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5-E CLASSROOM STEM ACTIVITY:
THE LIFE CYCLE OF A CELL PHONE

Ellen Egley
Education Content Manager, STEM Jobs

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THE NEXT BIG THING IN STEM

BY ELLEN EGLEY

Take a look at companies like Apple and Amazon and you'll see that creating the next big trend is essential for any tech company to stay ahead of the competition. These companies are always looking for imaginative innovators to create real products that seem like they belong in science fiction novels.

Just think - that smartphone in your pocket has more computing power than the tech NASA used to send astronauts to the moon. Technology has come a long way, but the future is even more exciting than the present. Check out some of the latest developments in personal tech that might just change the way we live.

SCENT TECH

Science has proven scent is the sense that has the strongest tie to memory (which is why your heart feels weird every time you smell your ex's deodorant), but Sony is betting it is also the sense that has the greatest effect on our moods. They developed the Aromastic, a small, handheld device that delivers a range of scents at the push of a button. Feeling tired? Get a little blast of an energizing scent like citrus. Feeling stressed? Choose a puff of a relaxing scent like lavender to calm you down.

This device might take off as a healthier alternative to things like energy drinks - and could be the first step toward smell-o-vision or being able to send scented emojis to your friends.

VIRTUAL AND AUGMENTED REALITY

Wait, what's the difference?

Virtual reality (VR) immerses the user in an artificial setting that looks and feels real, usually through a headset that provides both visuals and sound. Augmented reality (AR) overlays virtual elements in the real world (think Pokémon Go).

Both use the same types of technology to create a different version of reality, and both have some serious potential for the future beyond the world of gaming. Imagine learning about the ocean by using VR to explore its depths without leaving your classroom or using motion-activated commands to turn on your TV, preheat your oven, or answer your phone through AR. In medicine, VR could be used to train surgeons or even allow surgeries to be performed remotely.

The potential of this technology is limited only by our imaginations!

NANOTECHNOLOGY

OK - quick science review. Everything in our world, from the clothes we wear to the food we eat to the trees outside your window, is made up of atoms. They are the building blocks for all matter. Nanotechnology deals with the manipulation of individual atoms and molecules on the nanoscale, which is about 1 to 100 nanometers. To give you an idea of the size we're talking about, one sheet of newspaper is about 100,000 nanometers thick.

These nanoparticles have different chemical and physical properties than their larger-particle counterparts, which means that elements and compounds can be used in new and exciting ways on the nanoscale. Gold nanoparticle sensors, for instance, have been used to detect early stages of cancer using a simple breath test before tumors are large enough to show up on an X-ray. Chances are good that you've already used a substance containing nanoparticles - sunscreen. Nanoparticles of titanium dioxide and zinc are present in many sunscreens because they are highly reflective and can prevent solar radiation from penetrating your skin. Nano-coatings have also been used to make carpet and clothing stain resistant and paper waterproof.

The potential ramifications of tinkering at the nano-levels are still unknown, with some researchers concerned about the impact of nanomaterials on our food supply and long-term health. Whatever the future holds for this technology, it seems certain that it will change life as we know it.

There are tons of other exciting technical advancements being made every day. With the right STEM skills, you could help to engineer the next big thing that none of us can imagine living without.

5-E CLASSROOM STEM ACTIVITY: THE LIFE CYCLE OF A CELL PHONE

Here are some ideas for how high school teachers could use this story as a launching point for integrated STEM learning. Our activities follow the 5-E Learning Cycle Model.

Part 1: Engage

1. Discuss with students: We tend to take the technology we use every day for granted. What is some of the tech students rely on and couldn't imagine their lives without? What tech have they heard could become a reality in the near future (self-driving cars, commercial space travel, drone delivery systems, etc.)?
2. Have students read the article "The Next Big Thing in STEM" in *STEM Jobs* magazine.
3. Virtual and augmented reality are becoming so popular because they are relatively affordable and utilize devices that most people already own - smartphones. We're all so dependent on those little computers in our pockets, but have students ever thought about how those devices are made? What specific materials are they made of? Where do those materials come from? What happens when they throw the devices away?
4. Show students the short video on the materials used in cell phones that can be found at edu.STEMjobs.com/teacher-resources.
5. Discuss with students: Did they have any idea that precious metals and rare elements were used to create their phones? What surprised them most from the video?

Part 2: Explore

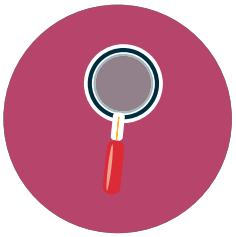
Break students into groups of four. Students will work together within their groups to answer the following questions about the entire life cycle of a cell phone:

1. What are the materials used to make a smartphone?
   a. Which are the most hazardous?
   b. Which are the most valuable?
   c. What is the purpose of each?
2. Where do these materials come from?
   a. Think about where on Earth these precious metals are mined. What is the effect on the workers and the environment?
   b. Where do the rare elements come from? How are they harvested? What is the effect on the workers and the environment?
3. Where are most smartphones manufactured?
   a. How do raw materials get from the source to manufacturing facilities?
   b. How are smartphones manufactured?
      i. Is the process manual, automated, or a combination of the two?
      ii. What are the environmental and human implications of this process?
   c. How do finished products get from the manufacturers to stores in the U.S.?
      i. What is the cost of this method of transportation?
      ii. What is the environmental impact of this method of transportation?
4. What happens to smartphones when we're done with them?
   a. How many smartphones are thrown away each year?
      i. What happens to the hazardous materials within the phones as they begin to degrade?
      ii. What are the possible health and environmental effects of these materials leaching into the soil and water supply?
   b. What recycling options are available?
   c. How can outdated smartphones be repurposed?
   d. What are the benefits of recycling or repurposing smartphones?

Recommended resources can be found at edu.STEMjobs.com/teacher-resources.

Part 3: Explain

1. Groups will create a tri-fold, poster, PowerPoint, or Google Slides presentation of their findings to share with the rest of the class. Presentations will be graded according to the rubric in the Evaluate section.
2. At the culmination of the presentations, discuss with students:
    a. What surprised them most from their research and peers' presentations?
    b. Has this project changed their thoughts about smartphones, scarcity of resources, and the "disposability" of personal technology?



Part 4: Elaborate

1. Have students reconvene in their groups to brainstorm possible solutions to the problems they uncovered. Some guiding questions to spark discussion are:
    a. How can they raise awareness about the health and environmental hazards of disposing of smartphones in landfills both locally and on a global scale?
    b. What types of change would they like to see in the smartphone industry to alleviate some of these hazards?
    c. What specific steps can they, as consumers of technology, take to influence this change in the industry?
2. Have each group informally present their ideas and solutions to the rest of the class.
3. Work with the entire class to create an action plan for the most easily implemented ideas and gauge student interest in pursuing some of the loftier goals.

Part 5: Evaluate

Group research and presentations and individual contributions will be scored according to the rubric below.

5	4	3	2	1
The presentation was clear, concise, and thorough. It provided precise information and explanations.		The presentation was informative. It answered most of the questions posed in the prompt in an understandable way.		The presentation was unclear and only provided a small portion of the required information.
The student contributed to the group's research, understanding, and presentation in meaningful ways.		The student contributed somewhat to the group's research and/or presentation.		The student did not contribute to the group's research or presentation.

Standards Addressed:

Next Generation Science Standards

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Common Core State Standards - Math

CCSS.MATH.CONTENT.HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and origin in graphs and displays.

Common Core State Standards - English and Language Arts

CCSS.ELA-LITERACY.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCSS.ELA-LITERACY.SL.11-12.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY.SL.11-12.2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
CCSS.ELA-LITERACY.SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
CCSS.ELA-LITERACY.WHST.11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
CCSS.ELA-LITERACY.WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Texas Essential Knowledge and Skills - Science

AS.12.A predict effects of chemical, organic, physical, and thermal changes from humans on the living and nonliving components of an aquatic ecosystem
B.11.B investigate and analyze how organisms, populations, and communities respond to external factors
B.12.F describe how environmental change can impact ecosystem stability
C.3.B communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials
C.5.B use the Periodic Table to identify and explain the properties of chemical families, including alkali metals, alkaline earth metals, halogens, noble gases, and transition metals
ES.5.C document the use and conservation of both renewable and non-renewable resources as they pertain to sustainability
ES.5.F evaluate the impact of waste management methods such as reduction, reuse, recycling, and composting on resource availability
ES.7.C analyze and predict the effects of non-renewable resource depletion
ES.9.A identify causes of air, soil, and water pollution, including point and nonpoint sources
ES.9.B investigate the types of air, soil, and water pollution such as chlorofluorocarbons, carbon dioxide, pH, pesticide runoff, thermal variations, metallic ions, heavy metals, and nuclear waste
ES.9.F evaluate cost-benefit trade-offs of commercial activities such as municipal development, farming, deforestation, over-harvesting, and mining
ES.9.I discuss the impact of research and technology on social ethics and legal practices in situations such as the design of new buildings, recycling, or emission standards