Chapter 44
The Use of Complementary Virtual and Real Scientific Models to Engage Students in Inquiry: Teaching and Learning Climate Change Science

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ABSTRACT

This chapter reports on a four-year study to change how climate change science is taught and learned in schools. The goal of the Climate Change Narrative Game Education (CHANGE) project is to take what is known about reform-based practices, incorporating students' lived experiences into the curriculum, and the integration of Information and Communications Technology (ICT) into the classroom. CHANGE uses the following: scientifically realistic text narratives (text stories with local characters, 50-100 years in the future, a local, place-based approach, a focus on the built environment, the use of simulations and games based on scientific data, and a web-based "intermedia" eBook narrative where sections of narrative text alternate with simulations and computer games. The chapter reports on the ways that we have used the above principles to connect classrooms and communities and school science with academic science to facilitate student inquiry into climate science by combining virtual serious educational games with in class, hands-on inquiry using scientific models.

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INTRODUCTION

It is an interesting time for science education. We are faced with global problems associated with advances in science and technology, while at the same time we seek solutions to them in new scientific knowledge and technological innovations. It is also a time in which there are massive changes in the ways that we share and use information as print and wired media are replaced by digital and wireless communications in the social sphere. All that said, classrooms in schools remain the familiar places in which the teaching and learning of science has changed little over the years. In particular, there are few visible effects of innovative uses of Information and Communications Technology (ICT) or the use of inquiry in the teaching and learning of science in schools.

The use of ICT has become ubiquitous in our contemporary lives. We see this in schools where students use it to write assignments, look up information, and communicate with teachers. Similarly, teachers use ICT to write lesson plans, handouts, quizzes and tests; to look up information; to present lessons; to record and calculate student grades; and to communicate with students, parents and administrators. For the most part these are examples of how ICT has replaced older technology, like printed books, paper and pencil, overhead projectors, calculators, and telephones. While there are teachers and students who engage with ICT in more innovative ways including the use of probeware, access to and analysis of real scientific data, and models and simulations, in the US, where we are located, these innovative uses of ICT are few and far between (e.g., Bang & Luft, 2013).

Similarly, the effects of a more than 50-year effort to transform the teaching of science to be more inquiry oriented are not common. In the mid 20th century governmental agencies around the world funded the development of courses and curriculum in which inquiry was central (e.g., Donahue, 1993; Nuffield Foundation, 2016; Tamir & Jungwirth, 1975). However, Stake and Easley (1978) found that in elementary schools there were only occasional efforts to do more than read about science topics, and that in secondary schools science was seldom taught as scientific inquiry and subjects were presented as what experts had found to be true. Twenty years later the National Science Education Standards (National Research Council, 1996) called again for the teaching of science as inquiry, and more efforts were made to transform teachers' practice (National Research Council, 2000). However, as with ICT, there is little visible evidence that teachers use inquiry oriented pedagogy.

There are many possible reasons why what happens in classrooms changes slowly if at all, including the negative effects of high stakes examinations, ill-prepared teachers, and the overall difficulty of enacting changes in large bureaucracies like school systems. There are also practical problems such as limited access to computers and other devices, and broadband access; and lack of scientific supplies and equipment. Another possible reason is that often the use of ICT and inquiry are presented as add-ons, rather than being incorporated into existing courses and curricula. In this chapter, we report on our efforts to change how climate change science is taught in schools within the context and structure of an existing high school course – Marine Science. We chose this course because many of the topics in its curriculum leant themselves to climate change science.

Our project -- the NSF-funded Climate Change Narrative Game Education (CHANGE)[1] project -- takes what we know about reform-based practices, the need to incorporate students' lived experiences into the curriculum, and the integration of Information and Communications Technology (ICT) to facilitate students' inquiry into climate science. Its aims are for students to gain a better understanding of the impacts of climate change on the natural environment and human-built world particularly within the place-based setting of the southeast US. It attempts to connect climate change and sea level rise