# Chapter 20
# Teaching the Greenhouse Effect with Inquiry–Based Computer Simulations:
## A WISE Case Study

**Edward Cohen**
*Piscatway Township Schools, USA*

**Timothy D. Zimmerman**
*Rutgers University, USA*

## EXECUTIVE SUMMARY

*This case study focuses on how students use a greenhouse effect simulation. The simulation is embedded within an inquiry-based technology-mediated science curriculum known as the Web-Based Inquiry Science Environment (WISE). For this research, students from a suburban, diverse, middle school setting were asked to use the simulation as part of a week-long class lesson on global warming and climate change. Using a combination of student interviews, focus groups, and students' conversations while they used the simulation, the authors present evidence of shifts in student motivation, understanding of science content, and ideas about the nature of science, all connected to the use of the simulation. From this data, the authors derived ways that teachers can help students develop deeper understandings of climate science topics through educational technology. Examples of these pedagogical approaches included allowing students to conduct "extreme testing" and increasing the time for free exploration of the simulation.*

## INTRODUCTION

With the increased public attention and debate around climate change, many science teachers and curriculum developers are seeking ways to help students understand the science involved in this topic. As part of the pedagogical solution to this challenge, many teachers are turning to technology tools to help students visualize, understand, and apply climate science concepts. However, many questions remain about best practices for teaching climate science using educational technology, especially the use of computer simulations. Our case study focuses on how students use a greenhouse effect simulation embedded within an inquiry-based, technology-mediated science curriculum. From this work, we derived several pedagogical principles for teaching climate science using computer simulations.

We see learning as a complex interplay between cognitive (individual and group), social, psychological, contextual, cultural and societal factors. From a pedagogical perspective, experiential (hands-on), inquiry-based curricula have emerged as productive approaches to teaching science (Zimmerman & Stage, 2008). Though there is some dispute over the effectiveness of inquiry-based pedagogical approaches (cf., Hmelo-Silver, Duncan, & Chinn, 2007; Kirshner, Sweller, & Clark, 2006), we agree with Hmelo-Silver et al.'s (2007) conclusions that empirical evidence supports the use of inquiry in classrooms. We adopt a definition of inquiry that views science learning as a complex treatment of both science content and science inquiry practices (Hmelo-Silver et al., 2007). In recent years, educational researchers have successfully utilized a combination of educational technologies for engaging students in inquiry-based science learning activities (Slotta & Linn, 2009). For example, the Web-based Inquiry Science Environment (WISE - http://wise.berkeley.edu) offers numerous inquiry tools such as drawing, graphing, data tables, concept mapping, online discussions, and student journals to support student learning (Linn & Hsi, 2000; Slotta, 2004; Slotta & Linn, 2009).

Computer-based simulations and models are said to be the most powerful advancements in math and science since the Renaissance (Bransford, Brown, & Cockling, 1999). In education, computer simulations and models are sometimes grouped, or the terms are used interchangeably. For consistency in this paper, we use the term *virtual models* to describe digital recreations of real-life phenomena that contain preset, non-changeable parameters, and use the term *simulation* to describe digital recreations that *allow for user interaction* with the real-life phenomena being portrayed in the simulation. Therefore, simulations allow users to manipulate the variables and thus the outcomes. This learner-centered approach presents opportunities for student inquiry.

The research described herein follows a practitioner inquiry paradigm. Practitioner inquiry, a broad category of educational research methodologies that includes ac-

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