**Measuring Energy Use of Programs: In Introduction and Application of Integrals**

Total Number of Lessons: [number of lessons]

Total Time for Module: [number of minutes]

Section 1: Module Overview and Curricular Connections

* **Module overview**: This module introduces students to integrals as the area under a curve. In addition, they will get to see two current methods of measuring the energy use of computer programs. Through examples of these two methods, students will then calculate the total energy used by a program. Comparisons to batteries in cell phones will be used and students will make a connection between why the high use of phones drains the battery so quickly. Then, students will answer application problems related to the topic.
* **Module goal**: SWBAT find the area under a curve and use it to answer real-world problems.
* **Module scope and rationale**: This will be a multi-day activity that gives a good introduction to integrals by demonstrating the process of summing rectangles and also gives real world application to integrals.
* **Connection to standards**:

ITEEA: The Designed World - Students will develop an understanding of and be able to select and use energy and power technologies. - In order to select, use, and understand energy and power technologies, students should learn that: - Power systems must have a source of energy, a process, and loads. (<http://asn.jesandco.org/resources/S11417E1>)

* **RET materials/ideas to be leveraged**: Benchmarking the energy use of different programs through software and hardware will be demonstrated and explained to students.
* **Prior knowledge needed for module**: Students should have completed Algebra 2 in order to use this module.

Section 2: Overview of Module Framework

* **Real-world context**: This module can be used to solve real problems involving how far something has traveled based on its velocity, how much energy is used based on the power consumption, and any other real world context that can be graphed against each other where the area under the graph would have meaning.
  + **Possible Lesson Ideas**: There will be a lesson where students are asked to figure out how far things have traveled or how much energy has been consumed from simple situations and then leveling up to energy consumption of a computer running an actual program, which will be more complicated.

* **Background STEM content**: This module will be tying into technology by introducing students to two different ways that researchers actually determine the amount of energy being used by the hardware within a computer. Students will get a description of the GPU and CPU, a rudimentary explanation of how they work and how to measure the energy being consumed by them.
  + **Possible Lesson Ideas**: Students will be tasked with calculating the actual energy usage of a program that is run on a computer.
* **Final Project**:

Students will be producing data on how much energy is used based either on a graph from Signal Express and DAQ hardware or based on an excel sheet created using pcm software.

Section 3: Module Sequencing and Assessment

* **Description of sequenced learning objectives**: This module is really one lesson that will span multiple days. The main learning objective builds up from simplistic examples into more complicated application.
* **Description of formative assessment approaches**: [When/what techniques will you use to assess student progress towards objectives during, and at the end of, each class period?]
* **Description of summative assessment approaches**: [How will you assess the final project and/or performance assessment? If you are using a rubric, what criteria will you examine?]

Section 4: Final Comments and Attached Files

* **Recommendations for implementation**: [Describe any “safety tips” or advice you have for other educators who might implement this module.]
* **List of attached files**: [should include any lesson plans and handouts relevant to the Module, if you have them ready]
  + [File name 1 and one line description]
  + [File name 2 and one line description]
  + [File name 3 and one line description]
  + [File name 4 and one line description]
  + [File name 5 and one line description]