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| **Title** | **Designing and Analyzing Data Collected from Wearable Devices to Solve Problems in Health Care** |
| **Introduction** | Have you ever wondered how clothing and other items you wear; such as a watch, shirt, coat, shoes, hat, and much more could save you or a love one’s life?  As humans, we are faced with many potential health risks in our society, which is why billions of dollars are poured into research centered on health care. The question remains, could research and the development of technology be used to improve our health care? If so, how can we design and program wearable devices to collect data; from such innovative developments; to make further advancements and preventative measures in healthcare.  This lesson was designed to make students aware of the health issues in our society and how wearable devices are being used to solve these health challenges. The tasks in the lessons are open-ended and are designed to have multiple approaches. With that in mind, the students are to learn how to use prior knowledge, critical thinking, and problem solving skills to make sense of the lesson’s task mathematically. They are encouraged to be risk takers and innovators, which is what engineers, scientist, and researchers use to make such strides in improving our health care system. |
| **Real Science Application** | A person’s gait can be used as an indication of serious health issues and or an early detection of a potential fall that could cause other health issues. For an example, a high temperature and a fast heart rate could be an indication of serious health issues in humans who are under a lot of stress. |

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| **Curriculum Alignment** | |  |  |  | | --- | --- | --- | | Content Area | Grade Level | NGSS / Common Core Math | |  |  |  | | Common Core Math II/III | 10th-12th | **F-BF.1**  Use technology to write a function a function that describes a relationship between two quantities; interpret functions that arise in application in text of the context.  **F-BF.4**  For a function that models a relationship between two quantities, interpret key features of graphs and tables. Sketch and analyze the function showing key features of the data over different intervals. | | Advanced Functions and Modeling | 11th-12th | **1.01a and b**  Create and use technology generated models for linear, polynomial, exponential, trigonometric, power, and logarithmic functions of bivariate date to analyze solve problems. Analyze and interpret the function in context to data.  Check models for goodness-of-fit, use the most appropriate model to draw conclusions and make predictions. | |
| **Learning Outcomes** | * Students will research concerns in our society (specifically among high school/college students) and brainstorm and create a 3-D drawing of a prototype of a wearable device can be used to assist in solving this concern. (Focus is on [One-Health](http://www.onehealthinitiative.com/)) * Students will understand how mathematics can be used to solve health concerns in our society. * Student will collect and organize data collected while experimenting with a wearable device. * The students will use technology and computer applications to collect and organize data for further analysis about the data collected from their wearable devices. * The students will be able to investigate data collected from the investigation to understand the relationship between bivariate data. * Students will be able to use technology to build regression functions in order to make further predictions about health concerns. |
| **Time Required and Location** | * 90 minute class period in the classroom on day 1. * Additional 90 minute class period in classroom on day 2 |

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| **Materials Needed** | **Teacher Material List**   * A wearable vest or shirt with an accelerometer, buzzer, and red-green-blue (rgb) light sensor. * Arduino lily pad kit, access to [sparkfun.com](https://www.sparkfun.com/) (this website has the instructions of the program on how to build a wearable device to detect the heart rate and temperature levels.   **Student Material List:**   * Laptop or a Desktop per student/group * [Geogebra](https://www.geogebra.org/) downloaded * Graphing calculator * [**Access to sketch-up**](http://www.sketchup.com/?gclid=CjwKEAiA7MWyBRDpi5TFqqmm6hMSJAD6GLeAejGbwY-MRb_n2AgmJIJKKZ4ZXPgNff-KxwCgQhAkPhoCFQ3w_wcB)  or a similar app, * Markers, scissors, tape, poster paper * [**Investigation instructions/handout for each student**](https://docs.google.com/document/d/1A_LBtasW4t6nV7b_AFnW2GWmvPevYeF9RDjuZTcsprM/edit?usp=sharing) |
| **Safety** | * If student are designing prototypes using Arduinos, avoid liquids and foods in open containers during this activity that could cause damage to equipment. * \*If students are creating prototypes, they will need to use needles for sewing. Store and use care with the needles they are sharp and could be dangerous if used or stored inappropriately. |
| **Student Prior Knowledge** | Students should be familiar with the different types of functions in mathematics; such as Linear, Quadratic, Cubic, Polynomial, Exponential, Logarithmic, power, and trigonometric functions. They will need to familiar with piecewise functions. They should be familiar with how to use a graphing calculator to create scatter plots and regression equations. Students should also be able to use the calculator to determine whether there is a strong or weak correlation between the relationships of the variables in this investigation. Students should be familiar with interpreting the meaning of the dependent and independent variable in context to this situation.  If using excel spreadsheet; students will need instructions on how to use excel to model functions. |
| **Teacher Preparations** | Teachers will need to:   * Be familiar with [**Arduino (lily pads)**](https://www.sparkfun.com/tutorials/308) and how to upload a program to the Arduino app for an Arduino to work properly. * Prepare a wearable device that can be presented and related to the investigation. * Make sure Geogebra is downloaded on laptops or devices that will be used. |
| **Activities** | 1. The teacher will give an introduction to inform the students about wearable devices and nanotechnology using a PowerPoint presentation ([**sample PowerPoint presentation**](https://drive.google.com/file/d/0B5JnVcH599txeDExTHV3bVkybWs/view?usp=sharing)), Prezi, or other new technology tools that can be used to give an elaborate presentation. (Optional: invite local researchers, professors and/or engineers to give the introduction or design your own presentation. 2. The teacher or a guest will present and explain a prototype (wearable device) developed; specifically a device developed by you (if there is a guest have him/her to present their prototype (the wearable device should focus on One Health). 3. After the presentation have the students to work in small groups to investigate the relationship between the heart rate and body temperature. [**Investigation Handout**](https://docs.google.com/document/d/1A_LBtasW4t6nV7b_AFnW2GWmvPevYeF9RDjuZTcsprM/edit?usp=sharing) 4. Conduct a whole class discussion about the Investigation on heart rate and body temperature. 5. As an project-based learning assessment component, have the students to work in a small collaborative group to complete the assessment (the link is posted in the assessment column below ) |
| **Assessment** | [**Assessment with Grading Rubric**](https://drive.google.com/file/d/0B5JnVcH599txQ0o5VFBXVDJ4ZFU/view?usp=sharing) |
| **Modifications** | There are different approaches to this lesson, the teacher can change this lesson to fit the needs of his/her class.  Technology can also be used as a way for student to interpret the meaning of any of the text used in the lesson for students with certain learning disabilities.  Time constraints can be extended to ensure that all students are understanding the lesson. Some groups maybe on different tasks in the lesson, which is normal.  Group collaboration and group dynamics should be considered carefully when completing this project.  Limited English student should be place in a group with a student who is willing to interpret or peer tutor the student.  Differentiation should be considered for a more advanced group that may be able to complete the extension while a student with a learning disability may only be able to generate functions using technology and make predictions. |
| **Alternative Assessments** | Same as the assessment, but may need extended time. |
| **References/Links** | **RELEVANT LINKS FOR THE LESSON**  [**Geogebra**](https://www.geogebra.org/)  [**Fun Spark (Lily pads)**](https://www.sparkfun.com/)  [**Stat Crunch (Data)**](http://www.statcrunch.com/5.0/viewreport.php?reportid=27708&groupid=964#Data1)  [**Sketch-Up**](http://www.sketchup.com/?gclid=CIC-pKaDrMkCFQsjHwodh40Gpw)  **WORK CITED FOR RESEARCH AND DESIGN OF PROTOTYPE**  **Incident Rate and Data Analysis**  [NCBI: Falls and Prevention](http://www.ncbi.nlm.nih.gov/books/NBK2653/)  **Wearable Devices for Fall Prevention**  [Arizona State University Research and Prototypes](http://surgery.arizona.edu/node/1672)  **Health Related Research**  [Health Line: Causes of Gait Abnormality](http://www.healthline.com/symptom/gait-abnormality)  [Mayo Clinic: Balance Problems](http://www.mayoclinic.org/diseases-conditions/balance-problems/basics/definition/con-20033442) |
| **Comments** | This lesson was design to give a general idea of how to incorporate an engineering lesson or other cross-curriculum lesson into a mathematics class.  For a Cross Curricular lesson with an Computer Science/Programming Class: materials will be needed to build wearables with temperature and heart monitors:  The topic idea and technology can be changed to suit the interest of the students. |
| **Author Information**  **Internship Professor** | I am Sherri Pinkney a 2015-16 Kenan Fellows. I am Nationally Board Certified in young adult Mathematics. I have been teaching for 15 years for the State of North Carolina. I am currently teaching at Knightdale High School of Collaborative Design. I currently teach in the Creative Design Institute at Knightdale High. I have taught all subjects of high school mathematics including all of the Advanced Placement Mathematic Courses.  Dr. Jesse Jur is an assistant professor for Textile Engineering, Chemistry, and Science at North Carolina State University. His research targets the development of materials processing methods for nanoscale inorganic integration with polymer-based materials, including nonwoven textiles. Applications for his research include new electronic textiles that respond to chemical, photo and mechanical environmental changes, as well as the enhancement of the mechanical and thermal stability of modified fiber system. |