ICCARS Math Sections

**Unit Essential Content and Expectations – Math**

This unit was written for students in grades 9-12 attending Beacon Day Treatment, a day treatment center for students with severe emotional impairments. Most students test below grade level and come to class with significant in their academic skills. Therefore, these lessons focus on mathematical concept and deemphasize arithmetic and other prerequisite skills. Students participated in each lesson, provided thoughtful answers, and internalized themes of the unit.

The mathematics portion of this multidisciplinary unit uses mathematics as a basis for exploring larger topics, indirectly and directly, including the science of climate change, the societal implications possible solutions, and personal opinions on the validity of climate change and the ability of one person to affect change.

Students will conduct numerical research to determine the validity of climate change data, begin formulating possible solutions for climate change, and look in depth at wind energy as an alternative to fossil fuels. Students analyze graphs, look for patterns, determine function families, and make predictions. Students will study William Kamkwamba, an 8th grade student in Malawi, who built a windmill from junkyard scraps and brought power to his rural home. The theme of Kamkwamba’s memoir involves the power and potential in a person’s ability realize knowledge and understanding, despite the unlikeliness of the desired outcome.

Essential mathematics reflect these Michigan High School Content Expectations for Mathematics:

L1.2.4 – Organize and summarize a data set in a table, plot, chart, or spreadsheet; find patterns in a display of data; understand and critique data displays in the media.

A2.3.1 – Identify a function as a member of a family of functions based on its symbolic or graphical representation

ISTE NETS addressed:

Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.

Critical Thinking, Problem Solving, and Decision Making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

**Lesson Plans**

**Title: Using Math to Explore Climate Change**

**Introduction:**

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**Instructional Objectives:**

* Students will look at graphs of existing data, look for patterns, causation, and correlation, and draw conclusions.
* Students will identify possible solutions to climate change through a spatial model called “The Wedge Game,” and then design a personal action plan that will allow themselves to be a part of the solution.
* Students will generate data by finding energy output from various configurations of wind turbines based on number of blades, angle of blades and pitch gauge.
* Students will learn about William Kamkwamba by reading his memoir, *The Boy Who Harnessed the Wind*, viewing his TED Talks, and visiting his website.
* Students will apply lessons and experiences from Kamkwamba’s story to their own understanding of alternative energy and the human role in creating and solving problems.
* Students will recreate Kamkwamba’s experience by utilizing the engineering process to build functional windmills from scrapyard materials.

**Prerequisites:**

Students should have prior knowledge of how to read and interpret data displays. Students should know and be able to identify characteristics of linear, quadratic and exponential functions.

**Safety:**

There are no unusual safety concerns for this unit.

**Major Understandings:**

* Data supports a strong correlation between trends in climate change, unusual weather, carbon dioxide levels, cloud cover, world population, and fossil fuel use.
* Climate change is a major problem that is reversible through a variety of realistic solutions, operationalized on both a large and small scale.
* The amount of power generated by wind turbines depends on a variety of factors that can be manipulated by the designer.
* One person with the right motivation, information, and need can realize a solution to complex problems.
* Building a windmill out of scrapyard pieces is challenging, but possible.

**Resources**

Handouts found in appendix

Climate Change Lesson parts 1 and 2

Personal Action Plan

Wind Experiment

Reading Log

Junkyard Wars Assignment Sheet

Math Rubric

Paper/pencil

Internet access

PBS Nova episode “Power Surge” (can be found on the internet)

Wind turbine laboratory kits

Box fan

Copies of the memoir *The Boy Who Harnessed the Wind*

Digital projector and AV hook ups to the computer with internet access

Access to YouTube for TED Talks

Scrapyard materials

Hand tools

Scissors

Tape (any kind, but masking tape or duct tape work best)

Glue (any kind, white school glue works just fine)

Mechanical fasteners (optional) such as Velcro, nails, screws, zip ties, etc.

**Lesson Development**

1 – ENGAGE (about 15 minutes)

Students research data related to climate change and begin to look at causation and correlation. Originally, these lessons, published at the My NASA Data website, utilized the Live Access Server data provided by NASA. However, the Live Access Server was updated, and directions provided in the lessons no longer aligned. Therefore, this lesson has been greatly modified and is presented independent of the Live Access Server. Future presentations of the same lesson may align with NASA once updated lesson plans are posted at the website.

Students will be asked what they think about trends involving world population, fossil fuel use, average temperature, cloud cover, extreme weather, and carbon dioxide levels. Do they think these are increasing or decreasing? Do they think there has been any change in any of these variables?

2 – EXPLORE (50-90 minutes)

Students will conduct internet research to find charts or graph that show trends for the variables discussed during the lesson. (Climate Change Lesson Part 1)

Next, students explore the relationship between chlorophyll levels and carbon dioxide levels using the Keeling Curve and data collected at the Maumee River watershed. Charts and graphs found through the My NASA Data site will be used. (Climate Change Lesson Part 2)

3 – EXPLAIN (50 minutes)

Students will write about the relationship between the variables discussed in the Engage lesson and whether or not they think there is causation or correlation. They must support their answers using the data from the graphs and charts they found. They will be asked to consider alternate explanations for trends besides increased greenhouse gases. Student findings will be reported in written responses on the handout.

Students will be asked to consider how data and conclusions related to the Maumee Watershed in Ohio relate to overall worldwide climate trends they saw in the first phase of research. Observations will be reported in written responses on the handout.

4 – EXTEND (90 minutes plus time at home reading the book)

Students watch the Power Surge video and answer multiple-choice questions as the answers appear in the video (Personal Action Plan handout). Students focus on various solutions, how much we will need to depend on each solution, and what individual people can do to be a part of the solution.

Students will answer the question, “How will you address the climate change problem?” by considering taking action personally, inciting others to action, or learning more about the topic. Students will then describe a personal action plan and how it will have a positive impact on global climate.

Students will put their plans into action and produce evidence of completion.

Teacher will show students the wind turbine and ask them to predict which configuration will yield the highest energy output (Wind Experiment handout). Teacher will explain to students that there are many variables that go into designing wind turbines and that we are looking at 3 of them in this lesson. She will encourage students to really think about their predictions and the reasons behind their predictions.

Students participate in the teacher-led laboratory experiment. Students test various wind turbine configurations by placing them in front of a box fan and reading energy output on a sensor. Students record data in tables on the handout and display their results in a graph.

Students answer questions based on their data. They identify their independent and dependent variables, identify labels for the axes, identify a function family, and note trends and behavior of the data. Students determine which independent variable yields the highest energy output for each configuration

Based on data collected in three separate experiments on number of blades, angle of blades, and pitch gauge, students choose an optimal configuration for energy output. They build that wind turbine and test it. They record their configuration and the energy output. Then, they compare that to their initial hypothesis.

Teacher will introduce the novel to the students by giving basic biographical information about Kamkwamba and asking students to imagine what it might be like to grow up like he did. Details about his life that teacher might preview: Kamkwamba grew up in Malawi, he lived in a rural area, his family had very limited resources, he had an idea to have electricity even though they never had it before (how could he even imagine it if he never had it? He was visionary), he endured great hardship including a famine and being kicked out of school for lack of payment, he was ridiculed by people who did not understand what he was doing.

For each chapter, students are given a theme and choose one scene or example from the book to draw and describe in at least 3 sentences (Reading Log). At the conclusion of the book, students write on the overall theme of the novel.

Students are given “scrapyard” materials including scrap wood, plastic, metal and paper as well as pieces from a windmill kit and are asked to build a windmill that stands by itself and turns. They may use hand tools, scissors, a limited supply of mechanical fasteners, tape and glue. They receive $10 in fake money to buy supplies (see appendix “Junkyard Wars Assignment Sheet” for details). Students make a sketch of their planned project with labeled parts and materials, “shop” in the junkyard for materials, build, revise, build, and finally test their finished product. Windmills that are free standing, stay standing once in front of a moving fan, and have blades that rotate pass the test.

5 – EVALUATE (30 minutes)

Students gather all materials completed as part of the unit. They complete written responses, complete the reading log, turn in finished and functioning wind turbine. Assessment is conducted according to the Math Rubric found in the appendix.