Using Basic Classroom Materials to Inspire The Next Century Of Innovators
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The Next Century of Innovators

boeing.com/100-days

Sept. 28, 2016
Agenda

Introductions
Holly Yettick, Director, Education Week Research Center

Science And Innovation Modules
Dr. Jennifer Stotts, STEM Education Consultant, Teaching Channel
Sandra Geisbush, M.Ed., NBCT, Educator at NEISD STEM Academy

STEM for Space Exploration
Tony Castilleja Jr., Systems Engineer, Boeing Space Exploration

Q&A
Holly Yettick, Director, Education Week Research Center
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Tony Castilleja Jr., *Systems Engineer*, Boeing Space Exploration
Science and Innovation Modules
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"What drew me to the project was actually the STEM component. It was an opportunity where I could teach and actually create the curriculum with two engineers... My students gained knowledge on how to rebuild, how to redesign, how to revamp, how to re-guide [their] thinking."

Tiffani Slaughter
5th Grade Teacher
Houston, TX
"The Next Generation Science Standards focus a lot on engineering practices and this project allowed me to strengthen my abilities in this area. It also allowed my students to be curious, to be inquisitive, to gather data and to consult each other and work as real scientists."

Jessica Levine
6th Grade Teacher
Seattle, WA

https://www.teachingchannel.org/engineering-curriculum-boeing
Polymers for the Planet

In this module, students design a biopolymer to be used as an alternative to plastics. Students engage in the engineering design process as they define the design problem, develop and test possible solutions, and optimize their solution. Through their work developing biopolymers, students figure out that combining two or more substances results in a new substance with different properties. In addition, students consider ways individuals and communities use science ideas to protect Earth’s resources and environment.

NGSS addressed by this module:
3-5-ETS1-1  3-5-ETS1-3  5-PS1-3  5-PS1-4  5-ESS3-1

Grade Band: 5-8

Watch the Video

Engineering Design in the Classroom: Polymers for the Planet

Download the Lessons

Entire Unit: Polymers for the Planet
DAYS 1–10: Polymers Teacher Handbook Download

DAY 1: Why We Need a Better Plastic
Students are introduced to the design problem to develop a biopolymer that is less harmful to the environment than plastic. Download

DAY 2: Characteristics and Properties of Polymers/Plastics
Students identify characteristics and properties of plastics and use this information to identify specific criteria for their biopolymer. Download

DAY 3: Materials We Can Use to Make a Biopolymer
Students develop their formulas to create biopolymer compounds for testing. Download

DAYS 4 & 5: How to Make Prototype Biopolymers
Student teams execute their test plans for making the biopolymer formulations they defined in Day 3. Download

DAY 6 & 7: Characteristics and Properties of Our Biopolymers
Students determine the characteristics and properties of their prototype biopolymer coupons and conduct a tensile strength test. Download

DAY 8: Sharing Our Findings
Students review the data and share the findings compiled during their qualitative observations and quantitative testing trials. Download

DAYS 9 & 10: Final Presentations and Findings
Students present their findings and optimization plans. Download

Download Additional Resources

Polymers Student Handbook
All Days Download

Wooden Stick Mold Video
DAYS 4 & 5 View

"The Next Generation Science Standards focus a lot on engineering practices and this project allowed me to strengthen my abilities in this area. It also allowed my students to be curious, to be inquisitive, to gather data and to consult each other and work as real scientists."

Jessica Levine
6th Grade Teacher, Seattle, WA
Polymers for the Planet
Day 1: Why We Need a Better Plastic

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Grade 5</th>
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<tbody>
<tr>
<td>Lesson Length</td>
<td>One 50-minute session (if possible, consider adding another day)</td>
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Lesson Overview

During this introductory lesson, students are introduced to the design problem. They learn that Premier Polymer Providers has hired them to develop a biopolymer that is less harmful to the environment than plastic. Students work to clearly define the design problem by exploring the societal issues related to creating and using plastics. Students write a letter back to Premier Polymer Providers articulating their understanding of the need for further work on biopolymers. The letters focus on the core ideas related to human impact on the environment.

Connecting to the Next Generation Science Standards

On Day 1, students make progress toward developing understanding across the following three dimensions:

- **Science and Engineering Practices:** Asking Questions and Defining Problems, Obtaining, Evaluating, and Communicating Information
- **Disciplinary Core Ideas:** ETS1.A Defining and Delimiting Engineering Problems, ESS3.C Human Impacts on Earth's Systems
- **Crosscutting Concepts:** Influence of Science, Engineering, and Technology on Society and the Natural World
"I think testing is a vital part of the engineering process; and to do it this early was a really fantastic way for them to really know that they are in the middle of an engineering unit [since] this is just their first iteration... [Students] were just really, highly engaged in that testing process."

Marcia Ventura
5th Grade Teacher
Seattle, WA
Module Iterations

Phase 1
- 20 Engineers + 10 Teachers
- Create & Teach

Phase 2
- 10 Teachers
- Tch Senior Science Editor

Phase 3
- Iterative Review
- Achieve + EQuIP Rubric

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DR. KEN HEYDRICK
Ex. Dir. TX STEM Coalition, National Science Education Leadership Association

DR. APRIL GARDNER
Science Educator with BSCS (Biological Sciences Curriculum Study)

DORA KASTEL
Senior Coordinator of PD, Gottesman Center for Science Teaching and Learning

THOMAS J. MCKENNA
Staff Scientist at Connecticut Science Center, Lead National Facilitator for NGSX

KARL MUENCH
8th Science Teacher, National Writing Project with NGSS
### Driving Question: How can we design a wind turbine blade that generates the most electricity?

<table>
<thead>
<tr>
<th>Question/Problem</th>
<th>What Students Are Doing</th>
<th>What Students Figure Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why does a pinwheel spin?</td>
<td>Students experiment with pinwheels to develop first draft models explaining why a pinwheel spins.</td>
<td>Pinwheels spin when wind hits the pinwheel blades. Depending on the angles of the wind or blades, the pinwheel spins at different speeds.</td>
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<tr>
<td>How can a wind turbine harness the wind?</td>
<td>Students create models to explain why an LED light turns on when wind turbine blades spin (and why a voltmeter reads a voltage output).</td>
<td>When wind turbine blades turn, they turn a magnetic rotor. The magnetic rotor creates electrical energy to turn on the LED light.</td>
</tr>
<tr>
<td>How can we maximize the energy output of our turbine?</td>
<td>Students experiment with blade designs to create a blade that generates the most speed and electricity.</td>
<td>Changing the size, length, width, angle, shape, and number of blades changes the speed and voltage output of the turbine.</td>
</tr>
<tr>
<td>How is energy from the wind transformed into electrical energy?</td>
<td>Students disassemble and create motors.</td>
<td>When the wind blows, the turbine spins, spinning a magnetic rotor, which converts mechanical energy into electrical energy.</td>
</tr>
<tr>
<td>How can we design a wind turbine blade that generates the most electricity?</td>
<td>Students experiment with multiple turbine blade designs to generate the most electricity. Students justify their decisions with science ideas.</td>
<td>Wind turbine blades must balance, lift, and drag. Certain sizes, shapes, materials, and angles can optimize output.</td>
</tr>
</tbody>
</table>
ENERGY AND MATTER
Energy can be transferred in various ways and between objects.

Students work with the idea that wind energy can be converted into electrical energy as they consider the design of the wind turbine prototype model.
Serving as an Educator in the USA and abroad for over 30 years, and as an advocate for STEM Programming for the past 15 years, it is exciting to see the impact that high quality (\textit{S})cience, (\textit{T})echnology, (\textit{E})ngineering, and (\textit{M})ath curriculum is having on the success of students. By encouraging innovative thinking and creative problem solving, through “real-world” experiences such as those developed through the Boeing/Teaching Channel Partnership, proactive teachers and students are taking the lead on the STEM Pathway to Success!
Why Spy? We Spy!

Cross-cutting Concepts

Engineering Design Process

SPY GLIDERS
Spy Gliders

Unmanned Aerial Vehicles are becoming more common in many areas of the world.

- Students design an unmanned aerial vehicle capable of carrying a payload over a given distance.
- Forces acting on the glider are explored.
- Engineering Design Processes, Forces of Flight, and Materials Engineering are key topics throughout this module.

Spy Gliders
Science and Innovation

A Boeing and Teaching Channel Partnership

**Spy Gliders**

**Module Features**

- Alignment: NGSS; Common Core State Standards
- Experiential Learning: Progressive; Team Building
- Dynamic Resources: Experts, Videos, Technology, Options for Supplies
- Differentiation: Readiness, Interests, Learning Profiles, Special Needs
- Innovation: Problem/Project Based Learning & Inquiry
- Critical Thinking: Engineering Design Process, Cause & Effect, Predictions, Measurement Data Collection/Analysis, Presentations
A Boeing and Teaching Channel Partnership

Spy Gliders
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STEM for Space Exploration
Launching the Next 100 years of Aerospace Innovation
Tony Castilleja – Mechanical Engineer

Space Shuttle Plane Designer Spaceship Tester

4 Years Bachelor’s Mechanical Engineering

2 Years Master’s Mechanical Engineering

10 Years with Boeing

4 Projects

Space Shuttle P8-A Military Airplane Boeing Starliner Space Launch System
Fundamentals of Flight

It starts with the basics to launch Human Spaceflight

Exterior

Landing

1-D Drop Test

From Real Spacecraft to Basic STEM Applications
Curiosity Machine makes Flight Hands-On

2-D Drop Test

3-D Drop Test

Back to Fundamentals – Air Powered Spinning Machine
Teaching from Blue Prints to Reality

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<th>Computer Design</th>
<th>Full Scale Mock-Ups</th>
<th>Space Hardware</th>
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<td>![Computer Design Image]</td>
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<th>Building</th>
<th>Testing</th>
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<td>![Blueprint Examples Image]</td>
<td>![Building Image]</td>
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Space Launch System

Fueled for Flight
Engineers - Who We Are

Space Launch System
Ready to **Boldly Go** on a
**New Century of Discovery**

Tony Castilleja
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www.boeing.com
Q&A

Science and Innovation Modules
Sept. 28, 2016
The End

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