Chapter 18
GBL as PBL:
Guidelines for Game-Based Learning in the Classroom and Informal Science Centers

Brad Hoge
University of Houston – Downtown, USA

ABSTRACT

GBL is proving to be a promising and engaging tool for STEM learning. How GBL affects content and mastery is unknown, however. For GBL to be more than an engaging tool for delivery of basic knowledge, it must be designed to achieve the goals of PBL. PBL achieves mastery by using principles of inquiry to promote constructive learning. The challenge is to keep GBL engaging while incorporating inquiry strategies into gameplay. This can be achieved through immersive micromanagement games that incorporate content mastery objectives into player strategies for advancement in the game's plot. Complexity introduced through evolving game scenarios should push players towards decisions based on content lessons. Players should be allowed to personalize their experience through the use of avatars and should play a role in the execution of strategies within the game. Team play and competition can also enhance the PBL elements and increase cognitive outcomes.

INTRODUCTION

Game-Based Learning (GBL) is proving to be a promising and engaging tool for STEM learning. The success of *Fold It* (Cooper et al., 2010), *Phylo* (Kawrykow et al., 2012), and *EteRNA* (EteRNA, 2011) are proving that players will engage with games that achieve real-world results. These "games with a purpose" have revolutionized our concept of what games can accomplish (Ahn and Dabbish, 2008). Many research programs and online smart game applications now exist. MIT in cooperation with Microsoft has developed the *Games to Teach Project*. *Alice:* Teaching Programming through 3D Animation and Storytelling, was created at Carnegie-Mellon University. Alice teaches computer programming through game play. Chiang Mai University in Thailand has numerous games available on their *Play to Learn* site. *SMILE* (Stanford Mobile Inquiry-Based Learning Environment) at Stanford University School of Education engages students in traditional classrooms with interactive learning environments. *Games for Learning* at Indiana

DOI: 10.4018/978-1-4666-8200-9.ch018

University, the *Learning Games Network* at Drexel University, and *New Century Energy*, developed by Tietronix Inc. for the Houston Independent School District, with help from The University of Houston – Downtown have produced innovative games as well as maintaining research programs. Links to each of these programs are included in Appendix A.

The expectation of all of these programs is that GBL can incorporate authentic learning into game strategies. Authentic learning is learning at high levels of Bloom's taxonomy by using the same tools and methods to learn as experts use to work in the real world. This type of learning is fundamental to the pedagogical philosophy of constructivism and has been shown to be the best way to teach STEM (science, technology, engineering, and mathematics) content and skills (Slough et al., 2004). Authentic learning is about inquiry and problem solving. This chapter will show how games can achieve the same authenticity of learning in informal science settings as well as in the classroom by incorporating the same principles of inquiry-based constructivism.

As Tom Chatfield, a British writer and commentator, suggested in his presentation to TED.com, games appeal to our evolved interest in problem solving, and can, therefore, be intentionally designed to achieve real cognitive benefits (Chatfield, 2010). The potential of GBL applications for achieving upper level cognitive learning objectives in educational settings is still to be fully realized, however. For GBL to be more than an engaging tool for delivery of basic knowledge, it must be designed to achieve the goals of inquiry learning as demonstrated by Project-Based Learning (PBL) models. PBL achieves content mastery by using principles of constructivism and inquiry. The challenge is to keep GBL engaging while incorporating inquiry strategies into game play. This can be achieved through immersive micromanagement games that incorporate content mastery objectives into player strategies for advancement in the game's plot. Complexity introduced through evolving game scenarios can push players towards decisions based on content knowledge acquisition. Players can also benefit by personalizing their experience through the use of avatars in order to play a role in the execution of strategies within the game. Team play and competition can also enhance the PBL elements and increase cognitive outcomes.

This chapter provides guidelines for developing effective GBL for classroom and informal science settings. The guidelines are supported by an analysis of the research behind the use of game-based learning as project-based and problem-based learning. The expertise of the author comes from his experience helping to build the New Century Energy Game (NCE) for the Houston Independent School District. NCE was shown to effectively incorporate both project-based and problem-based learning strategies into GBL (Hoge et al., 2012). This is because NCE incorporates numerous aspects of effective PBL into its design.

BACKGROUND

Inquiry Learning and Project-Based Learning

Science education has been moving towards an inquiry based constructivism since the early 1990's, due to the goals and guidelines of The National Science Teachers Association (1992), The American Association for the Advancement of Science (1993), and the National Research Council (1996). The National Science Education Standards call for a shift in emphasis from "focusing on student acquisition of information to focusing on student understanding and use of scientific knowledge, ideas, and inquiry processes" (NRC, 1996). Scientists explore the physical world for reproducible patterns which they represent by models and organize into theories according to laws (Hestenes and Jackson, 2004). The teaching method designed to achieve these goals is Project-