Incorporating Computer Simulations into Existing Physics Curriculum and Laboratory Investigations

RES 697 CREATIVE RESEARCH PROJECT 3 CREDIT HOURS MAE PHYSICS EDUCATION BALL STATE UNIVERSITY

ADVISOR: DR. JOEL BRYAN
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JAMIE L. CHAMPLIN

PHYSICS TEACHER

COLUMBUS NORTH HIGH SCHOOL

ABSTRACT:

Although hands-on student laboratory investigations are a vital and necessary component of an effective introductory physics learning experience, several factors severely limit the practicality of conducting the quantity of laboratory investigations that most high school classroom teachers desire. Among these are 1) the high costs frequently associated with specialized laboratory equipment, 2) the limited time allowed by the 45-minute class period schedule that many high schools follow, and 3) safety considerations.

VALUE AND SIGNIFICANCE OF THIS CREATIVE PROJECT:

Although it is not recommended that computer simulations totally replace traditional hands-on laboratory investigations, they are one possible response to the three considerations listed above.

- 1) The World Wide Web contains a rapidly growing number of physics-related simulations that are available at no cost to the user (see PhET: http://phet.colorado.edu/new/index.php) and can be used in the classroom or at home. No specialized laboratory equipment is needed to conduct otherwise cost-prohibitive investigations like the photoelectric effect (see http://phet.colorado.edu/new/simulations/sims.php?sim=Photoelectric_Effect) and unlikely collisions (see
- http://media.pearsoncmg.com/bc/aw_young_physics_11/pt1a/Media/Momentum/PendulumPersProjectileBowling/Main.html)
- 2) Time constraints are minimized as little or no set-up time is required. This allows extra time to be allotted for multiple trials and more detailed investigation.
- 3) Activities that could not otherwise be performed due to safety considerations, such as radioactive decay (see http://staff.gc.maricopa.edu/~mvillarb/SyRIS/lawdecay.htm), are now possible.

Slow motion, pause, and play-back features available in many simulations offer students greater opportunities for exploration and more detailed analysis. They also provide an excellent opportunity for students to further explore classroom laboratory activities at home without having to borrow and return classroom laboratory materials.

One disadvantage to the use of computer simulation is that students do not experience the "messiness," the potential frustration, and the subsequent problem solving opportunities that work with physical materials offers. Another disadvantage is that simulations are most often programmed to include only the actual variables relevant to the investigation, which limits the experiences that students would receive in the planning and analysis stages of scientific experimentation. These two disadvantages can, however, be minimized as the instructor carefully selects the simulations and designs the investigations.

The aim of this project is to design inquiry-based activities that use freely available computer simulations. These tutorials and activities may be used to introduce new topics, review previously learned topics, and/or to supplement topics that we have already been learning. It is expected that the incorporation of simulations into the introductory physics classroom will improve student understanding of physics by allowing more labs to be conducted and by making labs more meaningful and less rushed.

The final product of this creative project will be a web site that contains 1) a summary of research related to the use of computer simulations, 2) a bibliography of simulation research, and 3) links to the activities. They will be presented in the topical order most normally associated with high school physics curriculum, and in a format that allows users to make modifications specific to their learning objectives.