

Chapter 12

Designing Digital Objects to Scaffold Learning

Grant Van Eaton
Vanderbilt University, USA

Douglas B Clark
Vanderbilt University, USA

ABSTRACT

The design of digital objects and representations in digital games is highly consequential for learning. Digital objects in learning games provide opportunities to scaffold teacher and student learning toward deeper epistemological understanding of the concepts they represent, but objects and representations can also be interpreted in a manner that misrepresents the concepts in whose place they stand. For the current study, one teacher was observed using the SURGE learning environment. During the study, the teacher combined the learning environment with direct instruction to teach Newton's laws of force and motion. Findings highlight the importance of designs that (a) explicitly model the meaning of the representations in the learning environment, (b) provide opportunities for teachers and students to interact with the full range of the properties of the representational object, and (c) incentivize players to utilize representations in the environment to their full extent, such that the learning environment repeatedly reinforces the core concepts of the representation.

INTRODUCTION

In their review of the literature on digital games and simulations for science education, Clark, et al (2009) call on researchers to move beyond proofs of concept in terms of the possible efficacy of simulations and games to instead focus on ascertaining design principles that best support learning and conceptual change. Design principles in digital

learning environments necessarily rely on the use of representations. These representations model core concepts and have the power to scaffold the learning trajectories of both teachers and students. Representations, however, are malleable and have the potential to be interpreted by both teachers and students in ways other than intended by the designer. The current study analyzes extended interviews and video footage of a teacher and his

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students playing, learning, and teaching with a digital physics game designed for learning. The teacher was observed using the SURGE learning environment with four class periods totaling 136 students over the course of two weeks. During the study, the teacher combined the learning environment with direct instruction to teach Newton's laws of force and motion. Analyses focus on the teacher's and students' appropriation of the representational objects corresponding to the concepts of force, time, distance, and mass and the effects of these interactions on scaffolding the teacher and student's epistemology of force and motion. The primary data for this study include:

1. The video and audio of the teacher throughout the run in class,
2. Video and audio of interviews with the teacher outside of class before, during, and after the run,
3. Video and audio of the 68 student formative assessments that the teacher conducted during the classes.

The analyses of these data are supplemented by

1. Pre-post test data for the 122 students who completed the pre and post-tests, and
2. Post-gameplay interviews with the teacher and four students two months after gameplay.

This chapter analyzes these data in terms of two questions central to the interplay between design, representation, and epistemology:

- How do teachers and students interpret representations in the *Fuzzy Chronicles* learning environment?
- How do representations in *Fuzzy Chronicles* scaffold the development of teachers' and students' epistemology of force?

THEORETICAL FRAMEWORK

When thinking about how to use representations to scaffold concepts in a digital learning environment, Ball and Cohen's (1996) *educative curriculum* framework provides an orientation that positions the learning environment to scaffold learning not only for students, but also their teachers. As teachers play games in order to develop an understanding of their mechanics and how best to integrate them into curricula, the potential exists for games to scaffold teachers' learning of content as they interact with the game or simulation. Developing canonically aligned understandings of science content in teachers is especially important for students, as this development affects the quality of instruction students, in turn, receive. Teachers' understanding of Newtonian relationships influence not only the questions teachers ask when scaffolding their students' understanding, but also the tasks teachers plan for classroom instruction and the concepts these tasks reinforce (Feiman-Nemser, 2001). Using learning games to develop deeper content knowledge in teachers, however, will only be effective insofar as

1. The representations in the learning environment properly embody the focus concept(s), and
2. The correct scaffolds are in place to bridge teachers' intuitive understanding with the canonical understanding of concepts as represented in the game.

Representations in the Learning Environment

In order to discuss the potential for learning games to educate both teachers and students, and the role of representations, this chapter focuses on four representations in the *Fuzzy Chronicles* learning

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