EAGLE: An Intelligent Tutoring System to Support Experiential Learning Through Video Games

Laura NAISMITH, Emmanuel G. BLANCHARD, John RANELLUCCI and Susanne P. LAJOIE

ATLAS Laboratory, Faculty of Education, McGill University, Montreal, Canada
{laura.naismith, john.ranellucci}@mail.mcgill.ca
{emmanuel.blanchard, susanne.lajoie}@mcgill.ca

Abstract. EAGLE (Electronic Assistant for Game-Based Learning Experiences) is an intelligent tutoring system that supports learning with video games. We describe how a flexible ontology-based architecture can be used to model the learner, the game experience, and the domain of instruction. We then present an overview of how these elements interact within a learning experience.

Introduction

Video games can foster intrinsic motivation through factors of challenge, curiosity, control, fantasy, competition, cooperation, and recognition [1] and also act as tools to promote deep thinking and complex problem solving [2]. They are not, however, typically associated with academic learning [2]. Even when games contain useful real-world content, teachers rarely have the time to develop the necessary expertise with the game to use it effectively in the classroom [3]. Serious games, or games that are designed specifically for educational purposes, can be used to teach valued 21st century skills, including interpretation, problem-solving, information management and teamwork [4]. Unfortunately, due to a lack of funds for development and marketing, serious games are seldom released to the general public.

In this paper, we propose a new approach that utilizes the learning content that is already present in existing popular video games. We describe EAGLE (Electronic Assistant for Game-Based Learning Experiences), which is an intelligent tutoring system that relates this content to the learner’s goals within the game itself. If necessary, the system can also act to correct misinformation transmitted by the game. Examples of the domains of learning that EAGLE could support include history, for example through Sid Meier’s Civilizations series, and evolutionary biology, such as with the recent game Spore™.

1. EAGLE System Architecture

The role of EAGLE is firstly to evaluate and model the learner’s current conceptions in the domain of learning and secondly, to select and sequence instructional content to
reinforce correct conceptions and address misconceptions. In order to perform these tasks, EAGLE requires an underlying architecture that can represent the overall game experience (sequence of events, game objectives), the different possible routes through the game, and the learning content that is encountered as the learner progresses. Figure 1 presents the modular architecture that we have designed to address these issues.

![EAGLE System Architecture](image)

### 1.1. Knowledge Representation

EAGLE requires knowledge in the domain of instruction. We model this knowledge using the OMNIBUS framework [5], which uses ontology engineering techniques to support theory-aware instructional design.

Knowledge of the learner, including his or her current conceptions and learning preferences, is required in order to select and sequence learning content that is relevant and appropriate for the learner’s current level of understanding.

Games unfold in virtual environments, which have many similarities with real-world environments. We are developing an ontology to describe the learner’s game experience. A game experience consists of a series of events that affect the game environment. These events can either be initiated by the learner, other participating players, or the computer itself. Objectives of the game correspond to achieving a desired state in the environment.

Finally, EAGLE must situate domain knowledge within a game experience. In the OMNIBUS project, an $I_L_Event$ is specified to be a pair of Instructional and Learning events that establishes a link between a game action and a learning consequence. The expected learning outcomes related to the game experience thus refers to a set of $G_L_Events$ called the $expected set$. A subset of it refers to an intermediate objective and is called a $goal set$: this list of $G_L_Events$ describes in-games objectives (in terms of events to be encountered/initiated) and the expected learning gains associated with them.

### 1.2. Processing Modules

In EAGLE, each of the following tasks has a dedicated module:

**Debriefing.** A simple system based on a specific instance of this game experience ontology can be used to present debriefing questions to the learner in order to assess his
or her progression through the game. Using the goal set, EAGLE can administer a list of questions to the learner to evaluate his or her game experience and deduce learning outcomes. This results in a new set of G_L_Events (experience set) summarizing in-game events the learner encountered and the knowledge acquired regarding the domain of instruction.

**Updating the learner profile.** EAGLE keeps track of the experience set of the learner in a learner model. Further information such as learning preferences are also stored in this module and will be helpful for providing adaptive assistance.

**Providing learning assistance.** EAGLE evaluates the difference between a goal set and its related experience set to determine whether the learner’s actions in the game have resulted in potential learning outcomes. EAGLE can determine whether the game experience has resulted in a) a correct conception of real-world knowledge, b) a correct conception of game-transmitted knowledge that is factually incorrect, c) a known misconception not transmitted by the game, or d) an unknown conception or missed learning opportunity. Taking into account the learner model, EAGLE then selects and sequences learning content that will provide either reinforcement of correct conceptions (case a), targeted teaching to address incorrect game-transmitted knowledge or misconceptions (cases b and c) or an introduction to the topic (case d).

2. Conclusions

EAGLE is an intelligent tutoring system that supports learning with video games. EAGLE is unique in that it relates real-world learning content to the learner’s goals within the game itself. We conceive of EAGLE as a generic system that can support multiple games, multiple domains of instruction and multiple types of learners. We have designed a flexible ontology-based architecture to achieve these goals. Future work will address specific implementation challenges, including the provision of appropriate authoring tools and handling switching between systems. User trials will then be used to evaluate whether the use of EAGLE as a supplement to playing video games results in an integrated learning experience that is both enjoyable and effective.

**References**


