Alleviating the Entrance to Serious Games by Exploring the Use of Commonly Available Tools

Alleviating the Entrance to Serious Games by Exploring the Use of Commonly Available Tools

Peter van Rosmalen, Roland Klemke, Wim Westera
Centre for Learning Sciences and Technologies (CELSTEC), Open University of the Netherlands.
Email: {Peter.vanRosmalen, Roland.Klemke, Wim.Westera} @ou.nl.

Abstract
Despite the continuous and abundant growth of the game market the uptake of serious games in education has been quite limited. The uptake of serious games is seriously hampered by the general impression that games require complex technologies and that games are difficult to organise and to embed in the curriculum. Moreover, the education of future teachers and teaching consultants pays limited attention to the use of new technologies. This paper explores to what extent game templates can be designed that can be easily adopted and adapted by individual teachers and that only use commonly available tools in order to leverage the adoption of serious games. It discusses the design and first evaluation of two of such games: Argument, based on a Wiki, and StreetLearn, based on the Google App StreetView. Argument, a text-based game, has been used in a trial by students, in the role of teachers, of a Master of Learning Sciences Programme. Based on the experience of the Wiki game, StreetLearn, was designed. It goes beyond Argument by offering an easy way to include 3D-facilities in a serious game. The initial design of StreetLearn has been reviewed by teachers with a cultural science background and researchers in the field of technology enhanced learning. The results of the studies indicate that both tools are useful instruments that can be operated by the teachers themselves to build *game* and *game-alike* educational activities and, additionally, are a valuable step to gain experience with serious games.

Keywords: Serious games, Wiki-games, Wiki, Google StreetView, teacher training

1. Introduction

Games have a longstanding tradition in education and training covering a wide variety of application domains ranging from business, science to language learning. So far, however, the use of technology-based serious games, as compared to the boost in the games market ('PWC', 2010; 'National Gaming Survey', 2009), is very limited. Reports indicate that though the use of technology in general in education is more and more accepted, the use of serious games in particular is still limited (Ten Brummelhuis and Van Amerongen, 2010). Reasons that prohibit a genuine uptake of serious games, apart from practical issues such as financial barriers, are:

- The *high technical demands.* Games as well as game development are inherently complex (Westera et al, 2008);
- The difficulty to *organise* serious games in a way that they fit into the educational process and further the accomplishment of the pursued learning objectives (Klopfer, Osterweil and Salen, 2009);
- The difficulty to *support* serious games. Support by teachers in technology enhanced learning environments is not straightforward (Van Rosmalen et al, 2008). The amount of learners that can be supported simultaneously is limited. Moreover, with regard to the application of serious games, most teachers lack the familiarity with games and the required skills. The limited availability and experience of teachers severely reduces the amount and quality of feedback a learner might receive. Feedback, however, is considered a key condition for any learning to occur (Mory, 2003; Hattie and Timperley, 2007; Butler and Winne, 1995). Different approaches (Leutner, 1993; De Jong and Van Joolingen, 1998; Leemkuil, 2006) have been suggested and researched to improve and (partly) automate the level and quality of learner support. The design of support, however, is complex and time consuming.

In this paper, we explore and report on an approach to address the *high technical demands* and *the limited familiarity of teachers* with games. Instead of enforcing teachers to get acquainted with and adopt complex, multifaceted, immersive and technically highly demanding serious games, we propose to leverage the access to serious games. We aim to do this by offering them relatively simple serious games. Games that can be easily adopted *and* adapted by individual teachers and that only require access to commonly available and well known technology. Hence, the main research question of this study is to *explore* to what extent commonly available tools can be used to introduce serious games in education. More specifically:

- Is it possible to create appropriate and representative game scenarios with commonly available tools;
- What are the teachers' experiences (e.g., can they create or adopt one and apply them) and how do they perceive these kind of games.

We investigated the use of two kinds of tools, i.e., Wikis and the Google App StreetView. We investigated if and to what extent they could be used to develop a serious game that meets up to the expectations associated with games (Westera et al, 2008) *and* that can be easily used and adapted by the teachers. We started our research with Wikis because of their ease of use and their wide spread use in education. Next, based on this experience, in order to explore more advanced, dedicated game scenarios we selected Google Apps. Google Apps are well-known examples of free and popular tools which together make up a user's personal computer environment. The Google App StreetView was chosen to study its potential to embed 3D-technology in serious games, in our case in the context of cultural heritage. 3D-environments are an essential part of many popular games but, normally, it is not feasible to develop them for an educational game.

The paper is set up in the following way. First, we introduce the two serious games we designed, Argument and StreetLearn. Argument is built within a Wiki and merely with the tools of a Wiki. It contains a set of game rules, contents and planning. StreetLearn is designed as a simulated location-based game. It combines locations, objects, players, and tasks in a 3D-environment representing the real world. Both should be easily adaptable by a teacher. Subsequently, we discuss the evaluation of Argument in a pilot study with a group of students of our Master programme Learning Sciences and the first review of a mock-up of StreetLearn in a study with teachers of Cultural Science and researchers in the field of technology enhanced learning. Finally, we will conclude with a discussion of our findings.

2. Common Technologies and Serious Games

A Wiki, essentially, is no more than a website with facilities for creating, editing, linking and navigating web pages. Wikis are around for over a decade and fit very well into the Web 2.0 paradigm of user involvement and user created content. Because of their ease of use and because they allow users to be actively involved, they are widely used in education for a variety of applications (see e.g., Ayers and Ortega, 2010; Riehle and Bruckman, 2009) ranging from notes sharing, collaborative writing, exchange of ideas, e-portfolios, shared learning tasks, getting used to ICT, writing multi-media essays and project reports and alike. Popular Wiki-sites such as e.g., Wikispaces (http://educationalwikis.wikispaces.com/) assist teachers by offering free accounts and extensive ideas and references on how to use a Wiki in education. As will be demonstrated below, Wikis are quite suitable vehicles for (simple) serious games. Although games nowadays are commonly associated with complex, immersive worlds featuring high quality graphics and smooth and fast interactions, this is not the only way to consider games. Games such as board games, with a relatively simple set of rules, have been popular for centuries. Also in computer-based games there is a long tradition for simple alternatives ranging from Play by Email games (see for example: http://www.pbm.com/~lindahl/pbm_list/) to all kind of on-line quizzes.

With the release of a wide range of freely accessible, web-based applications, Google offers a whole range of productivity tools for various purposes (e.g., Gmail, Google Docs, Google Maps see http://mail.google.com/, http://docs.google.com/, http://maps.google.com/). Furthermore, Google offers open APIs (Application Programmer's Interface) that can be used by developers to create services and tools based on Google's suite of technologies. In many cases, this simplifies the process of developing specialised applications and services that rely on well tested user interfaces and back-end technologies. Google StreetView is one of these tools, offered by Google as an add-on to the popular Google Maps. StreetView offers navigable, 3D-like visualisations of the environment, displayed from a user point-of-view. A user can navigate through StreetView as if moving around the actual scenery.

The suite of Google tools has already attracted a number of game developers to create a range of games based on Google tools (e.g., a racing game and a flight simulator based on Google Maps see http://www.tomscott.com/realworldracer/ and http://www.isoma.net/games/goggles.html). Also for StreetView, experimental games have been developed (http://wonder-tonic.com/zombie/). As compared to the Wiki approach, StreetView offers a user interface that is considered to be closer to the expectations of gamers. However, the use of StreetView for serious games is still in its infancies.

Since there are no widely accepted definitions of a serious game, we will first start with the definition of a serious game we will build upon:

- "Multi-user online serious games are (mostly) competitive, situation-dependent, interactive electronic (learning) environments based on a set of rules and/or a model in which, given a number of constraints and a number of uncertainties, a challenging (learning) goal is pursued for which cooperation is essential" (Nadolski et al, 2006).

Argument is an online game that makes use of the collaborative nature of a Wiki. In Argument, teams argue pro or against a given argument following a fixed set of rules. Depending of their performance they receive scores and are shown in a Hall of Fame. Argument intends to elevate the learners' ability to get into details over a chosen topic i.e., to find and connect information on a topic, to discuss and defend a topic from a given position, to counter argue points raised by their opponents. It starts with a proposition directly linked with their domain of study. This proposition is the basis for four rounds of arguing. In round 1, each team writes a short essay on the position proposed either pro or contra. In round 2, the debate continues by writing five arguments in favour of their position. The teams may use, within given constraints, references to strengthen their arguments and 'cheat' arguments (an argument that sounds valid but is not) which gives, if accepted, additional points. In round 3, the teams challenge the arguments of their opponents. Finally, in round 4 the teams write their final, short essay summing up the arguments on their position. In each round a team can gain points for its contribution. A Hall of Fame is administered to show the team scores. All details of the game are explained in the Wiki including team composition, position to defend, background information, game rules, scores and scoring. Finally, each round is followed by a discussion either in a forum in the Wiki or in the class room (the full details of the game are available in the game template – in Dutch – at: http://wiki-games-argument-sjabloon.wikispaces.com/). To keep the ICT requirements as simple as possible all game logic and scoring is only described in writing. The rules and scoring, as in an 'old fashioned' board game, have to be followed manually by the learners and the teacher. Argument includes a manual (Van Rosmalen and Westera, 2010) with suggestions for adaptations including both variations on the rules of Argument and ideas for completely different game scenarios that could be implemented in a Wiki.

StreetLearn is designed as a simulated location-based game combining locations, objects, players, and tasks in a 3D-environment representing the real world. Players as well as all objects and tasks are associated with a specific location on the map. The game starts at a specific location on the map, where players are confronted with an initial task description. Typical tasks comprise finding locations, finding/taking objects, retrieving information, and answering questions. Solving a task leads to scores and usually a follow-up task. Players can be organised in competing teams that share tasks. Teams gain a team score, but individual players also score individually.

StreetLearn can be used for various learning purposes:

- **Preparation of physical trips.** A student group gets a first impression of the region they visit and of the special highlights that are available. Through explicit information and tasks to solve, many details will be learned before the visit which may later be recognised on-site.
- **Simulation of physical trips.** If a physical trip to a location is not possible, a student group can simulate the trip using StreetLearn. They get an impression of the region and of the special highlights that are available. Through explicit information and tasks to solve, many details will be learned. By using StreetLearn it is also possible to visit many scattered locations in a short time, offering the possibility to do comparative tasks.
- **Evaluation of physical trips.** The student group can virtually revisit locations at the remote site. They can recall memories from the remote site and re-experience locations and information gathered.
- **Simulation of specific situations.** In this scenario, the concrete location is less important, rather a specific physical detail is important (e.g., a specific traffic situation).

Looking at gaming processes and learning processes from a more theoretical perspective, StreetLearn is designed with the technical part of the learning process being controlled by the gaming process. According to Kelle et al (2011), the learning process is a slave of the gaming process. This means, that the game logic controls the flow of events and activities, fosters learning content to be displayed, assessments to be performed, and learning progress to be reported.

Technically, StreetLearn uses Google StreetView as front-end. This enables the user to control the system using a well known control mechanism and eases the pain of modelling a 3D-gaming environment on the educational budget. Also, the openly available Google map widgets can be used to create maps. This simplifies the technical effort for the creation of the gaming environment. Also, it lowers technical barriers for non-technical game authors, by relying on well-designed and tested user interfaces.

On top of the StreetView map representation a simple object model is defined that allows defining different kinds of objects (information objects, pickable items, interactive objects) and that has a representation of a player state (owned items, game state). Items are visualised in the StreetView front-end according to the user's navigation activities.

3. Materials and Methods

Having designed and developed our two game templates, we proceeded to carry out two studies utilizing a mainly qualitative research design to investigate if the games lived up to their intentions. This means investigating if they can indeed be easily adopted and adapted by individual teachers (and in this way leverage the adoption of serious games) to develop their serious games. In study 1, the template version of Argument was used by participants in the role of teachers to develop their own version of Argument or a derived Wiki-game. Before creating their own design the participants first played an instantiated version of Argument to get acquainted with it. In study 2, the first mock-up version of StreetLearn was evaluated by an "expert walkthrough". The evaluation focused on determining if the needs of the potential users were met in an easy to understand, useful and productive manner. Moreover, given the experience with Argument, the walkthrough in particular paid attention to the perceived game experience of StreetLearn. In both studies the most important questions to be explored were if the teachers were (or would expect to be) able to use and adapt the template version and if they could (or would expect be able to) apply it in their educational practice. Moreover, some general aspects were studied such as if the participants perceived the templates as a serious game (motivating and instructive) and for study 1, the ease of use and the quality of the instructions. As part of the evaluation the following data were collected:

- A questionnaire on the background of the participants and their participation. The questionnaire consisted of open questions for collecting the students' reflections on their experiences and closed questions asking for the agreement/disagreement on selected statements and the designs created by them (study 1).
- An expert walkthrough supported by a structured interview of the StreetLearn mock-up. The interview focussed on the possible use scenarios of StreetLearn and intended to determine if the proposed tool is easy to understand, useful and can be used in a productive manner (study 2).

All participants of study 1 were students of the Master Programme of Learning Sciences of the Open University of the Netherlands. They volunteered by responding to an open invitation mailing. The average working experience of the participants was 7.5 years (ranging between starting – 15 year), divided over Higher Education (3), Primary Education (2), Company training (2). Their experience with Wikis ranged from none (5) to limited experience (2). In the same line their experience with serious games varied between no experience (3) to limited experience (4).

Participants of study 2 were teachers from the field of Cultural Science and researchers from the field of technology enhanced learning with teaching experience. Participants volunteered to take part in the interview.

4. Results and discussion

Study 1 Wiki-game Argument. In this study 7 students participated in the role of teacher. All of the participants had used Argument as a student just prior to the design part of this study. They were asked to take this experience into account while designing and implementing their Wiki-game. They worked independently to create their own Wiki-game and were asked to complete this assignment within a period of 4 weeks. At the end of the period, 5 participants had completed the assignment, 4 of them created a full version, 1 concentrated mainly on suggestions for improvements, 2 participants were still working on it. The topics chosen for their Wiki-games ranged from how to spell verbs (primary education), radiology, and liberty of speech to research methods (higher education). There was a variety of implementations ranging from minor modifications to new designs inspired by Argument. The modifications (improvements) concerned:

- The tool used. One participant opted for Google sites. The motivation was that the functionality of Wikispaces was seen as too limited, in particular the possibilities to make a more advanced graphical design.
- The gaming element. A number of attempts were made to improve the gaming element:
  - Each player was allowed to choose their own individual topic within one central theme, this to avoid interdependencies between the players.
  - Extra bonus points for e.g., delivering in time; making the assignment of another team in case of their delivering too late; the quality of the writing itself.
  - The use of an anonymous guest player to avoid dead locks in case contributions are too late.

The participants confirmed in the questionnaire that it was fairly easy for them not only to create a Wiki-game but also to apply it in a useful manner to an (their) educational learning context. A Wiki was seen as a useful tool, with only one remark: the copying of pages, necessary to implement the game structure, was relatively time consuming. The major concern raised was that presenting Argument as a game was likely too much for 'spoiled' (i.e., used to challenging immersive games) students. In line with this the overall appreciation was negative for the game element of Argument (3 negative, 3 neutral, 1 positive) and positive for the instructive element (1 negative, 6 positive). Nevertheless, the final judgement on Argument was positive despite all the inherent limitations. A larger part of the participants indicated that Argument did inspire them to start using Wikis and other (easy to use) ICT tools, as an introduction to using serious games, or use Argument or a variation of it directly (table 1). Three participants eventually chose to further engage themselves in this topic and to use the approach for a project in one of their courses of the Master of Learning Sciences.

Table 1. Wiki-games conclusions (n=7)

	negative	neutral	positive
Argument inspired me to use Wikis or other easy to use ICT tools in my education		2	5
Argument inspired me to start using serious games.	1	2	4
I plan to start using Argument (or an adapted version of Argument)	2	1	4

Study 2 StreetLearn.
For this study, we interviewed two teachers with a cultural science background and two researchers with a technology enhanced learning background. We showed them the mock-up version of StreetLearn. We used a questionnaire with a seven-step Likert scale (from 1 = "I fully agree" to 7 = "I don't agree") and asked them four questions about the teacher side (their general interest in using such a tool for teaching, the usability of the user interface, the perceived functional completeness, and their foreseen ability to use the tool to create a game scenario on their own). Two questions regarded their expectation towards student's acceptance and benefit of using StreetLearn. In addition we included an open question for improvements and criticism.

The participants confirmed that the tool was useful and that they would like to use StreetLearn for their teaching. They also understood the user interface. However, in the open question they expressed their doubt, that they would be able to create a sufficiently complex scenario for a learning game on their own due to lack of experience in game authoring and the effort involved. They requested for additional tools and templates (e.g., predefined object types such as keys, phones, notebooks) that would simplify the authoring process. Additionally, they requested tools to monitor the trackability of the learning results (such as the inclusion of assessments and the visualisation of a teacher's dashboard with scores and results). Another issue mentioned was that due to Google StreetView's limited regional availability, some scenarios cannot be realised with StreetLearn.

Regarding the student side, the interviewees expected their students to be interested in using StreetLearn. About the benefit for students, participants were indifferent. Both teachers we interviewed are considering to create their own scenario and to include a group of students into an evaluation pilot of StreetLearn.

5. Discussion

The research described in this paper started from the observation that the uptake of serious games, despite its anticipated positive effects, is still limited. We focussed our studies on addressing the high, technical demands and the limited familiarity of teachers with games. For this, we investigated to what extent a Wiki and Google StreetView could be used by individual teachers to develop and run a

serious game. The first study, also taking into account the participants prior experience with Argument as a student, indicates that Argument enables the learner to get a good understanding of a chosen subject and supports the acquisition of complex skills such as arguing. Nevertheless, at the same time, it is clear that Argument does not fully meet the expectations of a serious game, created by commonly available games. To some extent this can be remediated by designing and developing additions to a Wiki, e.g., by making use of widgets, then again this may complicate the development of the Wiki-game too much. Also various improvements can be added as has been suggested, such as additional bonus points or an anonymous guest player. Moreover, this study also indicated that Argument was easy to adapt and adopt to the individual teacher's needs. Finally, the participants indicated that Argument did inspire them to start using Wikis and Argument itself and that being actively involved in the Wiki-game Argument was useful as an introduction to start using serious games.

With the StreetLearn mock-up we mainly tried to address issues of game experience and user interface interactivity (while keeping development costs low). The results of the second study indicate that teachers are interested to include the proposed technologies in their teaching practice. However, they still doubt if they are able to create interesting learning scenarios on their own. Also the request for more formal learning support (assessment, teacher dashboard) indicates that for a real transfer of StreetLearn into teaching practice some more development work and evaluation research has to be performed. One of the aims of our future work is to connect StreetLearn on the back-end side to a learning infrastructure that is capable of storing all learning related artefacts as well as individual progress profiles. This way, we aim to combine the ease of use of the StreetView-based front-end with the capabilities of an infrastructure that supports formal learning processes. One such infrastructure, the OICS (Open ICOPER content space), developed during the European project ICOPER (Najjar and Simon, 2009) combines learning object metadata repositories, learning outcome repositories, learning design repositories and learner profile repositories (Totschnig et al, 2009). The OICS offers a service interface which allows to retrieve from and to publish into the OICS (Totschnig et al, 2010). The OICS has already been used to support learning games (Schmitz et al, 2011) and is due to its service-based nature ideally suitable to serve a learning game, where a user does not expect to be confronted with learning management like user interfaces.

Together, obviously within the constraints of being two small, mainly qualitative studies, the studies indicate that both Wikis and Google Apps such as StreetView can be used to build games and *game alike* activities and to gain experience with serious games and therefore should be considered as an interesting alternative for the introduction of serious games.

6. Acknowledgments

We would like to thank the participants of our study for their time and the feedback given to the initial versions of Argument and StreetLearn. Part of the work presented in this paper was co-funded by SURFnet/Kennisnet in their programme 'Innovation of Higher Education 2010 Serious Gaming' (Argument) and 'Innovation of Higher Education 2011 Innovative Video Applications' (StreetLearn).

References

Ayers, Ph. and Ortega, F. (Eds.) (2010) Proceedings of the 6th International Symposium on Wikis and Open Collaboration 2010, Gdansk, Poland, ACM.

Butler, D. L., and Winne, P. H. (1995) 'Feedback and self-regulated learning: A theoretical synthesis', *Review of Educational Research*, vol. 65 no. 3, pp. 245–274.

De Jong, T. and Van Joolingen (1998) 'Scientific discovery learning with computer simulations of conceptual domains', *Review of Educational Research*, vol. 68 no. 2, pp. 179-201.

Hattie. J. and Timperley, H. (2007) 'The Power of Feedback', *Review of Educational Research*, vol. 77, no. 1, pp. 81–112.

Kelle, S., Klemke, R., Gruber, M. and Specht, M. (2011) 'Standardization of Game Based Learning Design', Proceedings of the International Conference on Computational Science and Applications. Heidelberg, Berlin, New York: Springer. June 20-23, 2011, Santander, Spain.

Klopfer, E., Osterweil, S. and Salen, K. (2009) *Moving Learning Games Forward, Obstacles Opportunities & Openness*, Cambridge MA: MIT/The Education Arcade, [Online], Available: http://education.mit.edu/papers/MovingLearningGamesForward_EdArcade.pdf [2 April 2011]

Leemkuil, H. (2006) *Is it all in the game? Learner support in an educational knowledge management simulation game,* Unpublished doctoral thesis. University of Twente, Enschede, The Netherlands. [Online], Available: http://halshs.archives-ouvertes.fr/docs/00/19/01/81/PDF/Leemkuil_2006.pdf [7 September 2010]

Leutner, D. (1993) 'Guided discovery learning with computer-based simulation games: Effects of adaptive and non-adaptive instructional support' *Learning and Instruction*, vol. 3, no. 2, pp. 113-132.

Mory, E.H. (2003) 'Feedback research revisited', in Jonassen, D.H. (ed.), *Handbook of Research for Educational Communications and Technology: A Project of the Association for Educational Communications and Technology* (2nd ed., pp. 745-783). Mahwah NJ, Lawrence Erlbaum.

Nadolski, R. J., van der Hijden, P., Tattersall, C., and Slootmaker, A. (2006) *Multi-user online serious games: Beleid, ontwerp en gebruik*, DU TOGA. Utrecht: Stichting Digitale Universiteit.

Najjar, J., and Simon, B. (2009) Learning Outcome Based Higher Education: iCoper Use Cases, IEEE International Conference on Advanced Learning Technologies (ICALT), workshop on European Workshop On E-Learning Standards Best Practice, Riga - Latvia, July 14 - 18, 2009.

National Gaming Survey (2009) Detailed data of gaming in the Netherlands. Newzo, TNS-NIPO. [Online], www.nationaalgamingonderzoek.nl

PWC (2010) Global Entertainment and Media Outlook: 2010-2014. [Online], http://www.pwc.com/

Riehle, D., and Bruckman, A. (Eds.) (2009) Proceedings of the 5th International Symposium on Wikis and Open Collaboration 2009 Orlando, Florida, ACM.

Schmitz, B., Czauderna, A., Klemke, R., and Specht, M. (2011) 'Game Based Learning for Computer Science Education' in Van der Veer, G., Sloep, P. and Van Eekelen, M. (Eds.), Proceedings of the Computer Science Education Research Conference (pp. 81-88). Presented at the Computer Science Education Research Conference, Heerlen, The Netherlands: ACM.

Ten Brummelhuis, A., and Van Amerongen, M. (2010) *Vier in Balans Monitor 2010: Ict in het onderwijs: de stand van zaken*, Kennisnet. [Online], Available: http://onderzoek.kennisnet.nl/vierinbalansmonitor [2 April 2011]

Totschnig, M., Derntl, M., Gutiérrez, I., Najjar, J., Klemke, R., Klerkx, J., and Müller, F. (2010) 'Repository services for outcome oriented learning', 4th international workshop on Search and Exchange of e-le@rning Materials (SE@M), Barcelona, 27-28 September 2010.

Totschnig, M., Klerkx, J. Klobučar, T., Law, E., Simon, B., and Ternier, S. (2009) D1.1 Open ICOPER Content Space Implementation of 1st Generation of Open ICOPER Content Space including Integration Mini Case Studies. ICOPER project deliverable. [Online], Available: http://www.educanext.org/dotlrn/clubs/icoper/newlors/Deliverables/Deliverables_-_Submitted/D1.1/D1.1-final.pdf [28 June 2010]

Van Rosmalen, P., Sloep, P., Kester, L., Brouns, F., de Croock, M., and Pannekeet, K. (2008) 'A learner support model based on peer tutor selection', *Journal of Computer Assisted Learning*, vol. 24, pp. 74-86.

Van Rosmalen, P., and Westera, W. (2010) *WIKI-games: Wiki-gebaseerde games in het hoger onderwijs (handleiding)*, Utrecht, Nederland: SURFnet Kennisnet Innovatieprogramma: Innovatieregeling Hoger Onderwijs 2010: Serious Gaming. [Online], Available: http://hdl.handle.net/1820/3051 [2 February 2011]

Westera, W., Nadolski, R., Hummel, H. and Wopereis, I. (2008) 'Serious Games for Higher Education: a Framework for Reducing Design Complexity', *Journal of Computer-Assisted Learning*, vol. 24, no. 5, pp. 420-432.