someone on your design team to write down the ideas that your team members come up with.

- Have your team members start sharing their ideas.

- Write down all ideas. Do not evaluate the ideas right now. Any type of evaluation, such as “That is a great idea!” or “I don’t think that will work,” will keep other members of the team from wanting to share their ideas.

- Even an idea that has no chance of working can trigger someone else to think of a new idea that just might work.

- Make sure everyone has a chance to share their ideas.
ENGINEERING DESIGN PROCESS

1. Identify and research the problem
2. Brainstorm
3. Share solutions
4. Design/redesign
5. Build
6. Test
7. Evaluate
8. Repeat
DEFINING AN ENGINEERING PROBLEM

Here are some questions you should be able to answer about the problem you want to solve. Answering these questions helps you define the engineering problem.

- What scientific information (research) is needed to solve this problem?
- What variables could affect the problem’s outcome?
- Will this problem result in a new:
  - object or product?
    (example: phone, solar tent, water quality test)
  - digital technology?
    (example: computer program/app)
  - system?
    (example: reorganize the school cafeteria so lunch lines aren’t as long)
- Who has the problem?
  Hint: Is the problem a global issue affecting many people, or is it a local issue affecting people in one area?
- What are the criteria for success?
- What are the constraints for this problem?
  Hint: Think about potential impacts on people and/or the environment.
- What funding (money) would be required for a solution?
  Hint: Think about who might want to invest in a solution to this problem.
PROBLEM EXAMPLES

How would you define and start solving these engineering problems? Are some easier than others to define and design solutions?

- Students are often late to class.
- Running shoes are too heavy.
- Many people around the world don’t have enough to eat.
- Some lightbulbs require too much electricity.
- Internet searches take too long.
- A lake is polluted by chemicals from a factory nearby.
What is FOSS?

• Full Option Science System
• Developed by UC Berkeley Lawrence Hall of Science
• Provides students the opportunity to think and act like scientists and engineers.
Three-Dimensional Active Learning

The FOSS program has always placed student learning of science practices on equal footing with science concepts and core ideas and the NGSS and Framework for K–12 Science Education have provided a new language with which to articulate this. In each FOSS Next Generation investigation, students are engaged in the three dimensions of the NGSS to develop increasingly complex knowledge and understanding.

Science and engineering practices are the cognitive tools scientists and engineers use to answer questions and design solutions. FOSS students use these tools to gather evidence and to explain real-world phenomena.

Grade level appropriate disciplinary core ideas are the concepts and established ideas of science. FOSS students develop these building blocks throughout investigations to make sense of phenomena.

Crosscutting concepts help students to connect the varied concepts and disciplines of science. FOSS students apply these concepts to different situations in order to make connections and develop comprehensive understanding.
FOSS INSTRUCTIONAL DESIGN

FOSS is designed around active investigation that provides engagement with science concepts and science and engineering practices. Surrounding and supporting those firsthand investigations are a wide range of experiences that help build student understanding of core science concepts and deepen scientific habits of mind.

The Elements of the FOSS Instructional Design

- Using Formative Assessment
- Integrating Science Notebooks
- Taking FOSS Outdoors
- Engaging in Science-Centered Language Development
- Accessing Technology
- Reading FOSS Science Resources Books
Comprehensive Package for FOSS

• Classroom Equipment Kit
• Investigations Guide
  – Print and Online
• FOSS Science Resources
• FOSS Technology
  – Transition from FOSSWeb to ThinkLink
• Teacher Resources
• Spanish Resources
• Live Organisms

Meet Your FOSS Module!
Your FOSS module includes one or more large boxes, called drawers, and two smaller boxes for the Teacher Toolkit, student books, and other equipment. Each drawer has a label on the front listing its contents. Your packing list is always in Drawer 1.

Permanent Equipment
Your equipment kit includes enough permanent equipment for up to 8 groups (32 students). This equipment is classroom-tested and expected to last 7–10 years.

Consumable Equipment
Your kit also includes consumable materials for three class uses. Convenient refill kits provide materials for three additional uses and are available through Delta Education.

Easy Set-up and Clean-up!
FOSS Next Generation equipment drawers are packed by investigation to facilitate prep and to make packing up for the next use a snap!

Live Organisms
Some investigations require live organisms. Schools are encouraged to purchase these organisms from a local biological supply company to minimize both transit time and the impact of adverse weather on the health of the organisms.

If living material cards are purchased from Delta Education, they will be shipped separately in a green and white envelope. Keep these cards in a safe place until it’s time to redeem them for the investigation.

Call Delta Education at 800-258-1102 at least three weeks before you need your organisms.
FOSS Pre-K-8 Scope and Sequence
<table>
<thead>
<tr>
<th>Grade</th>
<th>Physical Science</th>
<th>Earth Science</th>
<th>Life Science</th>
<th>STEM Enrichment</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Mixtures &amp; Solutions</td>
<td>Earth &amp; Sun</td>
<td>Living Systems</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Energy</td>
<td>Soils, Rocks, and Landforms</td>
<td>Environments</td>
<td>Sound Design†</td>
</tr>
<tr>
<td>3</td>
<td>Motion &amp; Matter</td>
<td>Water &amp; Climate</td>
<td>Structures of Life</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Solids &amp; Liquids</td>
<td>Pebbles, Sand &amp; Silt</td>
<td>Insects &amp; Plants</td>
<td>Forces in Action†</td>
</tr>
<tr>
<td>1</td>
<td>Sound &amp; Light</td>
<td>Air &amp; Weather</td>
<td>Plants &amp; Animals</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Materials &amp; Motion</td>
<td>Trees &amp; Weather</td>
<td>Animals Two by Two</td>
<td></td>
</tr>
<tr>
<td>Pre-K</td>
<td>Full-year Observing Nature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>Integrated Middle Grades</td>
<td>STEM Enrichment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
<td>-----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Heredity &amp; Adaptation*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ES, LS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electromagnetic Force*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PS, ES, E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gravity &amp; Kinetic Energy*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PS, E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waves*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PS, E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planetary Science</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PS, ES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Chemical Interactions</td>
<td>Variables &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PS, ES, E</td>
<td>Design†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Weather &amp; Water</td>
<td>Grades 5-8, E</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PS, ES, E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diversity of Life</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Human Systems Interactions*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FOSSWeb Demo Account

- [https://www.fossweb.com/](https://www.fossweb.com/)
- Log in
  - Email Address: [fossdemo@gmail.com](mailto:fossdemo@gmail.com)
  - Password: Spring 2021
UNI Yager Science Education Center

- Previously, UNI Science Education Resource Center
- Provides science curriculum resources and outreach for UNI Faculty, Staff, & Students and teachers & schools in Central Rivers AEA.
- Resources
  - Full Option Science System (FOSS) Science Kits
    - Next Generation and Pre-Next Generation
  - Other Pre-NGSS Science Kits
- Professional Learning Opportunities & Summer Workshops
If interested in learning more, contact us.

Lawrence.Escalada@UNI.edu

Alison.Beharka@UNI.edu