Computing and Simulation in the High School Classroom

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This research investigates methods for integrating computational modeling and programming in three high school physics classes at Lowell high School in Lowell, MA. In this work, a project based approach is undertaken in which students conduct experiments, build mathematical models and learn to program using MATLAB, a general purpose scientific problem solving and scenario modeling software platform. We discuss the approach taken where students first undergo a four-week introduction to basic programming skills and begin to apply these skills to a series of projects based on fundamental physics principles. In each project, the students are immersed in a closed-loop investigation of conducting experiments, recording measurements, noting initial conditions and design variables such as mass, physical dimensions and sources of potential energy. This is followed by the development of a dynamical model of the system that can predict the performance such as time or distance traveled. Students then program the model using MATLAB, compare the computational and experimental results and refine the model as necessary. When they recognize a reasonable correspondence, the computational model will be applied to search for optimal design variable values, propose engineering solutions and/or verify hypotheses. In this research we investigate the impact of these computing experiments on the students' ability to critically analyze the models they have constructed and distinguish between type of errors generated from experimental uncertainty, the conceptual model they develop and those resulting from programming logic. The inclusion of experiments has been found to be critically important as an incentive for promoting students interest in improving their computational modeling and programming abilities. We report on grade-based student modeling performance, student exit surveys, and comparative instructional considerations and merits. The project is a collaboration between Lowell High School and the NSF GK-12 Vibes and Waves in Action project (#0841392) at UMASS Lowell, with support from MathWorks Inc..

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