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

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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 middle 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

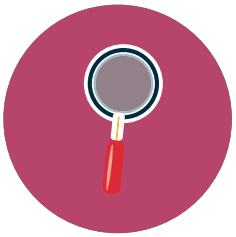
Break students into groups of four. Students will work together within their groups to answer the following questions about the entire life cycle of a cell phone:

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

MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.
MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Common Core State Standards - Math

CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them.
CCSS.MATH.CONTENT.7.NS.A.3 Solve real-world and mathematical problems involving the four operations with rational numbers.

Common Core State Standards - English and Language Arts

CCSS.ELA-LITERACY.RI.6.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
CCSS.ELA-LITERACY.W.6.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
CCSS.ELA-LITERACY.W.6.7 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
CCSS.ELA-LITERACY.W.6.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
CCSS.ELA-LITERACY.W.6.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
CCSS.ELA-LITERACY.SL.6.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.6.4 Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
CCSS.ELA-LITERACY.SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
CCSS.ELA-LITERACY.W.7.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
CCSS.ELA-LITERACY.W.7.7 Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
CCSS.ELA-LITERACY.W.7.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
CCSS.ELA-LITERACY.W.7.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
CCSS.ELA-LITERACY.SL.7.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
CCSS.ELA-LITERACY.SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
CCSS.ELA-LITERACY.W.8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
CCSS.ELA-LITERACY.W.8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
CCSS.ELA-LITERACY.W.8.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
CCSS.ELA-LITERACY.W.8.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
CCSS.ELA-LITERACY.SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
CCSS.ELA-LITERACY.SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Texas Essential Knowledge and Skills - Science

6.5.A know that an element is a pure substance represented by chemical symbols
6.5.B recognize that a limited number of the many known elements comprise the largest portion of solid Earth, living matter, oceans, and the atmosphere
6.5.C differentiate between elements and compounds on the most basic level
6.6.A compare metals, nonmetals, and metalloids using physical properties such as luster, conductivity, or malleability
7.8.C model the effects of human activity on groundwater and surface water in a watershed
8.5.B identify that protons determine an element's identity and valence electrons determine its chemical properties, including reactivity
8.5.C interpret the arrangement of the Periodic Table, including groups and periods, to explain how properties are used to classify elements
8.11.C explore how short- and long-term environmental changes affect organisms and traits in subsequent populations
8.11.D recognize human dependence on ocean systems and explain how human activities such as runoff, artificial reefs, or use of resources have modified these systems

Texas Essential Knowledge and Skills - Math

6.1.A apply mathematics to problems arising in everyday life, society, and the workplace
6.1.D communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate
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