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A framework for the design and integration of collaborative classroom games

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ABSTRACT

The progress registered in the use of video games as educational tools has not yet been successfully transferred to the classroom. In an attempt to close this gap, a framework was developed that assists in the design and classroom integration of educational games. The framework addresses both the educational dimension and the ludic dimension. The educational dimension employs Bloom's revised taxonomy to define learning objectives and applies the classroom multiplayer presential game (CMPG) pedagogical model while the ludic dimension determines the gaming elements subject to constraints imposed by the educational dimension. With a view to validating the framework, a game for teaching electrostatics was designed and experimentally implemented in a classroom context. An evaluation based on pre/post testing found that the game increased the average number of correct answers by students participating in the experiment from 6.11 to 10.00, a result found to be statistically significant. Thus validated, the framework offers a promising basis for further exploration through the development of other games and fine-tuning of its components.

1. Introduction

The use of video games as educational tools is slowly becoming an accepted practice in learning environments (Van Eck, 2006). There is growing recognition that several principles underlying these games can be beneficial to the learner: they give immediate feedback, facilitate transfer of concepts from theory to practice, enable the players to progress at individual rates, allow them to fail gracefully and give them freedom to explore and discover (Gee, 2003; Squire, 2003). Empirical research by many groups has shown the benefits of video games as learning tools (Clarke & Dede, 2007; Dede, 2009; Klopfer & Squire, 2008; Mitchell, Dede, & Dunleavy, 2009).

Different approaches to the integration of games as educational tools for primary, secondary and college level education have been studied. One of the most common is the use of multiplayer online games, which are usually contextualized in virtual spaces called multi-user virtual environments or MUVEs (Clarke & Dede, 2007; Dede, 2009). In this type of game each student plays on his/her computer and interacts virtually through the game with his/her classmates and the teacher (Paraskeva, Mysirlaki, & Papagianni, 2010). Another approach utilizes location-based or ubiquitous games. In these, students work collaboratively in an exploratory environment to achieve different goals, assisted by mobile handheld devices that are wirelessly networked and usually enhanced by additional technologies such as GPS and augmented reality (Dede, 2009; Klopfer & Squire, 2008; Liu & Chu, 2010; Mitchell et al., 2009).

Although these two approaches have shown good results in creating engaging learning experiences, they are not well suited to the school classroom, still the most important educational environment in our current system. This is reflected in a number of recent attempts to employ games in the classroom for subject-based learning. Original games have been developed to teach mathematics (Lee & Chen, 2009), biology and genetics (Annetta, Minogue, Holmes, & Cheng, 2009), electrostatics (Squire, Barnett, Grant, & Higginbotham, 2004) and history (Watson, Mong & Harris, 2011), and existing games have been tested for teaching social science topics (Cuenca López & Martín Cáceres, 2010). What is generally lacking in these experiences is an explicit integration of the game into the pedagogical process of the class. To achieve such integration, several elements need to be assured. Among others, the game should involve all the students in the class, the teacher must have the ability to control the game, and the duration of the game-play sessions should be adjusted to the length of the lecture

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(Susaeta, Jimenez, Nussbaum, Gajardo, Andreu & Villalta, 2010). In many cases games feel like a replacement for the class instructor rather than a tool to be used and controlled by him/her, potentially prompting some teachers to reject their use (Kebritchi, 2010).

This article presents a framework for the design of educational games and their integration in the classroom that is analyzed through a case study of a game to teach electrostatics. The structure of the article is the following: Section 2 introduces the framework and the different components for designing and integrating the game; Section 3 outlines the game developed within this framework to teach electrostatics; Section 4 describes an experimental application developed to test the game in a real classroom context and sets out the results obtained; and finally, Section 5 presents our conclusions and some suggestions for future research.

2. A framework for the design and integration of classroom games

The design and integration of classroom-based educational games must incorporate both an educational dimension, which defines how to build and integrate the game as a learning tool, and a ludic dimension, which determines how to create an engaging and fun experience (Aleven, Myers, Easterday, & Ogan, 2010). The educational dimension addresses two questions that are central to the creation of learning environments: First, what are the learning objectives of the activity? And second, how is the activity integrated pedagogically in the class? (Dillenbourg & Jermann, 2010). The ludic dimension, on the other hand, must tackle the central question in the design of any game: What elements should be included in the game in order to achieve the desired experience? (Schell, 2008). In an educational game the "desired experience" is the fulfillment of the learning goals by the students in the context of the class through an engaging and challenging experience. The ludic dimension of the design process is therefore subject to the educational dimension, meaning the game elements chosen must be constrained by both the learning objectives and the need for pedagogical integration.

Both dimensions are incorporated in our proposed framework for the design and integration of classroom games, shown here schematically in Fig. 1. As can be seen, the educational dimension is divided into two components. The first focuses on establishing the learning objectives of the game, defining the specific learning objectives it must achieve, while the second aims at determining how the game is pedagogically integrated in the class, specifying the pedagogical model to be used and the technology to support it. As for the ludic dimension, it identifies the specific elements the game should have to achieve the desired experience. These elements must incorporate the constraints implied by the educational dimension components.

2.1. Ludic dimension: game elements

To identify game elements that will reflect the desired educational experience we must first define the main elements in the design of any game. One way of categorizing game elements is the "elemental game tetrad" defined by Schell (2008), which divides all elements into four categories: mechanics, story, aesthetics and technology.

The mechanics of a game describes its procedures and rules, defining how players can achieve the game's goal. They are the key elements differentiating games from other kinds of media in that they give the former their interactivity (Schell, 2008).

The story describes the sequence of events that unfolds during a game. It can be very simple and linear, or highly complex and branching. The level of storytelling will vary, ranging from games that are completely abstract with very low narrative elements to story-driven games that more closely resemble interactive movies (Schell, 2008).

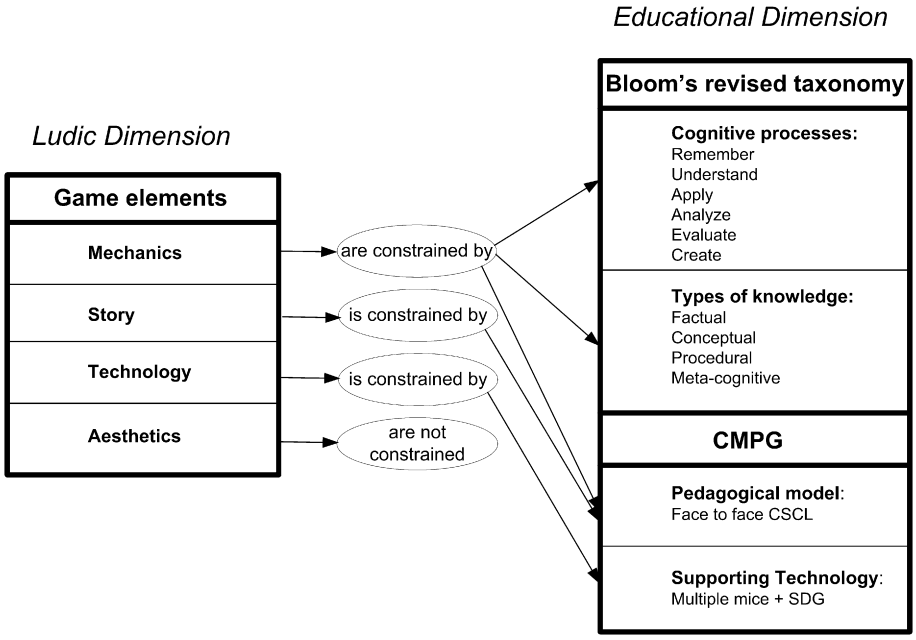

Fig. 1. The two dimensions of the proposed classroom games design framework. The educational dimension defines the pedagogical structure of the game, constraining the elements of the ludic dimension.