Chapter 18
Serious Game Framework for Design of Medical Applications

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ABSTRACT

Serious games have potential for achieving a variety of effectiveness goals for different stakeholders in complex domains like healthcare. The authors propose a Serious Game Framework (SGF) that provides a conceptual architecture that considers the design alternatives, support for multiple game types on the same architecture, and the ability to assess, research, and improve the learning process. The authors show with examples how with this, on one hand, the same knowledge content can be used in different serious games to achieve different learning outcomes and goals. On the other hand, the same goal can be achieved by different serious games, and user preferences might determine what games are used. The game interaction data also becomes shareable and useful for analysis and continuous improvement.

1 INTRODUCTION

Serious Games[1] are emerging as an innovative method to engage students at all levels and improve learning and delivery effectiveness (Telner 2010). Here we begin with the related goal of designing medical applications to engage K-Grey in life-long learning. The development of games can be expensive (e.g. a high cost of maintaining intelligent systems). Thus, to deliver games with effectiveness, we provide a conceptual framework that helps relate types of knowledge, to games types that help achieve specific learning outcomes. The benefits of this Serious Game Framework (SGF) are 1) a conceptual architecture that considers the design issues, 2) support for multiple game types on the same architecture, and 3) the ability to assess, research and improve the learning process.

There are several challenges associated with the design of a serious game due to the underly-

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ing knowledge that must be structured and used to meet different goals. For example, a serious game might be used for the purpose of training students that get entertainment from the game; teachers who want to promote education; and even human computation roles where the goal is to outsource complex work such as tissue/pattern recognition to larger populations (von Ahn, 2008). Specifically, some of these goals are:

- Achieve a particular learning outcome.
- Relate the knowledge to different roles such as training, assessment, decision-making, and human computation[2] roles.
- Achieve objectives like policy design and human computation or the ability to solve problems that cannot be solved effectively by computer (von Ahn, 2005).
- Overcome silos of different serious games where each serious game is currently separate, but there are requirements for the games to complement each other.

A framework is needed to conceptually integrate, analyze trade-offs and meet such goals.

We begin this paper with an overview of related research background concepts. Following this we will integrate this research into the Serious Game Framework and use a range of Medical Applications as examples of this framework. By applying the theories of learning and gaming to medical training, we illustrate how game design can help the cognitive, skill-based and affective learning and testing. We also present the underlying software architecture addressing issues like extensibility and scalability along with features for multiple designers. We conclude with research agendas in applications and computer science.

2 BACKGROUND CONCEPTS

To develop the Serious Game Framework (SGF) we first start with related knowledge structuring concepts. Much research has been done in related topics, ranging from learning strategies and outcomes (Wilson, 2009); to the design of games (Moreno-Ger,2008); to studies of principles to make games more attractive (Stewart,2009; Von Ahn,2005; Bates,2004); as well as the game attributes and its relationships to learning outcomes (Wilson, 2009). This too will be subsequently integrated into the framework.

2.1 Knowledge Types

Knowledge can be categorized as declarative, procedural, and strategic (Wilson, 2009). Specifically, learners gain three types of knowledge: declarative knowledge (i.e., knowledge about *what*), procedural knowledge (i.e., knowledge about *how*), and strategic or tacit knowledge (i.e., knowledge about *which, when, and why*). The specifics are summarized below.

Declarative knowledge is "knowing what" - a type of learning content focusing on the basics of more complex knowledge. It includes the vocabulary terms and phrases in a certain subject, the variety of details of facts and time sequences, and organizing ideas. Students are often required to memorize these concepts and facts. For example, tissue sample recognition in medical domain. Declarative knowledge is often a foundation for more complex knowledge. For designing this "knowing what"type of e-Learning content (concepts and facts), we use Learning ObjectS (LOs) to organize the declarative knowledge in proper granularity. LO is "the creation of digital educative items that can be reused in different digital educational contexts" (Vorvilas,2010, pp. 255). One can organize subject-matter knowledge into five broad categories: (1) vocabulary terms and phrases, (2) details, (3) organizing ideas, (4) skills and tactics, and (5) processes. The first three categories are informational in nature and are sometimes referred to as "declarative knowledge." The last two categories are more process oriented and are sometimes referred to as "procedural