Case Study Title:

Studying the Kinematics and Dynamics of Simple Harmonic Oscillator with the use of a Microcontroller-based System

Problem Backgound

Performing a physics experiment and taking valid measurements is not always possible, given the limitations in a school lab. The aim of this particular case study, is to allow students to properly validate fundamental physical laws and draw useful conclusions via an Arduino-based system. Studying a well known system, such as that of the harmonic oscillator, would offer pupils a great opportunity to familiarize themselves with advanced level topics in the fields of physics and mathematics.

STEM Topics Involved

Physics	■ ■ ■ ■ ■ ■ ■ ■ ■ ■
Maths	■ ■ ■ ■ ■ ■ □ □ □ □
Biology	□ □ □ □ □ □ □ □ □ □
Chemistry	□ □ □ □ □ □ □ □ □ □
Technology	■ ■ ■ ■ ■ □ □ □ □ □

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Pedagogic Methods Suggested

■ Lecture	□ Story Telling
■ Problem Based Learning	□ Peer Instruction
■ Inquiry Based Learning	■ Simulation
□ Project Based Learning	□ Role Playing
■ Direct Instruction	□ Debate
■ Collaborative Based Learning	■ Flipped Classroom Approach
□ Game Based Learning	

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Project No. 2019-1-RO01-KA202-063965

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Solution

The proposed solution is an activity that is appealing and stimulating to pupils and at the same time, it engages them in STEM projects. The harmonic motion of a vertical mass attached to a spring will be recorded by an accelerometer, so that raw data is gathered concerning the position and the vertical acceleration. That information will be processed by a microcontroller, which will provide graphs picturing the alteration of various distinct values such as the position, the velocity and the acceleration of the oscillator over time. A team of students will collaborate in order to prove Hook's Law of Linearity, by utilizing the device and drawing graphs depicting the spring force acting on the system, with respect to the deformation of the spring.

Equipment & Materials Required

- Arduino board
- Arduino IDE software
- Accelerometer
- Springs
- Inclination sensor
- Brass weights

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Assembly Instructions

1. Acquisition of all materials
2. Wiring of the Arduino unit and the accelerometer
3. Connection to the harmonic oscillator (spring with attached mass)
4. Coding of the device
5. Testing phase
6. Further discussion and proposals

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