Chapter 9
Moving to the Next Level: Designing Embedded Assessments into Educational Games

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ABSTRACT
The educational research community has been experimenting with educational games with a focus on pedagogy and curriculum, but little effort has been made to assess what students are actually learning in these environments. Designing embedded assessments into games is one of the critical gateways to creating learning tools that are maximally engaging for the learner, using sound pedagogical methodology as a foundation. The authors review the research in this area and describe technology that facilitates near real-time data collection through embedded assessments, visual data mining, inference mechanisms, and dynamic individualization. They then describe a methodology for creating valid embedded assessments and identify types of data that can be collected from gaming environments along with approaches for analysis, all toward the goal of individualized adaptation.

INTRODUCTION
Educational games are being used by many different people (Rieber, 1996): parents buy games for their children, teachers find games online that address the content they are focusing on, and many students find these environments engaging and worthwhile. Most research on using games for learning look at the outcome as a single unit, for example, students learned to add fractions. To make the most of digital learning environments, it would be useful to know what happened inside the game, when it happened, and how it happened. How can the learner get more of what they want or need, and less of what they do not want or need? To answer these questions, more in-game data needs to be collected, and sense made of the data. No small task, to be sure.

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In some sense, there is nothing new here. Human tutors have always answered these questions about individuals. However, while digital games provide environments for one-on-one learner interaction, they do not yet collect data about learner behavior and needs to determine the best course of action for the individual.

The focus of this chapter is on how to use game environments to provide one-on-one learning experiences. Even with advances in technology, there is still a need for humans to oversee individual learning, but digital games can scale, in ways that teachers cannot, to provide one-on-one experiences in the form of adaptive environments from the results of embedded assessments. This approach is key to fostering both engagement and learning, where the challenge must be neither too easy (promoting boredom) nor too hard (discouraging continued play).

**BACKGROUND**

**What is Embedded Assessment**

Embedded assessment is the process of measuring knowledge and ability as part of a learning activity rather than after the fact, when it is only an approximation of learner behavior. Student actions can be evaluated within context while carrying out tasks, or otherwise interacting in a gaming environment. (Note that we will use the terms “gaming environment” and “game” to refer to any online game that is intended for learning, including computer games, puzzles, drills, simulations, and 2D and 3D immersive spaces. By “online,” we mean any environment that communicates with the Internet, either in real-time or at some point.) These actions can be collected, viewed, and analyzed either immediately or after the session. Sometimes “so-called” embedded assessments are implemented as pop-up quizzes that a learner cannot bypass. We identify these as possible “tools” an educator might employ within a larger framework, but not as fully-realized embedded assessment.

Embedded assessments in games can focus on such things as content knowledge, process and procedures, and higher-order 21st century skills such as collaboration and strategic thinking (hereafter called “higher-order skills”; Partnership for 21st Century Skills, 2009). Stakeholders may obtain reports detailing student proficiencies and challenges – who needs help in teamwork, who is accelerating in math skills, and how well individuals compare with the larger population taking the course. Parents, teachers, administrators and others may gain valuable information that can be elusive during the course of traditional instruction.

**Why Focus on Embedded Assessment**

Assessment is not new. Tests are used successfully as gauges and gateways--for example, college entrance exams such as SAT or ACT, driving tests, and for fields such as medicine, cosmetology, and interior design. Assessment is also done successfully in the classroom, both formally and informally – teachers give quizzes and tests, they look into faces to gauge students’ grasp of the material, and they ask questions. If traditional assessments have been so successful, why turn to alternative types of assessments? Research and development of traditional high-stakes assessments have been going on for decades to maintain their validity and reliability. Alternative assessments fill a gap created by traditional assessments, which often label individuals unfairly and constrain them with limited goals (Reeves & Okey, 1996).

Why assess learning in games? While they are recommended as engaging approaches to learning, the adoption in education of games is slow because they have not yet been shown to be effective (Federation of American Scientists, 2006). One way to show they are effective is to measure the learning that occurs during play.
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