Professors’ Instructional Approaches and Students’ Perceptions of nanoHUB Simulation Tools

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Introduction:
Simulations:
• can provide a critical element of learning experiences, have become a critical part of computational science, and are considered as the “Third-leg” of the contemporary methodologies of science.
• can provide multiple representation to enhance comprehension and insight.
• Opportunities exist to use the same simulation as both a tool for experts and a learning environment for novices.

What needs to be done to accomplish this duality?

The tool:
The Network for Computational Nanotechnology (NCN) has developed nanoHUB as a resource for advancing nanoscience and nanotechnology. nanoHUB.org focuses on:
• pioneering the development of nanotechnology from science to manufacturing through innovative theory, providing research quality exploratory simulation, and novel cyberinfrastructure that support communities for research and learning.
It has become an outstanding educational source in nanotechnology-related concepts and theory.

Methods:
Goal: Identify professors’ instructional approaches and students’ perceptions of using the nanoHUB’s simulations as learning tools.

How do instructors integrate nanoHUB resources into their instructional practice?
What are students’ perceptions of using nanoHUB simulation tools?
Does students’ level of expertise and interest in the course content relate to their satisfaction with the instructional approach?

The participants for the study included:
• two professors in the NCN and
• 34 students who are enrolled in the graduate level classes these professors teach.
The data collection procedures included: interview professors and survey students.

Results:
Learning Outcomes
Instructional goal: To give their students a sense on how investigations must be conducted in their areas of expertise as well as ways in which professionals work on those disciplines.
Instructor A emphasized that the cognitive benefit for students is to help them develop a more intuitive understanding of what is happening with the materials from a molecular point of view.
Instructor B focused on helping students develop a more intuitive feel for the process of designing semiconductor devices by identifying and manipulating the important parameters and measurements to be considered in a model.

Instructional Approach
Frequency of use:
• Instructor A used the simulation tools to cover one specific learning goal.
• Instructor B made an intensive use of the simulation tools within the entire semester following a progression of complex activities culminating in a design challenge.

General approach:
• Introduce the basic concepts in class, describe the models and analytical and practical solutions.
• Explain how to operate the simulation tool.
• Solve the same models by simulation.
• Elicit from their students to compare the approximations done in class versus the exact solutions computed by the simulation tools.

Evidence of Learning
The participants designed assessments featuring real challenges.
Instructor A focused his assessment to:
• comparing student’s solution with the solution given by the article authors.
• predicting behavior of materials according to specific parameters.
• comparing the behavior with experimental values.
• reading a journal article and predicting parameters of a specific material using the simulation tool and then.
• reading a paper that presents some measured data from a current generation device.
• predicting behavior of materials according to specific parameters.
• comparing the behavior with experimental values.
• writing a paper that presents some measured data from a current generation device.
• tweaking the parameters in the model so they can get a best fit.
• meeting parameters of a next generation device.

Implications:
Results indicate the potential of integrating the nanoHUB simulation tools into formal learning experiences.
Instructors leveraged nanoHUB simulation tools potential in providing students with authentic learning experiences in which knowledge was successfully applied to practical applications.
The students’ surveys show favorable results in how professors incorporate nanoHUB simulation tools to learning experiences in different disciplines.
Future work: How can instructors in undergraduate courses follow similar approaches? Would additional scaffolding be needed?