Chapter 25
Building Bridges:
Teachers Leveraging Game-Based Implicit Science Learning in Physics Classrooms

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ABSTRACT

This chapter describes the analysis of 729 daily teacher logs from a 2013-14 national classroom implementation study with hundreds of high school physics students using the game, Impulse, finding classrooms using materials to bridge implicit and explicit science learning performed significantly better than control classrooms (Rowe et al., 2014). This effect was moderated by whether or not the class was a Honors/AP class. The authors examine the student and teacher demographics, science content, instructional materials and methods, and game-based pedagogies as potential explanations for those findings. The largest difference among Honors/AP vs. non-Honors/AP classrooms using any Bridge activities was their use of formal, teacher-led discussion.

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INTRODUCTION

Game-based learning has been a growing field of research over the past decade or more (e.g. Gee, 2013; Squire, 2007), with many researchers using the data logs generated by digital games to study learning (Glasslab, 2014; Clarke, Nelson, Chang, D'Angelo, Slack, & Martinez-Gazza, 2011). Educational games are most often designed for use within classrooms and therefore include some formalizations such as content explanations and/or test questions that require explicit understanding of the material. These games typically differ from the games learners *choose* to play in their free time (Isbister, 2010), games that we call *free-choice* games.

Free-choice games are highly engaging, "sticky" environments that typically do not present any school-like interfaces. These games can still be designed with game mechanics that mirror authentic and idealized science. By aligning game mechanics (player actions in the game) with learning mechanics (learning goals designed into the game) and assessment mechanics (evidence for learning that can be seen through gameplay logs), researchers can support and examine *implicit* learning that takes place through well-designed gameplay (Plass et al., 2013), even gameplay that takes place outside class.

Implicit learning in games, however, does not ensure explicit (more formalized) learning that students are expected to demonstrate in class. The connection between implicit learning from experience and explicit classroom learning must be facilitated, typically through social interactions with a teacher and other learners (Hattie & Yates, 2013). This is true for game-based learning where the "big G Game" learning happens during interactions between peers, and between players and teachers, both of which can take place outside the game (Gee, 2013; Hayes & Gee, 2012).

In 2013-14 the authors conducted a national classroom implementation study with hundreds of high school physics students using the game, *Impulse* (Rowe, Asbell-Clarke, Bardar, Kasman, & MacEachern, 2014) where science learning was measured in classes that played the game and were provided with bridge activities--materials designed to help teachers bridge science content in the game with their formal instruction. For this chapter, we focus on the analysis of teachers logs from that implementation study to highlight the types of activities that occurred in implementation classes that can explain how these bridge activities were used in class. Our goal is to understand what resources teachers need, and what we can provide in terms of tools and professional development, to help STEM teachers leverage implicit learning in games to improve explicit learning in class.

Impulse is a free-choice game available for free from most app stores and can be played on the web or on a tablet. In *Impulse,* players are immersed in a physics simulator in which they must intuitively predict the Newtonian motion of a set of balls to successfully avoid collisions while navigating their ball to the goal. Players use an impulse (triggered by their click or touch) to apply a force to balls, all of which obey Newton's laws of motion and gravitation.

In the *Impulse* implementation study, teachers (and their students) were assigned to one of three conditions. Students in the Game group (209 students in 21 classes) were encouraged by their teachers to play *Impulse* outside of class. Students in the Bridge group (179 students in 18 classes) were encouraged to play the game outside of class and their teachers incorporated examples from the game into their classroom instruction on Newtonian mechanics. One hundred eight (108) students in 11 classes in the Control group neither played the game nor had game examples in class. Students in all groups completed assessments of their implicit understanding of the science concepts before and after the instruction on Newtonian mechanics.

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