Re-purposing existing generic games and simulations for e-learning

Open Universiteit
www.ou.nl

Re-purposing existing generic games and simulations for e-learning

Daniel Burgos, Colin Tattersall and Rob Koper
Educational Technology Expertise Center (OTEC)
Open University of the Netherlands
Valkenburgerweg 177; PO Box 2960
6401 DL Heerlen; The Netherlands
{daniel.burgos;colin.tattersall;rob.koper}@ou.nl

November 24th, 2005

Abstract

There is a growing interest among teachers in using games as a part of their lesson plans. A standardised, interoperable approach to the sharing of such game-based lesson plans would allow teachers and educational technologists to compare and contrast Digital Game Based Learning scenarios, allowing best practices and lessons learned to emerge. Although games can be used as 'add-ons' in educational contexts, greater benefits can be attained by integrating games more fully into the educational process, i.e. by repurposing existing games to target the specific learning objectives. In this article we analyse this problem. We developed two possible solutions based on the integration and the interaction of games and learning scenarios. The first solution is based on 'pedagogical wrappers', where games are linked to e-learning flows but without interaction and communication. The second solution sees a tighter integration which supports ongoing interaction and communication between game and e-learning flow. We applied both solutions to a generic game. This game was firstly programmed in Action Script and later re-used for learning purposes and represented in IMS Learning Design. We analysed the pros and cons of each solution and identify research topics for further research.

Keywords

Re-use, re-purposing, game, simulation, e-learning, IMS Learning Design, Unit of Learning

1. Introduction

Games allow players to experience, to try, to improve skills, to learn content and to practice strategy (Turkle, 1995; Piaget, 1962; Vigotsky, 1978). A digital game is a game played in an electronic platform fulfilling the following features (Huizinga, 1971; Caillois, 1958; Wolf, 2003): a) It is a voluntary action, started and completed by the user as he wants; b) It is also imaginary, parallel to the real world, replicating a universe or an activity without any consequence in the real life; c) It is limited, in time and space; d) It follows a set of rules, a specific and private framework; and e) It provides an uncertain solution sinceevery run, every play, is different and depends of unpredictable user behaviour. Beyond these generic features, educational games exhibit additional characteristics (Sutton-Smith, 2001; Salen, 2003): a) an educational game starts

with a premise to be solved; b) Being unproductive, it does not generate any property or wealthy; c) The main drive is the gaming activity itself; d) there is at least one right solution; and e) the user/player learns a skill or attains a competence, introducing new knowledge, fixing previous acquired knowledge, training skills, sharing experiences, discovering new concepts, developing outcomes.

This article focuses on the use of *generic* games in education rather than on games designed specifically for educational purposes since: a) Educational games are built for a specific educational goals and are focused on specific pedagogical aspects; b) educational games often tightly control the gaming flow, leaving the user in a passive role; c) Educational games are less widely available (Leyland, 1996).

Games have the power of engaging people. They are fun and provide interaction, interactivity, problem solving, story and other elements that give the user involvement, structure, motivation and creativity, among other benefits (Prensky, 2001). They also provide one or several focused goals, well defined rules, challenging and clear tasks, affiliation, choice and the right to be wrong without adverse consequences (Jones et al, 1994). A key factor is that games also provide outcomes and feedback in real-time (Rieber, 1996; Laurillard, 2002), guiding the user in taking actions, helping to focus activity and decisions and the evolution of the story. They are attractive for the players but also for the teachers as they engage and excite the students as well as provide a mean of interaction and learning.

There are several pedagogical approaches that can be used inside and/or around a game, such as learning by doing, learning from mistakes, goal-oriented learning, role playing and constructivist learning (Prensky, 2001). However, using a game for learning purposes involves more than leaving students to play without a context or guide, hoping for results (Gee, 2005). Exploiting the attraction of popular and widely available games in learning processes requires the appropriate scope, focus and context (Provenzo, 1991).

Examples of generic games used for learning include the Sims, SimCity, Flight Simulator, Pac-Man, FIFA, SuperMario Bros, Civilization, Rayman and Diablo II, for instance (Dickey, 2005; Squire, 2004; Jenkins, 2003). All of them belong to different categories of games. Following the taxonomy written by Crawford (1984) focused on objectives and nature of the game, we find several well-defined categories, like skill-and-action, combat, maze, sports, paddle, race and strategy. Prensky, (2001) introduces a categorization focused on pairs of opposite features, such as intrinsic versus extrinsic, reflective versus action, single-player versus multi-player.

The central question addressed in this article is how to re-purpose generic games for use in e-learning. We stress the importance of interoperability so that the lesson plans which result from such re-purposing can more easily be shared by teachers and educational technologists and used in different e-learning platforms and environments. We view lesson plans as combining pedagogy, and structured resources, files and links, to form Units of Learning (UoL) (Koper and Tattersall, 2005). We define re-use as the action of taking an existing piece of content, learning object, learning activity, game or stand-alone module and using it out of its original context without modification. In contrast, re-purposing is defined as the re-use of some item for a different objective than the one it was created for.

2. Problem definition and two approaches

2.1. Problem definition: re-purposing existing digital generic games and simulations within a pedagogical wrapper

Currently, teachers sometimes use generic games in their lesson plans (Cobb, 2001; Squire, 2005; Jenkins, 2003; Eskelinen, 2001). However, the use of games is often isolated from e-learning systems, leading to a disconnect between educational setting and game; a tighter integration offers pedagogical advantages. We illustrate these advantages with the following example. A teacher has a lesson plan explaining historical facts about the Fall of Rome and the collapse of the Western Roman Empire and he/she wants to tackle several activities: 1) Activity 1: Provide an overview of Rome at IV and V Centuries; 2) Activity 2: Make two groups in the classroom. One group will study the Romans and another one will study the Huns. Both will provide a detailed report and it will be uploaded online; 3) Activity 3: Each team studies the report of the other team; 4) Activity 4: Both teams will be divided in groups of five people and play the generic game 'Rome. Total War. Barbarian Invasion' (SEGA, 2005) during a period of a week; 5) Activity 5: A final online chat will raise up some questions and stress some key aspects of the Empire, the Huns and this period of the History. The game, ´Rome. Total War. Barbarian Invasion´, is a best-selling generic game distributed around the world.

The first approach will run the Activity 4 as an external game without any communication with the main flow. The students will extract an overview of the History as long as they play a game, but no connection is established with the Activity 3 or the Activity 5 inside the learning flow. The teacher, acting as a moderator, will focus all these activities and could stress some issues based only on his perception. In the second approach, in Activity 3 a team could choose between several packs with three specific features to assign to the other group. For instance, the team of Romans could choose the pack number one consisting of amount of troops, strategy and time to assign to the team of Huns. The Huns could select a set of other three features to assign the Romans. The packs would have a mix of some good and bad features to keep a balanced starting point based on the previous knowledge of the participants acquired in Activity 2 and Activity 3. All these selections could be sent directly to the initial set-up of the game (Activity 4), as they could start playing with the pre-configuration. During the game, a list of values with the places visited, the conquests and the profit and loss of features is sent to the learning flow to provide a detailed report after the game. Based on this values the system could complement the weak points of each team providing extra access to some specific content.

We first examine how the game could be used in parallel with, but separate to an e-learning system, before turning to the advantages of a tighter integration. In addition, to illustrate the advantages of integration, we list several further examples along the two approaches.

2.2. Approach A: A pedagogical environment as a container of a game without any communication between them

The game is incorporated to a learning flow but no further communication is established with it. It is executed as a stand-alone module embedded in a unit of learning (UoL). They can also be stored and run locally or remotely with a link from the UoL. Still, it is under the pedagogy expressed along the UoL as it is a part of the UoL. An example of a possible scenario could be

the use of 'SimCity 4' (Electronic Arts, 2005) to work on Economics and the administration costs in a large city. A teacher could define an e-lesson plan with some activities focused on economical and administrative theory and a practical case using 'SimCity 4' as a simulator to recreate the scenario. In a certain stage of the learning flow, the student runs a local execution of 'SimCity 4' and use this experience to write an assessment on the topic afterwards.
Another possible scenario could be based on Asian Geography: a) Groups of three students in a classroom have to enrol in a multi-player game of the Olympic Games hosted in a remote central server. Using the game 'Athens 2004' (Eidos Interactive, 2004) every student chooses a different country of Asia; b) the game is set-up to count four sports. They play the first sport against the other countries and get a winner team; c) The students fill paper forms of his own country very in detailed and hang them out in the classroom and have time to go through them; d) They play a second sport in 'Athens 2004'; e) Run of an electronic quiz on Asian Geography; f) They play a third sport, etcetera.

A third possible scenario could work on Dimensions and Perspective. The goal could be the understanding of a perspective: a) An introduction about 3D perspective in the daily life; b) Theoretical description of how to build a perspective; c) Play the game Tetris 3 (Zipkin, 2004) about fitting blocks in a 3D grid. This small game is inside the unit of learning as another packed resource; d) Practical assessment on perspective.

Richards (2005) describes this solution that leaves all the pedagogical workload to the pedagogical wrapper but not necessarily to the game itself. Along this way of integration, allocating or linking an external game inside a learning flow is straightforward because the game is used as another learning object, launched in a certain moment. Therefore, it works as another collateral activity without a real communication with the e-learning system, like reading a text, or posting to a forum or visiting a website. This is, something inside the learning flow as a learning object without return of any value to the flow, without any input from the flow and without any bearing in the flow, so. As there is no communication to and from the game with the wrapper none of them cannot influence in the set-up, the run or the progress of the other, or even of other activities. It is a kind of built-in or linked component without actual dynamic connection with its context.

2.3. Approach B: A pedagogical environment with a game as a fully integrated activity in the learning flow and some bi-directional communication between them

The game is incorporated to a learning flow, it is able to receive information sent by the educational wrapper and it is also able to send itself information generated during the execution of the game to the wrapper. This way, both layers (main flow and game) can interact one to each other in runtime and modify features of both on the fly.

An example of a learning scenario in this approach could be based on General Knowledge and Adaptive Learning: a) Run of a test with general knowledge questions for a single student using the generic game Trivial Pursuit (Horn Abbot Ltd, 2004); b) there are three possible activities to be carried on afterwards. Depending on the result from the Trivial the student will be allowed to follow only one of them fitted to his/her level of knowledge.

A second possible scenario could be focused on Genetics and Contextual Feedback: a) A student works on the heredity of physical characteristics and he/she must define which consequences will come up after crossing three generations of people, focused on simple issues, as hair colour and eyes colour; b) the student fills an electronic form with his/her theory; c) the student runs the simulation game ´The Sims 2´ (Electronic Arts, 2005a) and check if his/her theory is correct and if he/she gets what was predicted. If not, he can change this simulation on the fly and reconsider his/her theory, like in a lab; d) the assessment on the final result is provided in the main learning flow, together with a contextual feedback on the performance.

Along this way of integration the run of the game is not just a stand-alone one isolated inside a learning flow, it is a fully integrated part of the learning flow itself able to influence on it, to modify it and to adapt it along the running of the unit of learning. Therefore, there is a bi-directional sending of values between the game and the learning wrapper.

The suggested way of communication between these two elements is through an in-between layer created to allow the sending and reception of variables and values (Figure 1). This dispatcher would be the bridge between the pedagogical modeller and the externally programmed game facilitating the flow between them.
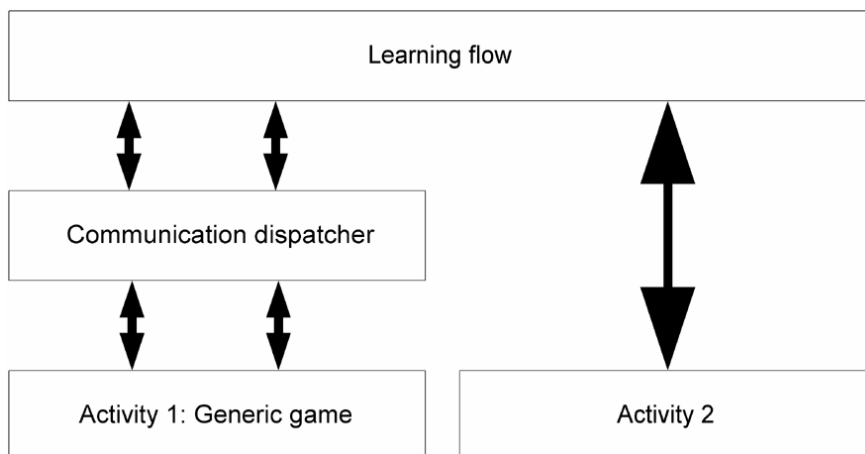

Figure 1. Architecture of communication between the learning flow and the game

Technically, we can compare this to the use of the methods GET and POST in a HTML page, that allow sending and receiving values between the HTML page and the outside. Java, JavaScript, Action Script, Lingo and a large number of programming languages can interchange values with the previously defined variables through this heading. Another comparison would be the suggested integration of SCORM packages inside IMS Learning Design structures while using a dispatcher (Tattersall, 2005).

3. Case study: Caminatas

3.1. Definition

Caminatas (OUP, 2004) consists of several stand-alone playable modules with basic data communication, grouped around a central main module to grant access and share tasks. It has

personalisation features (user name), audio settings, and some adaptivity (Figure 2). It was originally scripted and programmed in Flash/Action Script by the first author of this paper, together with the publishing company Oxford University Press and it has been used at the Open University of the Netherlands for gaming research and IMS Learning Design (Burgos, 2005). IMS Learning Design (IMS, 2003) is a pedagogically expressive specification to model units of learning. Through its description of different roles, activities, environments, methods, properties, conditions and notifications, it can be used to transform regular lesson plans into formally specified Units of Learning (UoL) that can be run with a specific player. The player coordinates the teachers, the students and the activities in the learning process.

Figure 2. Original game Caminatas programmed in Action Script

Originally, the game had twelve different sections and playable modules but we selected just a few of them to be re-purposed. In the new version, the game consists of three very different moments or sections: 'Introduction', 'Learning language' and 'Goodbye'. 'Introduction' shows the front page and requests some initial personal information of the player. In the 'Learning language' section, two playable modules of the game are run using the data gathered in the previous step. In the last section, 'Goodbye', this data is used again to personalize the closing message. The three sections are single files which send and receive the input data between them. Within the 'Learning language' section two playable stand-alone modules are available. They can be played individually and in an isolated way. Also, it is not needed to play both to finish the game. The first module is based on the classical game of 'Memory' where the player must find pairs of identical images turning upside-down two cards at the same time. When a pair is found it is put aside. The game ends when all the pairs have been found or when the time is over (Figure 3). This game is not an educational game but can be used for educational goals. For instance, to improve memory, to identify signs, to train perception skills, to speed up simple arithmetical

calculations, etce. The second module is based on a game of 'Differences', where the user needs to find a number of differences between two almost identical images. Again, this game is not an educational one, but can be used with this approach.
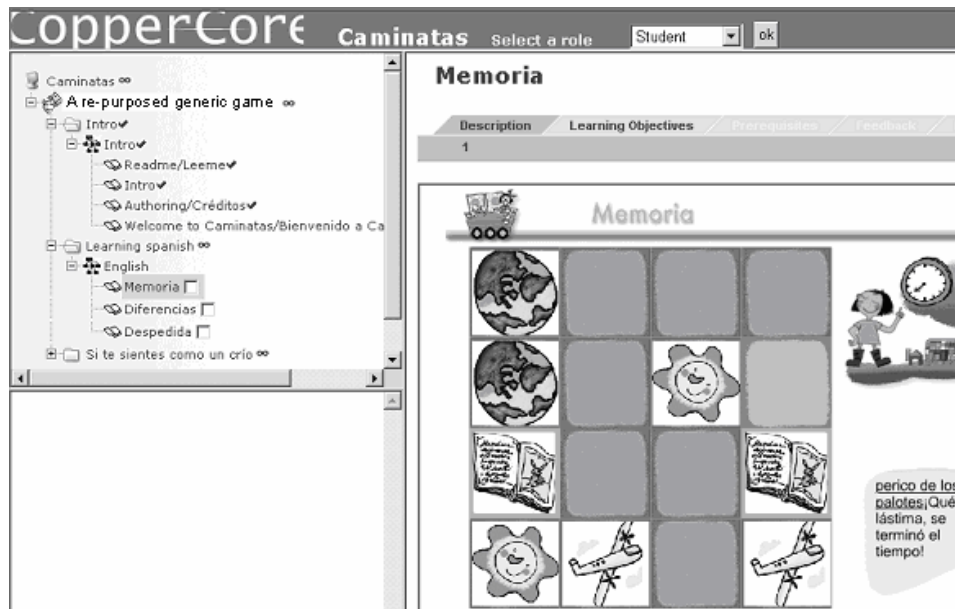

Figure 3. Generic game Caminatas re-purposed in IMS LD to learn Spanish without any communication between the playable module and the educational wrapper

Neither of these two modules is an educational game *per se*, and they can be re-purposed for different uses and objectives. They can be considered as generic games and their goal and nature are provided by the context where they are used, also as a part of an e-learning lesson plan. More specific, these two games were first programmed as puzzles for Primary School (with the Oxford University Press publishing company) and re-purposed as educational games to acquire some basic Spanish knowledge becoming a part of a learning flow modelled in IMS Learning Design. We get a new use of existing learning objects taking care of the educational wrapper where they are built in.

3.2. Approaches to re-purposing

The first solution (A) integrates the generic game inside a learning structure, modelled in IMS Learning Design in our specific case, but using it as a container of isolated stand-alone modules. This goes with no communication between the wrapper and the game. There is no value sent to the game from the pedagogical structure and no value sent back to the wrapper from the game. IMS Learning Design, or any other pedagogical modeller, becomes a mere skeleton where to insert already created games (Richards, 2004). This means that neither part influences the other as none of them knows about the other and they keep a simple link. There is no dynamic integration into the learning flow and the game remains as a static learning object inside a pedagogical structure and with no further possibility of information interchange.

As examples, this approach could be used in several scenarios. First, while learning the Spanish language, to play the modules as a support before and after two theoretical lessons. A second

scenario could be focused on the ability to use the mouse pointer for elder people, providing some isolated exercises that help them to practise accurate clicking. In this case the two playable modules could be provided with no specific sequence and a simple text in the beginning and in the end of the UoL: a) Short introduction; b) Memory and Differences; c) short closing. A third scenario could improve the perception skills working with a defined time to solve the same module several times along the flow but with a lower duration every time. For instance, a sequence of activities could be: a) Introduction; b) Memory game with 60 seconds; c) Memory game with 40 seconds; d) Memory game with 20 seconds; e) theoretical background on perception.

If we use some of the existing IMS Learning Design editors, like CopperAuthor (van der Vegt, 2005) or Reload LD Editor (Bolton, 2004), for instance, to include a generic game or a simulation in a UoL only means a link to a resource or to a learning object. Simplicity of integration is the biggest advantage, as any generic game could be re-purposed without further modification through a simple link

The second solution (B) allows the sending and receiving of data between game and e-learning system. In this way, the two can support each other and take into consideration some information in both provided for the most appropriate learning experience. Both, the game and the wrapper, can send and receive specific values stored in properties or variables to each other. Therefore, the game becomes a fully integrated additional activity in the learning flow able to adapt certain values and features dynamically.

Following the three practical scenarios defined for the first solution (Spanish language, mouse pointer and perception) we could modify them to take advantage of the full communication. In the first one (learning Spanish lessons) we could use a previous test of knowledge to decide how much helping text in Spanish and which level of difficulty the game has (Figure 4). In the second scenario (using the game as a mean to improve skills on the mouse use for elder people) we could a) run a previous test to state the level of accuracy; b) depending on the result of the test, provide the game of Memory with more or less time to fulfil it; c) depending on the result of the game, provide a contextual feedback, stressing the importance of keeping active at elder age. In the final scenario (on perception) we could a) run the Differences game with medium-size changes between the two images; b) depending on the result of the game, provide a feedback about its accuracy and follow two possible itineraries, one repeating the game with large-size changes in the images and another one going through the Memory game with a similar protocol.
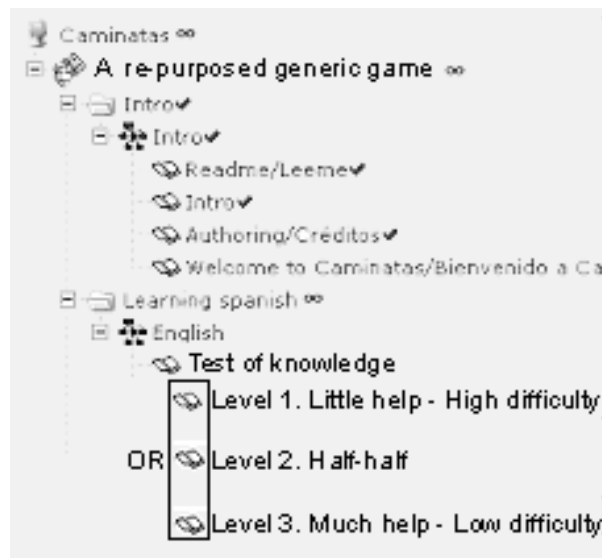
Figure 4. Re-purposing of Caminatas for learning Spanish with full communication between the playable module and the educational wrapper

The main advantage of this solution is the full control of the learning flow while using the game and the other way around, making the game another activity inside the lesson plan, and not an aside. The main disadvantage is that some modification in the existing game is required to allow the communication with the wrapper. This modification could require some programming skills from the learning designer or the teacher, or an editor capable of setting-up the variables and values to be used in the two pieces of software in an easy way. As not all the users have these abilities, and taking into consideration the current state of the educational wrappers, IMS Learning Design included, there is no easy way to implement this solution, by now. In addition, we would need a middle layer or dispatcher to establish the communication between the game and the educational wrapper. To summarize, the technical complexity and/or the lack of appropriate software are the major points against.

4. Conclusion

The use of educational games within lesson plans is an increasingly common practice for teachers and educational technologists. Games connect specific content and skills with a friendly environment where the student is able to play, try, make mistakes and learn. The possibility of re-purposing existing generic games and simulations in a didactic scenario providing a new pedagogical use to them becomes a challenge and a need in e- learning environments.

Digital games and simulations have a number of features that make them advisable to be used in learning processes. They improve certain skills and abilities, provide runtime feedback and allow the learning flow to be adapted on the fly. They also provide a good vehicle to establish social relationships and strengthen cognitive aspects in the player. Taking the generic game Caminatas as a base, we have re-purposed it from its original goal to an educational objective inside a pedagogical context modelled with the specification IMS Learning Design. The first solution is integrating a game in a pedagogical structure through a link, without interaction and communication. The main advantage in this approach is its simplicity for teachers and learning

designers. The disadvantage is that the game is played as an isolated learning object with no consequences to the main e-learning system.

The second solution allows the interchange of values to and from the learning flow. The main advantage is that the game becomes another key part in the running lesson plan, opening up possibilities for adapting the learning flow on the basis of results and performance from the game, and able to use values from the e-learning system that could modify some features of the game. The main disadvantage is that this solution needs a technical approach which is not yet easily implemented.

Future research is focused on developing a software layer that can bridge the gap between an external module, game or simulation and an e-learning system based on IMS Learning Design. This will provide a more powerful environment for the integration of existing generic games and simulations into e-learning structures. This middle-layer should allow passing values between the IMS Learning Design structure and the external item and it should also allow some kind of interaction from one to each other. In addition, this dispatcher should be managed by a sort of editor or interface easy to use for teachers and learning designers without any need of a specific technical background.

References

Bolton (2004) *Reload Project*. United Kingdom: The University of Bolton, The University of Strathclyde and JISC. Available at http://www.reload.ac.uk/editor.html. Retrieved August 31st, 2005

Bruckman, A. (1993) Community support for constructivist learning. In *Computer Supported Cooperative Work (CSCW)*, issue 7, pp 47-86. Springer

Burgos, D. (2005) *Unit of Learning 'Caminatas'*. Heerlen: Open University of The Netherlands. Available at http://moodle.learningnetworks.org/course/view.php?id=20. Last access in November 11th, 2005

Caillois, R. (1958) *Les jeux et les homes: Le masque et le vertige*. Paris : Gallimard [English translation : (1962) *Man, play and games*. London: Thames and Hudson]

Cobb, P., Stephan, M., McClain, K., Gravemeijer, K. (2001). Participating in classroom mathematical practices. In *Journal of the Learning Sciences*, 10, 113–163

Crawford, C. (1984) *The art of computer game design*. New York: McGraw-Hill

Dickey, M. D. (2005) Engaging by design: How engagement strategies in popular computer and video games can inform instructional design. In *Educational Technology Research & Development*, 53(2), 67-83. New York: Springer

Eidos Interactive (2004) Athens 2004

Electronic Arts (2005) SimCity 2004. Available at http://simcity.ea.com/. Last access in November 16th, 2005

Electronic Arts (2005a) *The Sims 2*. Available at www.eagames.com and at www.thesimsresource.com. Last access in November 17th, 2005

Eskelinen, M. (2001) The Gaming Situation. In *Game Studies*, Volume 1, issue 1

Gee, J.P. (2005) What Would a State of the Art Instructional Video Game Look Like?. In *Innovate Journal of online education*. Volume 1. Issue 6. Florida: Fischler School of Education and Human Services, Nova Southeastern University

Horn Abbot LTd. (2004) *Trivial Pursuit*. Available at www.trivialpursuit.com. Last access in November 16th, 2005

Huizinga, Johan (1938) *Homo Ludens*. Beacon Press

IEEE (2003) *IEEE Standard for Learning Object Metadata*. Designation: 1484.12.1-2002. Available at http://ltsc.ieee.org/wg12/par1484-12-1.html. Last access in November 10th, 2005

IMS (2003) *Learning Design*. Boston: USA. Available at www.imsglobal.org. Retrieved on July 30th, 2005

Jenkins, H., Squire, K. (2003) Understanding Civilization (III). In *Computer Games Magazine*. September 2003. Richmond, USA. Available at http://www.educationarcade.org/modules.php?op=modload&name=Sections&file=index&req=viewarticle&artid=44&page=1. Last access in November 15, 2005.

Koper, R. (2001) *Modeling units of study from a pedagogical perspective: the pedagogical meta-model behind EML*. Heerlen: Open University of The Netherlands. Available at http://hdl.handle.net/1820/36. Last access in November 10th, 2005

Koper, R., Tattersall, C. (2005) *Learning Design: A Handbook on Modelling and Delivering Networked Education and Training*. Germany: Springer Verlag

Laurillard, D. (1998) Multimedia and the learner's experience of narrative. In *Computers in Education*, 31, 229-243

Leyland, B. (1996) *How can computer games offer deep learning and still be fun*. In the conference Ascilite, December 2nd-4th, 1996. Available at [http://www.ascilite.org.au/conferences/adelaide96/papers/14.html]. Last access in November 9th, 2005.

OUP (2004) *Caminatas*. Madrid: Oxford University Press

Piaget, J. (1962). *Play, dreams and imitation in childhood*. New York: Norton

Prensky, M. (2001) *Digital games-based learning*. New York: McGraw-Hill

Provenzo, E.F. (1991) *Video kids: making sense of Nintendo*. Cambridge, MA: Harvard University Press

Richards, G. (2005) Designing Educational Games. In Koper, R., Tattersall, C. (2005) *Learning Design: A Handbook on Modelling and Delivering Networked Education and Training*. Chapter 13. Germany: Springer Verlag

Rieber, L.P. (1996) Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations and games. In *Educational Technology Research and Development*, 44(2), 43-58

Salen, K., Zimmerman, E. (2003) *Rules of play: game design fundamentals*. Cambridge, MA: The MIT Press

SEGA (2005) *Rome. Total War. Barbarian Invasion*. Available at www.sega.com

Squire, K. (2005) Changing the Game: What Happens When Video Games Enter the Classroom?. In *Innovate* 1 (6). Florida: Nova Southeastern University. Available at http://www.innovateonline.info/index.php?view=article&id=82 . Last access in November 15, 2005

Squire, K., Barab, S. (2004). Replaying History: Engaging Urban Underserved Students in Learning World History Through Computer Simulation Games. In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A. S. Nixon & F. Herrera (Eds.), *Embracing diversity in the Learning Sciences: Proceedings of the sixth international conference of the Learning Sciences* (pp. 505-512). Mahwah, NJ: Lawrence Erlbaum Associates.

Sutton-Smith, B. (2001) *The ambiguity of play*. Cambridge, MA: Harvard University Press

Tattersall, C., Burgos, D., Vogten, H., Martens, H., Koper, R. (2005) *How to use IMS Learning Design and SCORM 2004 together*. Paper accepted for the SCORM 2006 conference. Tamkang University, Taipei, Taiwan, January 17 - 19, 2006 [http://ia.nknu.edu.tw/scorm2006/]

Turkle, S. (1995) *Life on the screen: Identity in the age of the internet*. New York: Simon&Schuster

Van der Vegt, Wim (2005) *CopperAuthor*. Heerlen: Open University of The Netherlands. Retrieved at www.coppercore.org . Retrieved on July 29th, 2005

Vygotksy, L. (1978) Mind and society. Cambridge, MA: MIT Press

Wolf, M.J.P, Perron, B. (Eds) (2003) *The video game theory reader*. Routledge, Inc.

Zipkin, G. (2004) *Tetris 3*. California Polytechnic State University San Luis Obispo. Available at www.csc.calpoly.edu/~zwood/teaching/csc471/finalproj24/gzipkin/. Last access in November 16th, 2005