Grant Number 1404
(For Office Use Only)

2013-2014 Grants for Great Ideas Application

Please complete the next two pages in the space provided only. Do not use a font size smaller than a 10.

Overview

1. Project Title: **Mastering Motion in the Physics Classroom**

2. Grade(s) participating in grant: **10, 11, 12**

3. Subject(s) a. **On-level Physics, Pre-AP Physics, AP Physics** b. Serves primarily Special Education? **No**

4. Target population to be served: **All High School physics students**

5. Implementation date: a. **Fall 2014** b. Completion Date: **Ongoing**

6. Total dollar amount requested: **$3,514.34** Are there additional funding sources? _X_No____Yes
If "yes", please explain.

7. Projected number of students impacted by grant project? **Approximately 250 students per year.**

Application Narrative:

8. Abstract (no more than 100 words)

Learning physics is no easy task; it is one of the most challenging courses that high school students take. The challenge lies in bringing together physics concepts, mathematical equations and graphical data that follow the equations. The ability to tie these together is critical to a full understanding of motion and hands-on labs are the key. The purpose of *Mastering Motion in the Physics Classroom* is to increase the physics students' level of comprehension and mastery of motion using labs. Data will be collected and analyzed using the revolutionary Motion Encoder System enabling students to fully understand motion.

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1. **Purpose:** (What is and how will the project be implemented?)

   The purpose of *Mastering Motion in the Physics Classroom* is to increase the physics students' level of comprehension and mastery of motion, also called dynamics. Aspects of motion are studied the entire first semester in on-level, Pre-AP and the entire year in AP Physics. Studying motion includes the relationship between distance travelled and the associated velocity and acceleration of the object. The equipment requested in this grant provides a revolutionary way for physics students to study and more fully understand dynamics using graphical analysis.

2. **Description of Instructional Procedures** (Describe proposed activities and tasks. Provide detail so that the review committee can distinguish innovative ideas.)

   This equipment will be used in numerous hands-on physics labs for all three grade levels where motion is studied. Titles of the labs include *Investigating Motion, Determining g on a Ramp, Static and Kinetic Friction, Momentum, Energy and Collisions, Newton's First Law, Newton's Second Law, Newton's Third Law,* and *Energy Storage and Transfer.* In each lab motion data will be collected using the Motion Encoder System. An optical sensor beneath the dynamics cart senses the passage of the cart over a marked strip on the track. The position information is sent as an encoded IR signal to a receiver at the track's end. By avoiding the possibility of stray sound reflections, this optical-only system provides excellent, repeatable, and noise-resistant motion data. The data is graphed in real time with the help of existing equipment that includes low friction carts, a low friction track, computer, and data analysis software. Students will then work to understand the connections between physics concepts and equations learned in the classroom, equations learned in math classes and the graphs generated with the Motion Encoder System.

3. **Need/Rationale** (State the specific need(s) this project addresses. Who are the target populations, number of students involved, immediate and future, and how will they benefit from the proposed project? Please relate to district and campus plans. Include any research that supports the need for this project.)

   Learning physics is no easy task; it is one of the most challenging courses that high school students take. Part of the reason for this is the challenge of tying together physics concepts, mathematical equations that model these concepts and graphical data collected in the lab that follow the equations. The ability to bring together these three aspects of physics is the key to the mastery of motion in the physics classroom; hands on labs are the key to bringing it all together. In these labs, students see motion and its changes along with the motion graphs created in real time. With this information students will be able to recognize mathematically the graphs from previous knowledge received in their math classes and see how these mathematical equations are related to the physics equations learned in the classroom. This equipment allows the data to be collected and graphs generated with incredible accuracy making the analysis step easier and more productive.

In support of this premise, Laurence S. Cain, in a College Board publication, (*College Board AP Physics 2006-2007 Professional Development Workshop Materials Special Focus: Graphical Analysis*), states "As chair of the AP Physics Development Committee, I am pleased to present these theme materials on graphical analysis. The ability to analyze graphs is an important and necessary skill for AP Physics students. The AP Physics Course Description lists several key abilities evaluated by the AP Exam, including drawing and interpreting graphs and representing data or physical relationships in graphical form. The laboratory section of the exam also requires graphing skills with questions that ask students to "analyze data, including displaying data in graphical or tabular form, fitting lines and curves to data points in graphs, performing calculations with data, or making extrapolations and interpolations from data." Students need to be able to think about the material in their physics courses in terms of conceptual, verbal, graphical, and mathematical ideas. As part of these comprehensive skills for understanding the physical world around them, students must be able to perform graphical analysis in its many forms. Thus the AP Physics Exams continue to address the analysis of graphs in all types of questions, including laboratory-related questions. In many areas of physics, there also appears to be a disconnect between what students learn in their mathematics courses and how they apply that knowledge in their physics courses."

In addressing problem areas in graphical analysis, Cain continues one "area involves the ability to view and interpret graphs that are already given or to predict what a graph will look like. This area spans all topics in physics and requires a good conceptual and mathematical understanding of the underlying physics. Students should be able to interpret graphs and make predictions. Particularly important is the ability to interpret position, velocity, and acceleration graphs. The conceptual understanding involved in using slopes and areas to find kinematical variables and the relationships among them is an important ability for students to develop. This understanding sets the stage for the use of graphical analysis later in the AP courses."

Randall Knight, in *Instructor's Guide: Physics for Scientists and Engineers* reports that even though nearly all students can graph a set of data or can read a value from a graph, they experience difficulties with interpreting the information presented graphically.

Additionally, Eshach (2006) argues that educators should be aware of the importance of body knowledge and that they should provide students with appropriate sensomotoric experiences which could constitute a solid basis on which the correct scientific concepts may be later constructed. Indeed, sensory interactions with the environment have been considered as crucial for the development of higher reasoning skills across domains (Piaget, 1954, 1976). It has also been shown that this type of analysis increases students' graph reading and creation ability in general and connect them to the real world.

The equipment requested in this grant proposal will be used to tie these aspects of graphical analysis together to assist students master the study of motion.

All levels of high school physics courses study motion extensively so sophomores, junior, and senior will benefit from using this new equipment. This will be approximately 250 students each year.

4. **Objectives:** (What do you intend to achieve? Objectives must be measurable in terms of student behavior or performance.)

Our objective is to increase students' comprehension of motion tying together concepts, formulas, and graphs; specifically as it relates to the relationships between distance, velocity and acceleration. Having gained the skill of understanding the relationships between concepts, mathematical formulas, and graphical data other topics covered in each of the physics courses can be learned at a deeper level and at a quicker pace.

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5. **Evaluation:** (Describe how you will measure the success of your project. What methods of evaluation will be used? What tools will be used to determine project effectiveness?)

We will use several means of evaluation in order to determine the success of this project. The first will be in the interaction with students as they conduct the labs by checking for understanding as they analyze the motion being studied. This increased understanding will be further verified in the grading of the labs. Secondly, we have developed a series of worksheets where students are given motion graphs and asked to describe the motion that created the graph. We expect that grades would increase 10-15% on these assessments. Finally, these items are also included on unit and benchmark tests; again we expect these items to be answered correctly at a higher rate.

6. **Innovation:** (How is this project concept innovative?)

As mentioned earlier, the Motion Encoder System uses an optical sensor beneath the dynamics cart that senses the passage of the cart over a marked strip on the track. The position information is sent as an encoded IR signal to a receiver at the track's end. By avoiding the possibility of stray sound reflections, this optical-only system provides excellent, repeatable, and noise-resistant motion data. Because the position information is relayed by a narrow IR beam, multiple Motion Encoder Carts can be used in a single lab. Two can even be used at a time on a single track, allowing students to study collisions. The optical motion encoder consists of three parts: a Motion Encoder Cart with a Sensor and transmitter, a Motion Encoder Receiver that connects to your interface, and a track equipped with a Motion Encoder Strip. Together they allow unparallelled ease, simplicity, and accuracy in motion measurement.

Contents of the Motion Encoder Upgrade Kits: motion encoder receiver, cart transmitter with associated electronics, magnetic strip for track.

Students using the Vernier Motion Encoder System. The computer display show distance vs. time and velocity vs. time graphs.

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7. Identify any relevant community/school partners involved in the project and their role(s): (There does not have to be a school or community partner.)

8. ***Budget:*** **How will the funds be used?**

Item	Supplier	Cost/Item	Total
Motion Encoder Upgrade Kit (12)	**Vernier Software and Tech**	**$140.65**	**$1,687.80**
Motion Encoder Transmitter Parts (12)	**Vernier Software and Tech**	**$ 93.12**	**$1,117.44**
Motion Encoder Cart Receiver (12)	**Vernier Software and Tech**	**$ 53.35**	**$ 640.20**
Shipping			**$ 68.90**
Total			**$3,514.34**

Remember to add shipping if needed.

Grant Applications should be submitted to the Lindale ISD Education Foundation by the deadline.
bethanymg@lindaleeagles.org or (903) 881-4001 ext.1015.

Signature of the Director of Technology * Leslie Garakani **Date** 2-12-14

**** Required when funds will be used to purchase technology and/or media equipment. Applications requiring technology signatures must be submitted to that department no later than 4:30 P.M. Thursday, February 13, 2014. Early submission of a rough draft to the Director of Technology (Leslie Garakani) is encouraged so he can make alternate equipment suggestions when applicable.***