**Modeling the Mother Functions**

**Science and Mathematics Investigation**

**Fayetteville High School Algebra II - Physics**

**Next Generation Science Standards:**

There are many instances in the NGSS where the students are asked to create mathematical models to explain relationships. Their facility in creating graphs, creating mathematical models from those graphs and being able to make predictions from their models is a central part of any successful science class.

**Common Core Mathematics:**

Functions are an underlying principle of Common Core mathematics. Historically math classes have looked at the relationship between two variables sans any context. With common core we are now going to be relating two variables ***in context.*** Concepts such as domain and range, x-intercept, y-intercept, maximum and minimum, take on a new meaning in Common Core mathematics.

**\*\*Teacher NOTES\*\***

The intent is to fundamentally change each discipline’s approach to graphing. The discussion should be started with a conversation between the Physics teachers and the Mathematics teachers in August. The math teachers will be exposed to some of the questions the students are commonly asked in the Modeling Physics class room.

When discussing graphs in the mathematics classroom, units should be discussed. Any graph can have distance and time added to the axes. This will give the graph a context, and allow for questions to be asked to help the students understand the relationship between these variables in a context that is familiar to both students and teachers. This will also greatly help students understand graph interpretation in the science classroom, where there is always a context. As the units of distance and time become natural, others, such as velocity and time, etc. can be implemented by the math teacher.

When discussing graphs in the science classroom, transformations should be discussed. The application of a transformation in the science class comes in the form of a modification of the experiment. To shift A, h, and k, the experiment must be changed in some manner. Discussing this with students, using proper terminology, will help increase their understanding of the transformations done abstractly in their mathematics class. The three forms of a function are the standard, the vertex, and the intercept. Discussing these in the science classroom will reinforce what the student is learning in both disciplines.

**Investigation Title**

**THE Investigation**

**Purpose:** Integrate the investigation of the Mother Functions with their scientific applications. Rather than a specific activity, as such, this is more of a systemic change in the manner in which graphs are discussed in both the science and mathematics classes. The activities that follow are merely a few examples of how this change can be implemented into each discipline.

**Learning Goals:**

* Become comfortable with the nature and needs of a given mother function. Design an experiment and collect data that model one or more of the mother functions. Relate the transformations of the functions to modifications in their experiment.

**Equipment:**

* TI inspire and CBR 2 or equivalent data collection equipment
* Ball, coffee filters or other device for dropping
* Cars – free rolling, pull back (acceleration), constant velocity
* Tape, meter stick
* Inclined plane
* Stopwatch or other timing device
* Whiteboard, markers

**Discussion:**

There are seven mother functions, and seven measures of a graph. The goal of this investigation is to collect some data that can be modeled by using one of the seven functions. Then, determine ways to modify the data collection methodology to represent a given translation of the mother function. Focus should be given to the units of the variables, and constants within the mother functions.

**Procedure:**

1. Linear data – Given a constant motion vehicle, timer, and measuring device discover a linear relationship between distance and time, in the form A(x-h) +k = y
2. Quadratic data – Given a motion detector and a device to collect data (ball or other..) discover a quadratic relationship between distance and time in the form of A(x-h)2 + k = y
3. Continue for other models as you see fit, or provide data as appropriate.

**Data Analysis:**

1. Students should be able to identify the units for the constants and complete the following table for each function

|  |  |  |  |
| --- | --- | --- | --- |
| **Constant** | **Value** | **Units** | **Contextual Meaning** |
| A |  |  |  |
| h |  |  |  |
| k |  |  |  |
| B |  |  |  |
| C |  |  |  |
| p |  |  |  |
| q |  |  |  |

1. The teacher will assign the students to redesign the experiment to cause a change in the assigned constants. For example, one team may be assigned the task of re-designing their experiment to cause an increase in A and a decrease in k.
2. The students will whiteboard their investigation and modifications, and present to the class. Important aspects to include in whiteboard presentation are what the investigation was, original and modified values of the constants, how they changed their experiment, and a sketch of the original and modified graphs.

**Future expectations:**

**Mathematics class:** The teachers will incorporate units as much as possible. For every graph they encounter, consider it as a position vs. time and discuss the graph in context. Suggest using the CBR or other program to help clarify with a “walk the graph” investigation.

**Science class:** Incorporate the mother functions as they appear in the curriculum. Also, discuss possible transformations of the functions as related to the experimental design.

For the next academic year the math and science teachers will identify other areas in the math curriculum where investigations to enhance the math-science experience of the student could occur.