Chapter 8
Changing the Rules:
Injecting Content into Computer Games

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ABSTRACT
The increasing availability of information and communication technology makes it possible to explore new concepts and strategies in teaching and learning processes. The reduction of cost and the amelioration of processing power of computers allow bringing to the classroom software of greater complexity. This way, the use of simple computer presentations is gradually replaced by hypermedia systems capable of combining different kinds of information. Interactive simulators represent a next step, allowing students to participate in an active process of experimentation. These tools make use of numeric models to represent the dynamics of systems with high accuracy. Video games can blend the numeric and media capabilities of computers with a presentation format that provides a pleasant experience and promotes a deep engagement in activities. These characteristics have a positive impact on learning results, explaining the interest on such software. The construction of educational games requires knowledge from very diverse fields, like pedagogy, cognitive psychology, computer graphics, simulation and software engineering. Each area of expertise has its own view from the issues involved; bringing together different professionals in a coherent manner can be a challenging task. This work describes tools to help organize the design and decisions during the implementation of an educational game. They facilitate the communication between project members, by documenting design options in different stages.

INTRODUCTION
Many subjects studied in science, engineering and technology present a procedural character, represented by sequences of events and interactions involving elements inside a system. For instance, protein synthesis, water cycle and current flow in galvanic cells are a few examples of contents studied in secondary and undergraduate curricula that present such characteristics. Modern systems exhibit increasing structural complexity and intricate
behaviours; this can be observed in electronic devices, software and industrial processes. Several abstract and conceptual problems have an algorithmic nature with similar aspects. Numerical calculus, system control and signal filtering are examples involving sequence of operations. These processes are, indeed, frequently described with the help of flowcharts.

Mechanisms that cannot be concretely observed and that contain dynamic features are particularly hard to study and understand. In this case, students are required to figure out the functioning of a system from models and descriptions, most of the time using static diagrams and texts. Systems where several activities occur simultaneously are even more complicated to deal with.

Information Technologies can be used to address many issues in this context. Hypermedia software enables the combination of texts, sounds and animated images, contributing to clarify explanations and to enhance the cognitive experience of the students. Simulation programs go one step further and provide interaction, allowing students to formulate and test hypothesis, independently or under teacher guidance. This creates a space of experimentation and can be identified with a learn-by-doing paradigm, generally recognized as more effective than passive learning to absorb information.

Computer games share with simulators the capability to handle user interaction. This functionality is carefully projected to obtain an engaging, enjoyable environment. The user acceptance is a central objective to developers, who must create compelling activities inside a pleasing scenery; the success of a video game can be measured by its capability to keep users focused on the action. In essence, this is similar to what teachers strive to do in class and is one of the factors that explain the interest in edutainment.

Video games have a strong potential in pedagogical applications, but their construction with this objective still lacks well established methodologies. Computer interfaces are unusual blackboards and teachers are not acquainted with all the ergonomic issues that permeate their design. On the other side, computer developers do not have the necessary background to deal with pedagogical requirements. Finding the correct balance between playfulness and information transmission remains an open issue. Besides this, the translation of contents from biology, chemistry and other areas into the video game vocabulary of symbols, images and characters still relies primarily on the creativity of teachers and programmers. These problems stand on an interdisciplinary boundary, not fully explored in the current literature. It relates teaching-learning methodologies with the development of computer applications targeted at education.

THE ROLE OF GAMES IN EDUCATION

Facilitating the transfer of information is a central issue in the teaching-learning process. Teachers combine texts, diagrams and oral expositions in order to explain subjects under different perspectives, creating several opportunities for the students to review, analyse and retain information. Nonetheless, the traditional tools used in classroom, like slides and books, are not completely adapted to describe dynamic processes. Representing this kind of phenomena on a blackboard can be a daunting task. The wrong choice for the diagrams or the sequence of events can make it difficult for the students to follow the explanations, or give a false and frustrating impression of complexity. Systems where processes can occur in parallel add another complication for both teachers and students.

Complex mechanisms that involve large amounts of information represent another barrier, forcing teachers to fragment the presentation of material. The result is often an abstract, highly theorized view that requires the students to construct mental representations: