Uncovering Student Ideas about Engineering and Technology

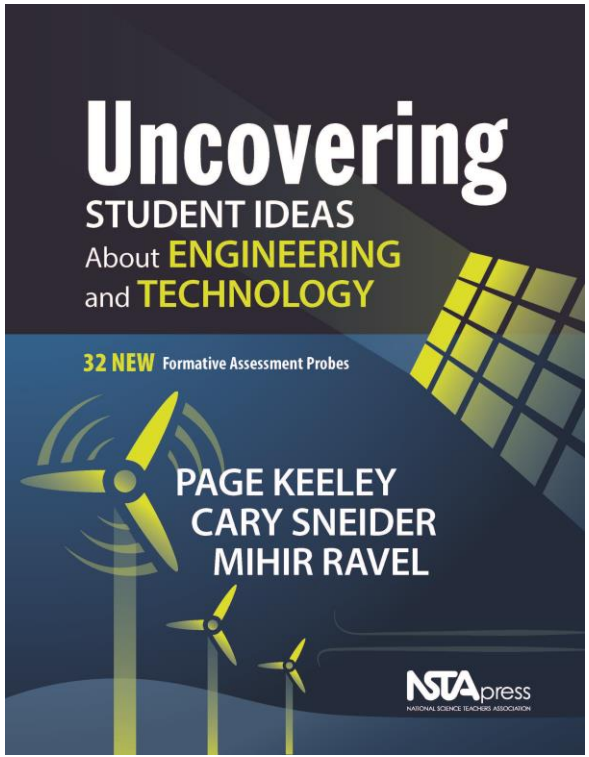
ELEMENTARY

Page Keeley, Cary Sneider, and Mihir Ravel

STEM20

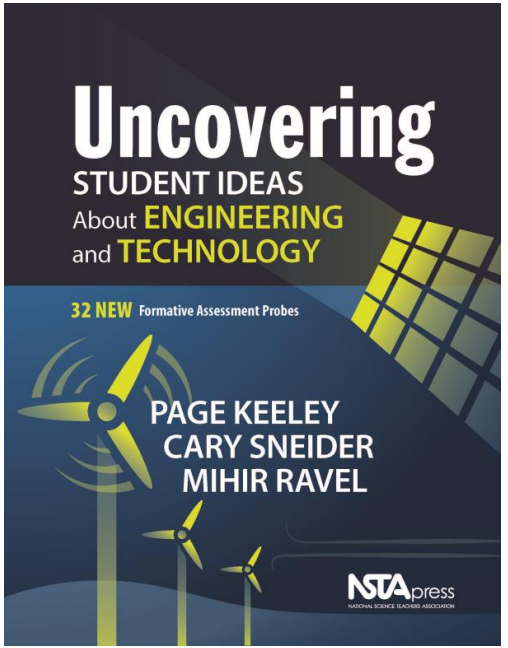
A NSTA Virtual Event

July 27, 2020

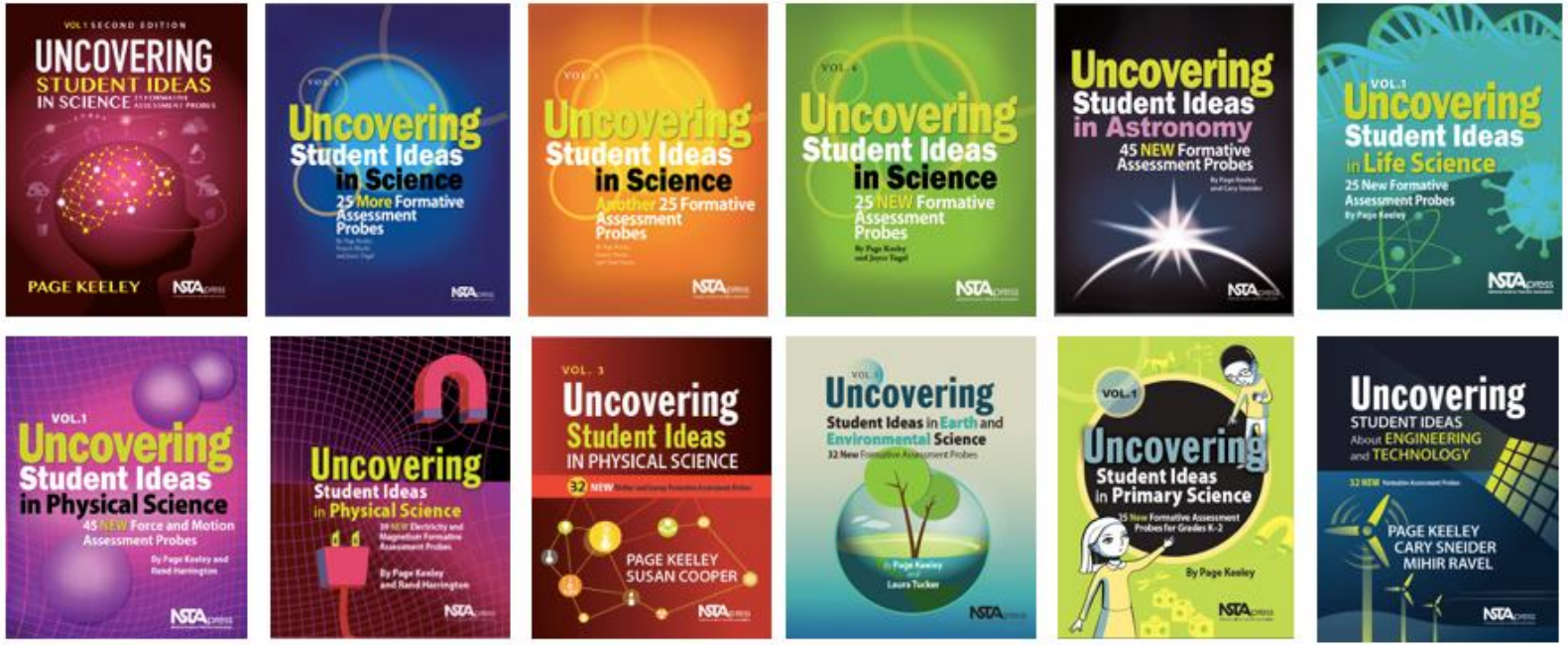


Framing Questions for This Session:

- How does this book fit into the *Uncovering Student Ideas* series?
- Why focus on engineering and technology?
- What are some of the key ideas about engineering and technology included in this book?
- What can we learn by examining students' responses?



www.uncoveringstudentideas.org



Formative assessment probes are are assessment **for** learning rather than assessment **of** learning; and- often it is assessment **as** learning!

Eliciting Students' Ideas

Students' initial ideas are used to build a bridge from where the student is to where the student needs to be to understand and use core ideas and practices.

Four Key Questions

1) What is technology?

2) What is engineering and why Is it Important?

3) Who engineers?

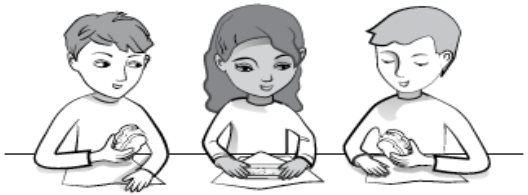
4) How is engineering done?

1) What is technology?

Probe 1

How would your students answer this question?

Surrounded by Technologies



Reggie: It looks like we have only cold sandwiches today—I heard the cafeteria had a problem. It sure would be simpler if there was no more technology. Then, things would just work right all the time.

Ebony: Are you joking? If there was no more technology, the lights would go out too, so we couldn't see what we were eating.

Tishon: That's not all. We wouldn't even be eating these cold sandwiches, because bread is a technology.

Reggie and Ebony: Huh? What do you mean by that, Tishon?

Do you agree with Tishon that "bread is a technology"?

___ Yes, I agree with Tishon. ___ No, I disagree with Tishon.

Explain your thinking. How did you decide whether bread is a technology?

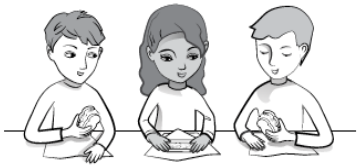
1) What Is Technology?

Purpose: Elicit sudents' understanding of *technology***.**

Explanation: There are no wrong answers. But the best answer is Tishon's who understands that people made the bread, so it is a technology.

Research: Several studies have shown that most people think of technology as only mechanical or electrical devices.

Surrounded by Technologies



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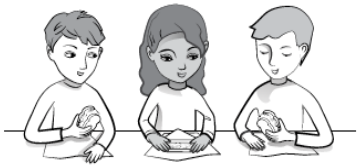
1) What Is Technology?

Probe 1 Key Ideas

- Technologies are all of the ways that people have changed the natural world to meet their needs, including products, processes, and systems.
- We live in a world in which we are surrounded by technologies.
- Engineering is a process of solving problems by improving or inventing new technologies.

Surrounded by Technologies



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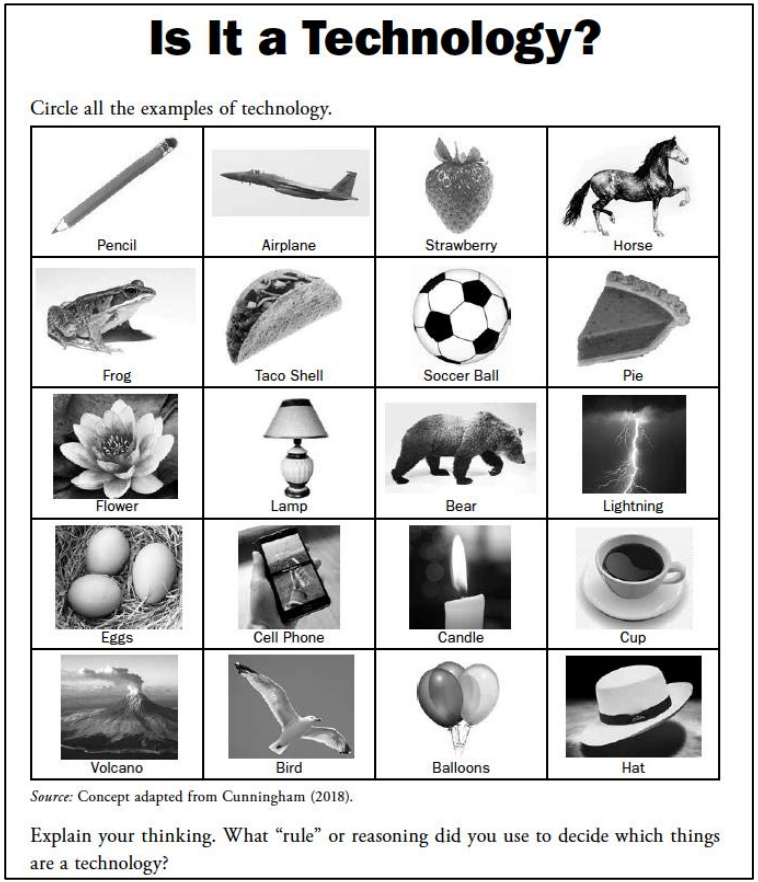
Explain your thinking. How did you decide whether bread is a technology?

1) What Is Technology?

Probe 2 Key Ideas

- Technology includes all types of human-made systems and processes; not just electronic devices.
- We live in a world in which we are surrounded by technologies.
- Engineering is a process of solving problems by improving or inventing new technologies.



Is It a Technology?

Circle all the examples of technology.

Pencil	Airplane	Strawberry	Horse
Frog	Taco Shell	Soccer Ball	Pie
Flower	Lamp	Bear	Lightning
Eggs	Cell Phone	Candle	Cup
Volcano	Bird	Balloons	Hat

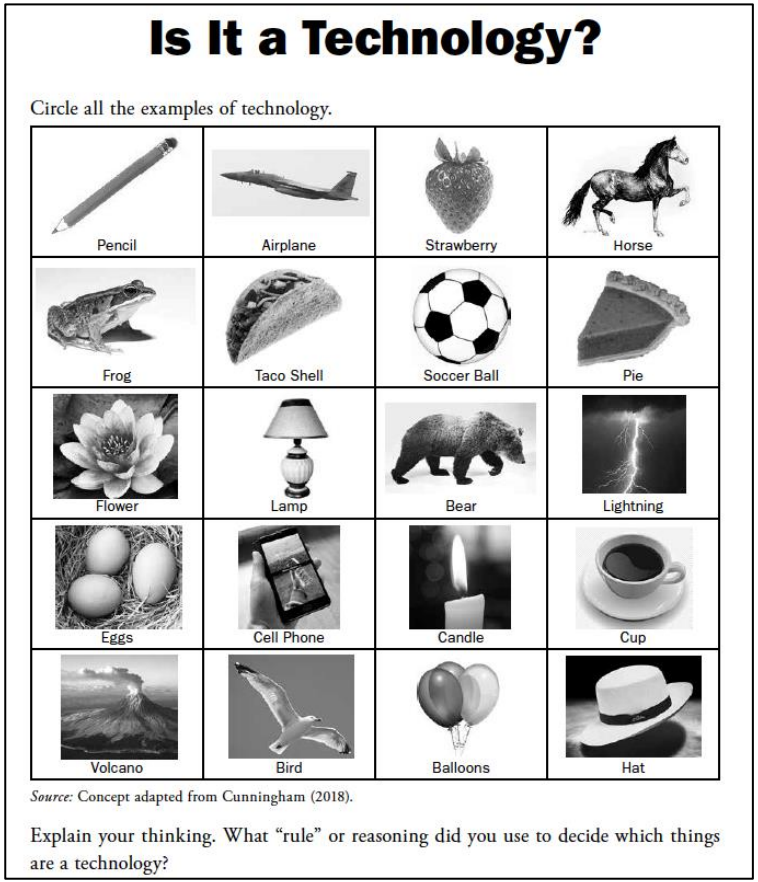
Source: Concept adapted from Cunningham (2018).

Explain your thinking. What "rule" or reasoning did you use to decide which things are a technology?

Concept thanks to Christine Cunningham and Kathy Lachapelle

1) What Is Technology?

Takeaway #1 We live in a world of technologies!



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2) What is Engineering and why is it important?

Probe 3

How would your students answer this question?

What's the Purpose of Technology?

Five friends were talking about new and improved technologies. They each had a different idea about why technologies are always being developed.

Bijou: I think technologies are developed to make life easier for everyone.

Eve: I think technologies are developed to meet people's need for clean water, food, and shelter.

Franco: I think technologies are developed to make the world a better place for people, plants, and animals.

Marisol: I think technologies are developed for all the reasons you said.

Hal: I disagree with all of you. I think technologies are developed for a different reason than what you all said.

Who do you agree with the most? _____ Explain your thinking.

2) What is Engineering and why is it important?

Purpose: Find out what your students think about engineering and its importance.

Explanation: The best answer is Marisol's, that technology makes life easier, helps people meet basic needs and make the world a better place.

Research: Studies show that the more students understand the value of engineering, and its relevance to their lives and their communities, the more interested they become in the subject, especially for girls and youth of color.

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Who do you agree with the most? _____ Explain your thinking.

2) What is Engineering and why is it important?

Probe 3 Key Ideas

- Engineering can help people solve problems and meet their needs.
- Engineering can help to preserve and improve the environment.
- Engineering can make a better world for people and animals.

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2) What is Engineering and why is it important?

Takeaway #2

Engineers make a better world!

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Four Key Questions – Big Ideas

1) What is technology?

2) What is engineering and why Is it Important?

3) *Who engineers?*

4) *How is engineering done?*

A key to success on this book project: we didn't just "write" it – we "engineered" it!

- Define:
  - *daily life - engineering "magic" is everywhere*
  - friendly language
  - diversity of characters and scenarios
- Design:
  - *modular architecture*
  - *themes > probes > support*
- Optimize
  - iterated and improved multiple cycles

TOC - Modular Architecture

Section 1: What Is Technology?

Section 2: What Is Engineering?

Section 3: Defining Problems

Section 4: Designing and Testing Solutions

3) Who Engineers?

Probe 9

How would your students answer this question?

Who Can Become an Engineer?

Tanya: My neighbor told me that anyone can become an engineer.

Anna: That's definitely true. My sister is an engineer, but when she was young she was only interested in history and community service. In high school, she learned that engineers solve real problems in society, so she became a civil engineer to work on affordable housing.

Marisol: That's exciting! I can become an engineer and solve real problems! I heard that engineers need science and math so now I see why they're such valuable classes.

Leon: Anyone can become an engineer, even if they don't study science and math. You can learn science and math after you become an engineer.

Who do you agree with more—Marisol or Leon? _____ Explain why you agree.

3) Who Engineers?

Purpose: Determine if students understand that anyone can become an engineer if they are willing to learn and help others.

Explanation: The best answer is Marisol's since she understands that anyone can become an engineering, and that engineers use math and science.

Research: On a national test of science and technology literacy, girls scored higher than boys. However, relatively few girls choose to become engineers.

Who Can Become an Engineer?

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Who do you agree with more—Marisol or Leon? _____ Explain why you agree.

3) Who Engineers?

Probe 9 Key Ideas

- Engineering as a profession is open to people with a wide variety of interests and capabilities.
- Engineers design products, processes, and systems that meet people's needs.
- Engineering requires scientific and mathematical thinking.

Who Can Become an Engineer?

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3) Who Engineers?

Takeaway #3

Everyone Engineers!

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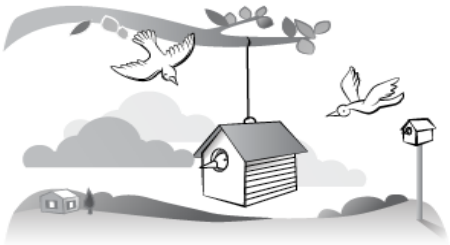
Who do you agree with more—Marisol or Leon? _____ Explain why you agree.

4) How Is Engineering Done?

Probe 20

How would your students answer this question?

Who Needs It?



Simone recently graduated from college with an engineering degree. She has just been hired by a company to design its new line of birdhouses. She knows that every product has a *client*. The *client* is usually a person or group who has a problem or need that requires a solution. Identifying clients is an important step early in an engineering design process. She asks her friends to help her identify a client for the birdhouses.

Ling: The client is the person who hired you. Just ask your employer to tell you as much as they can about what they want the new birdhouses to be like.

Annapurna: I think the client is the person who is likely to buy a birdhouse. If you meet that person's needs, then your employer will be happy. Go to a garden shop where they sell birdhouses and ask the customers what they are looking for.

Deepali: We need to think of this from the user's point of view. Your client is clearly the bird that will be living in the birdhouse. Go visit some gardens and parks to see which birdhouses attract the most birds!

Melvin: I think all three of you identified a client for the birdhouse.

Katrina: I disagree with all of you. The client is someone else.

Who do you agree with the most? _____ Explain your thinking.

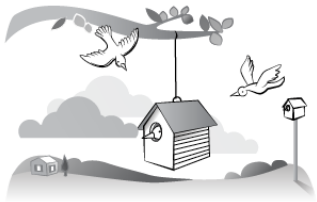
4) How Is Engineering Done?

Purpose: Find out students' ideas about whose needs should be taken into account when defining a problem.

Explanation: The best answer is Melvin's since if any one of the "clients" are ignored, the design will fail.

Research: Researchers have had success teaching students the importance of consulting with clients by using fictional stories about people who have a problem to solve.

Who Needs It?



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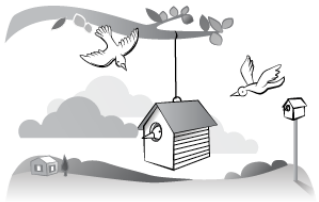
4) How Is Engineering Done?

Probe 20 Key Ideas

- Defining the problem to be solved is the first step in engineering design.
- Identifying a “client” is necessary to be clear about whose needs the solution must meet.

Who Needs It?



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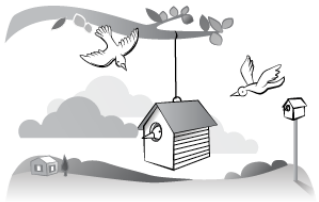
4) How Is Engineering Done?

Takeaway #4

Engineering is a lifelong skill!

Who Needs It?



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Book Takeaways - Four Big Ideas

1) What is technology?

Takeaway #1: We live in a world of technologies!

2) What is engineering and why Is it Important?

Takeaway #2: Engineers make a better world!

3) Who engineers?

Takeaway #3: Everyone engineers!

4) How is engineering done?

Takeaway #4: Engineering is a lifelong skill!

Teaching Takeaways – Engineering

1) An equation to engage ALL students: E = 5 C's
   - Compassion
   - Curiosity
   - Creativity
   - Commitment
   - Careful (contraction of CareFull = Compassion!)

   = Engineering
2) Assessment *FOR* Learning & Assessment *AS* Learning
3) Start from Students' Daily Lives – and Your Own!

2 T's - a parting Thought and Thank you

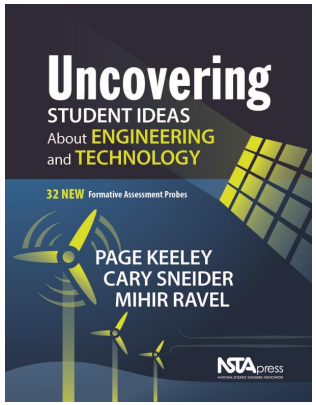
"Any sufficiently advanced *Technology* is indistinguishable from *Magic" - Arthur C. Clarke*

"Any sufficiently advanced *Teaching* is indistinguishable from *Magic" – a grateful student*

The Uncovering Student Ideas in Engineering & Technology book has a powerful blend of recipes, but the magic only comes alive when YOU use it in your teaching!

Questions? – we love them!
USIE&T Probes are all about "what's on your mind"

Page Keeley



Mihir Ravel

Cary Sneider

Download a sample chapter – Probe #20 - Birdhouses!
https://static.nsta.org/pdfs/samples/PB455Xweb.pdf

Defining Problems 20

Who Needs It?

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Book Details
https://secure.nsta.org/store/product_detail.aspx?id=10.2505/9781681403113