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| **Title** | **Wear This: Your Life Depends on It** |
| **Introduction** | Technology is giving us greater and greater control over our health. Today, people can download apps onto their cell phones to monitor some of their health conditions and to relay that information to their physicians. Wearable devices, such as Fitbits, encourage the wearers to stay motivated and improve their health by tracking their activity, exercise, food, weight and sleep.  In this project-based lesson plan, students will first get an overall look at nanotechnology and how this field of scientific research is being used to transform healthcare. Students are encouraged to work in teams to design a device that can help the wearer tackle health issues that plague students and that lessen their current quality of life. Students will be expected to conduct independent research and create a product that does not currently exist. The devices will need to be attractive, be devices that are energy efficient and be ones that will fit into the lifestyle of the wearer. |
| **Real Science Application** | As mentioned in the Introduction, nanotechnology is a field of scientific research that is being used to improve life in a number of ways, including transforming healthcare. Because scientists now have the tools to manipulate molecules and atoms, they can create products that transform healthcare. Researchers are creating self-cleaning toilets and showers. They have created wearable devices that help track their activity, exercise, food, weight and sleep. They have created garments that eliminate odor and repel fluids. They have designed gold nanobullets that can target and eliminate cancer cells. This lesson exposes students to this exciting field of scientific research and encourages them to envision other applications of nanotechnology to healthcare and become junior researchers in their own right. |
| **Curriculum Alignment** | **Content Area Grade Level Common Core/Essential Standards: Science**  Science 7.L.1.4 7 Summarize the general functions of the major systems of the human body (**digestion, respiration, reproduction, circulation, and excretion**) and ways that these systems interact with each other to sustain life.  Science 7.P.2.1 7 Explain how kinetic and potential energy contribute to the mechanical energy of an object.  Science 7.P.2.2 7 Explain how energy can be transformed from one form to another (specifically potential energy and kinetic energy) using a model or a diagram of a moving object (roller coaster, pendulum, or cars on ramps as examples).  Science 7.P.2.3 7 Recognize that energy can be transferred from one system to another when two objects push or pull on each other over a distance (work) and electrical circuits require a complete loop through which an electrical current can pass. |
| **Learning Outcomes** | Students will   * Work in teams to design a model of a wearable device * Be able to explain to an audience how the device will interact with the human body to sustain life or to improve the overall health of an individual. * Be able to explain to an audience how potential energy and kinetic energy can be harvested to sustain the device. |
| **Time Required and Location** | This lesson is designed to be completed over a period of five days.  Day 1 will be completed in the classroom.  Day 2 will be completed in the classroom and in the hallway outside the classroom.  Day 3 will be completed in the media center or computer lab. Students will need access to computers or IPads.  Day 4 will be completed in the classroom.  Day 5 will be completed in the classroom. |
| **Materials Needed** | This section contains 2 lists: one with materials and resources needed by the teacher and the second with materials and resources needed by students. Include quantities for all materials, such as books, handouts, technology, paper and pencils, art supplies, and so on.  Materials and resources needed by the teacher:   * PowerPoint presentation providing introductory material on nanotechnology * YouTube video clip: “Powers of Ten” (<https://www.youtube.com/watch?v=5CKd0aPSWe8>) * Photocopied sheets with the word “Fact” and photocopied sheets with the word “Fiction,” one set of sheets per for each cluster of four students in the classroom. * Two or three Fitbits * Two dozen golf balls * Three sets of 100 index cards, sealed in plastic shrink-wrap * 20 metric rulers * A tablet of easel paper * Eight folders * 30 or more permanent markers * Laptop computer and projector * Ipads, class set or computers, class set * A copy of the book “Nanoscale Science” by M. Gail Jones, Michael R. Falvo, Amy R. Taylor and Bethany P. Broadwell (NSTA Press) * copies of the golfball activity (p. 13) * 12 copies of the card stock activity (p. 14) * 12 copies of the counting activity (p. 15). * Handout outlining project specifications, with rubric   Materials needed by the student:   * Notebook paper for taking notes and planning, day 3 * Ink pen or pencil * Cell phone (timekeeping function or app) |
| **Safety** | No chemicals will be used in this lesson. Some students will volunteer to participate in some forms of exercise using a Fitbit. |
| **Student Prior Knowledge** | This lesson is part of a unit on kinetic and potential energy. Students are likely familiar with the use of wearable devices such as Fitbits. This should help provide a link with the goals of the lesson – how kinetic energy can be harvested or potential energy can be produced to sustain wearable devices of the future. The teacher will also tap into prior knowledge through links to popular science fiction books and films that have referenced nanotechnology, nanites or nanobots. |
| **Teacher Preparations** | In order to effectively teach this lesson, the teacher will need to   * Become familiar with the term “nano” and how he/she can help students grasp the idea of billions or one-billionth * Become familiar with the basics of the field of nanotechnology – how it originated, how it is transforming various fields – healthcare, environmental engineering, textiles, etc. * Become familiar with the use of wearable devices and be able to guide students into using a Fitbit to monitor exercise or activity * Reserve the computer lab or a class set of Ipads for day 3 of the lesson. * Arrange the classroom for students to work in teams of three or four. * Make copies of the handouts needed for days 2 and 3. * Seek permission to reproduce activity sheets for activity on day 2 from NSTA Press. Permission can be sought through: their Copyright Clearance Center ([www.copyright.com](http://www.copyright.com)) or by calling 978-750-8400. |
| **Activities** | **Day One:**  Prior to students arriving, the teacher will have set up student desks in clusters of threes or fours. The teacher will place a sheet labeled Fact and a sheet labeled Fiction at each cluster.  The teacher will use the first day of this lesson to introduce the field of nanotechnology to students, using a PowerPoint presentation to present the introductory material.  ***ENGAGE***: The teacher will help students make connections with prior knowledge of films and books where nanotechnology has been referenced through use of terms like “nanites” or “nanobots.”  ***EXPLAIN***: The teacher will then provide an introduction to the term “nano” and to the size referenced by the term.  The teacher will briefly describe the history of nanotechnology, including early references and the current active research, thanks to high-powered microscopes and microtools.  The teacher will reference connections to career opportunities in this field. (Total: 15 minutes)  ***ENGAGE***: The teacher will guide students into taking guesses at what is currently possible in the field of nanotechnology and what is currently not possible through projecting 10 statements on the screen (one at a time) and having students determine if the statement is Fact or Fiction. Students will quickly discuss the statement in their cluster and one student designee per cluster will hold up the sheet representing their decision (Fact or Fiction), when requested by the teacher. The teacher will provide the correct response and provide a brief explanation why the statement is true or false (15 minutes).  ***ENGAGE/EXPLAIN***: At the close of class, the teacher will briefly explain the mathematical exponent represented by nanometers (5 minutes). Then the teacher will show a YouTube clip, “Powers of Ten,” to help students understand working with molecules and matter at the atomic level (9 minutes).  **Day Two:**  On Day 2, the teacher will guide students into an understanding of the concept of a billion (or a billionth). The teacher will introduce the concept of the use of wearable devices for healthy living.  Prior to class, the teacher will place a folder at each desk cluster containing handouts for the first activity to be carried out in class. Each student in five of the clusters will also receive metric rulers. The students at three clusters working on the activity involving counting to a billion will not receive a metric ruler. They will be permitted to use their cell phones to time their counting, using the stopwatch app feature on the phone. Prior to class, the teacher will need to have marked off a distance of 100 feet in the hallway and placed long strips of tape on the floor for a starting point and an ending point for this length.  ***EXPLAIN/ENGAGE/EXPLORE***: The teacher will briefly refer to the exponential lesson from the prior day, reminding students of what research at the nano level means. To help guide students into understanding the concept of a billion, the teacher will explain the activities that students will complete simultaneously in their clusters. Two clusters will determine how many golf balls would be required to fill a classroom and how large a space would be needed to contain 1 billion golf balls. Three clusters will determine how the height of a billion index cards. Three clusters will determine how long it would take to count to a billion. (The activity sheets for these cluster groups can be found on pages 13-15 of the book “Nanoscale Science.”) The recap of prior day teaching on exponents and the explanation of the first activity of the class period will take 10 minutes. Students will need 15 minutes to complete their individual activity.  The teacher will project the answers to the activity and let students compare the answers they got to those being projected. Students will then place their completed sheets in the folder. (5 minutes)  The teacher will next explain the use of wearable devices and how they are helping people track their physical activity, sleep, food intake, exercise and sleep. (5 minutes)  ***ENGAGE/ELABORATE***: With remaining time, the teacher will ask for three to four volunteers for an activity involving exercise. When the volunteers are selected, the teacher will explain how he is going to use a phone app to measure activity level of the volunteers. He will explain how he wants the students to transition into the hallway before movement begins: The teacher will have the students who did not volunteer to line up on both sides of the hallway between the places marked on the floor with tape. The teacher will have the students who volunteered stand at one end of the hallway behind a taped lined. The teacher will stand at the other end of the hallway behind the second taped line. At the teacher’s direction, the first volunteer will use some form of creative movement to get from one line to the next (walk, run, dance, skip, shuffle, etc.). The teacher will time the movement from one line to the next and show the student how the app measured the exercise taken.  When all students have crossed the finish line, students will return to the classroom and prepare for dismissal. (10 minutes)  **Day Three:**  On day 3, the teacher will introduce the two-day cluster project for designing a wearable device. The teacher will take students to the computer lab (or provide them with Ipads) to carry out their research.  Prior to students arriving, the teacher should place a folder at each cluster containing a handout describing a two-day project. The folder should contain enough handouts for each student in the cluster.  **ENGAGE**: The teacher will open the class by posing the following statements and question: “Yesterday, I showed you a wearable device called a Fitbit and explained how that device is being used to track certain activities humans do on a daily basis. What has yet to be developed by researchers are devices that can help students monitor the conditions that trigger certain health problems. What health problems do students face in their lives that might be solved or helped if a wearable device were created that could signal the onset of the problem? Talk among yourselves for two minutes and come up with several problems that might be helped in the future by wearable devices. (1-2 minutes)  **EXPLORE/ELABORATE**: After a two-minute brainstorming session, the teacher should ask for types of health problems discussed in the clusters. The teacher will list the health problems on the board as students name them. (5-8 minutes)  **EXPLAIN**: The teacher will ask each cluster to open the folder and to distribute one handout to each student in the cluster. The teacher will then read over the project students will take on for the next two days. The teacher will then ask for each cluster to look over the list on the board and to come up with a health problem that can be the focus of their project.  **EXPLORE**: For the remainder of this class period, students will research aspects of the health problem. The handout will explain the aspects students will need to research before they can begin designing a wearable device to help fellow students facing the health problem. Aspects include: what triggers the health problem, what happens when the student experiences the health problem, what parts of the body are affected by the health problem, what eases the health problem following its onset.  **EXPLORE/ELABORATE**: When students have gathered their information, they will discuss their findings with each other and begin to brainstorm their wearable device. The teacher should have student clusters seated near each other in the library or computer lab.  **Day Four:**  On day 4, students will take their research and form a plan for creating a wearable device that can provide a cure or a prevention or a relief for the chosen health problem that is the focus of their project. Students will be back in their classroom for this work.  Prior to the beginning to the class, the teacher will place two or three markers and two sheets of easel paper at each cluster. The teacher will place a folder at each cluster, with copies of the project rubric for each student in the cluster.  At the beginning of the class, the teacher will ask students to take out the rubric for the project. He will go over the rubric so students have an understanding of what they are attempting to design during the class period.  ***EXPLAIN***: The project calls upon students to design a wearable device that can alert students to the environmental triggers or the bodily signals that forecast the onset of the health problem. The device will need to be attractive, so students will not feel embarrassed wearing it and will not avoid wearing it. The device needs to be worn in an area of the body where it would pick up the signs of the impending problem. The device needs to have an energy source. It needs to be fueled by a battery or by kinetic energy or solar energy or body heat, etc. Students need to take into account what activities a human being puts himself or herself through in a day’s time. Students also need to be able to explain how it will provide students with information about the possible onset of a health issue.  Students will need to understand that they will need to use the class period to come to a consensus about their wearable device and to be prepared to present their findings to fellow students on day 5.  ***EXPLORE/ELABORATE***: Students will work the remainder of the class period on the project. Students will list relevant information on the easel paper so they can hold up their plans and explain them the following day.  **Day 5:**  On day 5, students will present their projects cluster by cluster. Students have 5 minutes per cluster to make their presentations.  ***EVALUATE***: The teacher will use the rubric to grade the students on their presentations. |
| **Assessment** | The teacher will determine to what extent students met the learning outcomes listed earlier in this lesson plan by the information provided during group presentations. The teacher will use the rubric to grade presentations. |
| **Modifications** | Having students work in clusters should alleviate the need for most modifications. Since each student in the cluster receives the same grade for the presentation, clusters can elect not to have a student with weaker vocabulary be the main spokesman for the project. Instead, this student can be the illustrator of the wearable device or even agree to hold up the easel paper during the presentation.  Teachers should be prepared to help students with weaker reading skills during the research phase of the project. Teachers and media center directors can guide students to simpler web sites on the health problem that is the focus for the cluster group.  The teacher or media center director can also help a student access the text-to-speech function on the computer. The student should be provided with headphones. This way, the student can have the text read aloud to him/her.  Since groups are discussing their findings, this should provide reinforcement for struggling students. |
| **Alternative Assessments** | Again, having students work in clusters should alleviate the need for alternative assessments. However, students could record their projects on a flip camera and provide the video files to the teacher in lieu or making presentations in front of a class.  The teacher could also have students who struggle with writing meet with him and discuss how they would come up with a device and how it would provide a benefit to the wearer. Students still should be able to provide a drawing of the device they envision and go over its features with the teacher. |
| **References** | * Booker, Richard, and Earl Boysen. *Nanotechnology for Dummies.* Indianapolis: Wiley Publishing Inc., 2005. * Jones, M. Gail, et al. *Nanoscale science.* Arlington, VA: NSTA Press, 2007. * Niemeyer, Kyle. “What is Nanotechnology? Science in ‘Fantastic Voyage’ and ‘I, Robot.’” *Wordpress.* Wordpress. 31 Mar. 2011. Web. 24 Feb. 2015. * *Powers of Ten* [Video file] (1977). Retrieved from <https://www.youtube.com/watch?v=5CKd0aPSWe8>. |
| **Comments** | This lesson plan can be extended by giving students more time to create a plan for a wearable device. Such extended time would best be supplemented by instruction on the sources of kinetic energy for powering the device and the limitations of such.  The lesson plan can be shortened by focusing on one health problem, providing students with the info needed for the triggers of the health problem and having each group brainstorm how a device could be created to alert its wearer to environmental triggers or bodily indicators.  I have not had a chance to teach this lesson but have linked with a teacher to do so when he returns from a leave of absence.  All photos in the PowerPoint that can be provided with this lesson plan have been granted permission to be used for educational purposes. |

Cluster Project: Creating a Wearable Device to Combat a Health Problem

Today and tomorrow, you will be working with the students in your cluster to create a wearable device that can help alert students to the potential for an onset to a health problem they typically faced.

We have discussed some health problems in class that typically plague your classmates. Now, you and your cluster mates have selected a problem to focus on, and your device will help students before the problem is triggered.

Before you can design your device, you need to do some research. Each of you needs to find sources on the Internet that can help you understand the following about the problem you have chosen to tackle:

* What triggers the health problem in the first place? Is it something in the environment? Is it something happening in the human body? Is it a particular food?
* What happens when the student experiences the health problem? Does he faint? Does she experience seizures? Does he undergo physical changes?
* What parts of the body are affected by the health problem when it surfaces?
* What can ease the health problem after it has been triggered? Medicine? Insulin? An inhaler?

Once you know the answers to these questions, you need to come back together as a team and discuss what you can do to design something that will alert students to the triggers that could set off a problem for them.

Keep the following in mind when you move into the design phase of your wearable device:

* The device will need to be attractive, so students will not feel embarrassed wearing it and will not avoid wearing it.
* The device needs to be worn in an area of the body where it would pick up the signs of the impending problem.
* The device needs to have an energy source. It needs to be fueled by a battery or by kinetic energy or solar energy or body heat, etc.
* Students need to take into account what activities a human being puts himself or herself through in a day’s time.
* The team will also need to be able to explain how it will provide students with information about the possible onset of a health issue.

Rubric: Creating a Wearable Device to Combat a Health Problem

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| --- | --- | --- | --- | --- |
| Category | **4** | **3** | **2** | **1** |
| Device function | Device designed with attractiveness, wear/tear, source of energy, triggers, alert features in mind | Four of the five design features presented | Three of the five design features presented | One or two of the design features presented |
| Scientific knowledge of health problem | Student team was able to explain: what triggers the health problem, what reactions it causes physically, what parts of the body are affected, what eases the problem after onset | Three of the four topics addressed concerning the health problem | Two of the four topics addressed concerning the health problem | Only one of the four topics addressed concerning the health problem |
| Use of time in project work | All four team members actively engaged in contributing to the design and work of the project | Three of the four team members actively engaged in contributing to the design and work of the project | Two of the four team members actively engaged in contributing to the design and work of the project | One of the four team members actively engaged in contributing to the design and work of the project |
| Class presentation | Team cluster exhibited poise, enthusiasm, clarity in speech, and voice projection during presentation to class | Team cluster exhibited three of the four criteria during presentation to class | Team cluster exhibited two of the four criteria during presentation to class | Team cluster exhibited one of the four criteria during presentation to class |

Team members:

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Health problem: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_