Viktor Wendel, Stefan Göbel, Ralf Steinmetz:
Game Mastering in Collaborative Multiplayer Serious Games. In: Stefan Göbel, Wolfgang Müller, Bodo Urban, Josef Wiemeyer: E-Learning and Games for Training, Education, Health and Sports - LNCS, vol. 7516, p. 23-34, Springer, September 2012. ISBN 978-3-642-33465-8.

Game Mastering in Collaborative Multiplayer Serious Games

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The concept of computer-supported collaborative learning (CSCL) emerged more than twenty years ago and has developed various shapes since. Also, the concept of Serious Games has been established during the last years as an alternative and a supplement to traditional learning methods. Serious Games can be used in self-regulated learning scenarios and a variety of successful Serious Games exist today with target groups ranging from preschool to adolescents. Game-based CSCL approaches are emerging during the last years. However, although it is clear that the role of the instructor is of utmost importance in collaborative learning scenarios, only few concepts exist to support the instructor in game-based CSCL environments.

In this paper, we propose a novel concept for the support of instructors in their role as a "Game Master" in collaborative Serious Games. Our concept aims at supporting the instructor by defining necessary information about players, the group and the interactions between group members. It also defines controlling methods and necessary interfaces in order to provide the instructor with the necessary elements to control/steer a game during runtime. We created a framework from our conceptual work and implemented our concept as an extension to an existing Serious Game for training of collaboration skills.

1 Motivation

Today, it has become more and more important to share working activities over computer networks and the Internet and to work collaboratively online or offline. The increasing importance of collaborative working and social skills in today's working environment is one reason why new forms of teaching have found their way into school curricula. Collaborative learning is a concept which is no longer a mere alternative to traditional learning but an established method for teaching self-regulated learning or social skills like communication or teamwork. As today's working life requires both collaboration and teamwork skills as well as knowledge about the use of new media, it seems logical to combine collaborative learning with digital learning. The concept of computer-supported collaborative learning (CSCL) first appeared more than twenty years ago and has developed various shapes until today. One very promising branch is the combination of CSCL concepts with Serious Gaming concepts. It has been shown [1–4] that Serious Games can be used in various learning scenarios and a variety of successful

Serious Games examples exist today with target groups ranging from preschool to adolescents.

However, to the best of our knowledge, there are only a very limited number of Serious Games adressing collaboration or collaborative learning. Various research [5–7] showed that the role of the teacher in collaborative learning scenarios is vital. They all point out the necessity of an instructor for orchestration and coordination of multiple learning activities as well as interaction between learners. Moreover, until today there rarely exist any concepts for how to integrate teachers in Serious Games for collaborative learning in a way such that they can support the learning process best.

In this paper, we propose a novel concept for the support of teachers/trainers in their role as a "Game Master" in collaborative Serious Games. We focus on the genre of 3D 3rd person multiplayer games as this genre is quite popular and well known among both casual and regular players, thus enabling an easy entry. Our concept aims at supporting instructor by defining necessary information about single players, the group and the interactions between group members. It also defines controlling methods and necessary interfaces in order to provide the instructor with the necessary elements to control/steer a game during runtime. We created a framework from our conceptual work and implemented our concept as an extension to an existing Serious Game for training of collaboration skills which we presented in [8]. Furthermore, we propose an interface for using our framework in similar 3rd person multiplayer games.

The rest of this paper is structured as follows: In Section 2 we discuss related work, in Section 3, we describe our concept in detail and in Section 4 we explain our implementation as an extension to the Serious Game *'Escape From Wilson Island'*. We conclude our work with a short summary and a description of next steps.

2 Related Work

2.1 Learning with Multiplayer Games

An overview of games used in educational research is provided by Squire [9]. He describes the various forms and genres of games already being used in education, especially in classroom so far. Those are mainly 'Drill-and-practice' games, simulations, and strategy games. Whereas 'Drill-and-practice' games are mostly utilized for learning by enriching factual recall exercises in a playful way, simulation games can be used to simplify complex systems, i.e. laws of physics, ecosystems (Sim Earth[1]), or politics. On the other hand, high fidelity simulations can be used for realistic training scenarios as often used by military or e.g. flight simulators.

Most educational games developed during the last ten years, especially learning games, were mainly simple simulation games (TechForce[2]) or learning ad-

[1] www.maxis.com

[2] www.techforce.de

ventures (Geographicus[3], Winterfest[4]). Those games were created as a playful alternative to learning facts by heart or to provide a playful environment for learning through trial and error (e.g. physics games).

It is however possible to use multiplayer technologies for learning in classroom. Herz [10] argues that *"... RPG* [5] *game persona is the most fully dimensional representation of a persons accumulated knowledge and experience gained in the online environment"*. Delwiche [11] held online classes using SecondLife[6] and the Massive Multiplayer Onling Game(MMOG) Everquest[7] in order to try out new teaching methods. Mansour and El-Said [12] found that *"... playing Serious Games positively influences students' [...] learning performance"*. In [13], Steinkhler addresses the question of how learning of tomorrow can profit of MMOGs. Wang et al. [14] designed a collaborative learning environment to show how technology can be used to enhance collaboration in learning. However, none of these games provide support for an instructor to be able to assess or control such a game at run-time.

The potential of CSCL is being known and researched for many years [15]. The combination of CSCL technology and gaming technology however, is a rather new field with only few examples. Hämäläinen [1] for example designed an environment for comuter-supported learning for vocational learning. Their findings suggest that game-based learning "may enrich learning and the pedagogical use of technology" but they also point out many remaining challenges like the lack of proof of effectiveness or the role of the teacher in such a scenario. Zea et al. [16] designed a collaborative game for learning vowels adressing children aged 3-4.

2.2 Game Mastering

One of these challenges is the fact that instructors are usually only insufficiently integrated when using game-based approaches for learning in groups or classes and are not able to orchestrate collaborative learning processes properly [7]. It has been argued ([5, 17]) that real-time orchestration is vital for collaborative learning scenarios to be successful. Also, Azevedo et al. [18] argue that externally-facilitated regulated learning (using a human tutor) is more effective than self-regulated learning when using hypermedia. Kreijns et al. [19] state that technological environments can support teachers' abilities to foster productive knowledge construction by helping them to control and assess learning activities.

Tychsen et al. [20] proposed an approach for a virtual Game Master based on the idea of the Game Master role in pen-and-paper roleplay games.

Hämäläinen and Oksanen [7] developed a scripted 3D learning game for vocational learning with real-time teacher orchestration. Their findings indicate that the teacher plays a vital role in knowledge construction processes.

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[3] www.braingame.de
[4] www.lernspiel-winterfest.de
[5] Role Playing Game, author's note
[6] secondlife.com
[7] www.everquest.com

3 Concept

As mentioned before, in game-based learning scenarios for self-regulated learning in classroom the role of the teacher is vital. The teacher has various responsibilities in the learning process: observation, orchestration, assistance, correction, or mediation of the learning process and the interactions between learners.

In order to pursue these responsibilities, the teacher needs to be able to observe both the (learning) behavior and the interactions of learners as well as to interfere with the learning process whenever he/she thinks it is necessary. Moreover, the teacher needs to be able to recognize mistakes made by learners and provide them with hints, corrections or advice on what to do better.

In terms of controlling the game, we refer to the teacher as the "Game Master" (GM). We can summarize that the GM's needs mechanisms for

1. Observing the gaming/learning process
2. Controlling/ Influencing / Orchestrating the gaming/learning process.

3.1 Components of the Game

Before we can describe how the GM can observe and control a game, we need to define the components of a game. Again, we focus on 3rd person 3D multiplayer games. For our concept, we can break down such games into the following three parts: *Game World*, *Players*, *(Inter)Actions*.

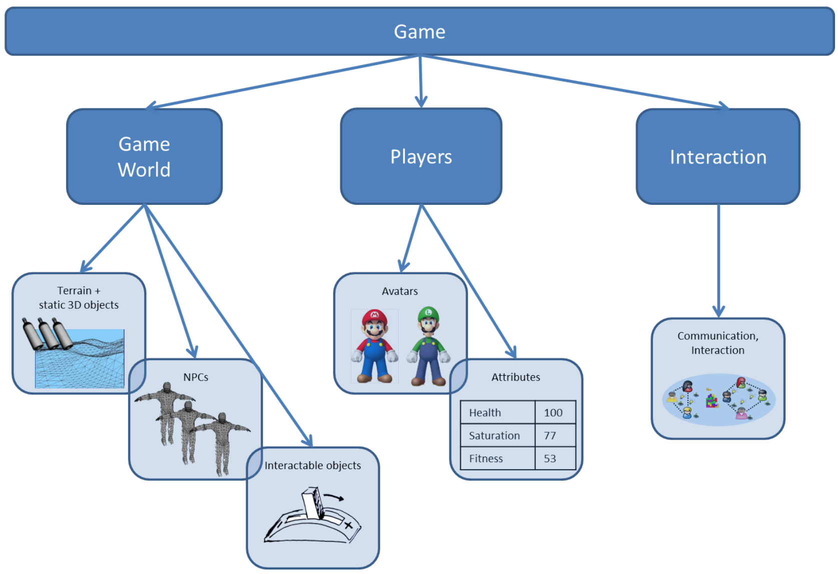

Fig. 1. Game world components

These components can be further subdivided (cf. Figure 1). The *Game World* consists of the level (static 3D objects and terrain), Non-player Characters (NPCs), and interactable objects. The *Players* entity consists of the players' avatars (and their position in the game world) as well as their game relevant attributes (like e.g. health, skills, inventory, etc.). *Interactions* can be categorized as communication (direct or indirect), direct interaction (e.g. trading items, fighting with each other) and derived interaction (spatial proximity to other players).

Group Model To capture player behavior, learner behavior, and player interactions, we introduce a group model. The group model consists of three elements: a player model, a learner model, and an interaction model. The group model is presented to the GM, in order for him to be able to analyze the learning progress, player preferences and interactions between the players/learning group.

Player Model The player model describes the preferred style of play. According to Bartle [21], player types in roleplay games can be categorized according to their style of play. They can tend to either act or interact with either the game world or with other players. Along these two dimensions, Bartle defines four player archetypes: the socializer (interacting, players), the killer (acting, players), the explorer (interacting, world), and the achiever (acting, world). Whenever there are parts of the game which can be passed in more than one way, each way stands for a certain style of play. The players choose one of these ways according to their preferences. The player's player model will then be adapted accordingly (see [22]). The GM can use this information to alter other parts of the game which the players will pass next in a way such that it fits their preferred style of play most.

Learner Model The learner model describes learning behavior as well as learning progress. For the learning progress we use a hierarchical description (cf. [22]) of learning goals. Those are structured in a directed graph where learning objects which have other learning goals as prerequisites are connected with an arrow to those, thus forming a hierarchical graph.

Interaction Model Whereas the group player model and the group learner model are combinations of the player and learner models of the individual members, the group interaction model is build differently. We differentiate between interactions in terms of

1. communication
2. action

between two or more players.

Communication can take place between two or more players in form of a conversation. Important information for the instructor is: The content of the conversation (topic, offtopic, relation to problems). The number of notions from each member of the conversation (indicates if only one person is talking or if it is a bidirectional communication). Actions between players can also be unidirectional or bidirectional. Players trading items for example are interacting with each other bidirectionally. Figure 2 summarizes the group model.

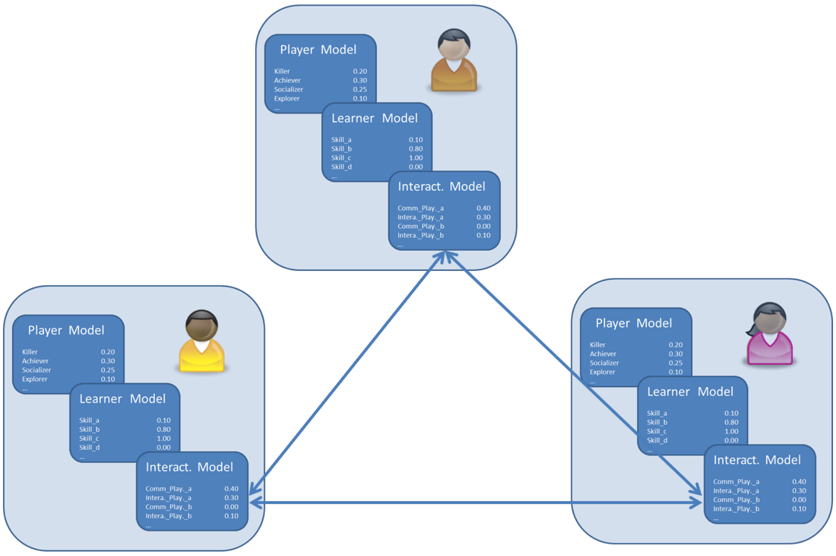

Fig. 2. Group model

3.2 GM Interface

All of the items mentioned in Section 3.1 are game-specific and differ from game to game. We cannot assume that any collaborative 3rd person 3D Serious Game contains NPCs or contains a 'health' avatar attribute. Therefore, in order for the GM to have both a comprehensive overview over the entire game and to be able influence/control it, the game needs to implement an interface describing which information the game provides and which input/control parameter it accepts (Figure 3). Regarding the information, the game needs to specify

– the Game Master's view over the game world,
– relevant (player) attributes and their type,
– game state variables (including the states of game relevant objects),
– NPC variables,
– the player communication (details about which player talks to which other player).

Regarding the input/control parameters, the game needs to enable

– manipulation of parameters for control (e.g. for difficulty)
– altering the game world (difficulty, placing hints, providing second chances)
– talking to players (directly via chat/global messages or indirectly via NPCs)

The above mentioned interface can be implemented by the game itself, thus providing a special GM interface. The GM would then just be a special role inside the game. Another approach would be to implement a stand-alone GM overview and control tool which then can connect to games using the API. Whereas the approach describe in this paper refers to the former, we are currently developing an approach for the latter.

Although visualization of the offered information and the manipulation and control tools is important, it is rather a human-computer interface related problem and thus it is not the focus of this work.

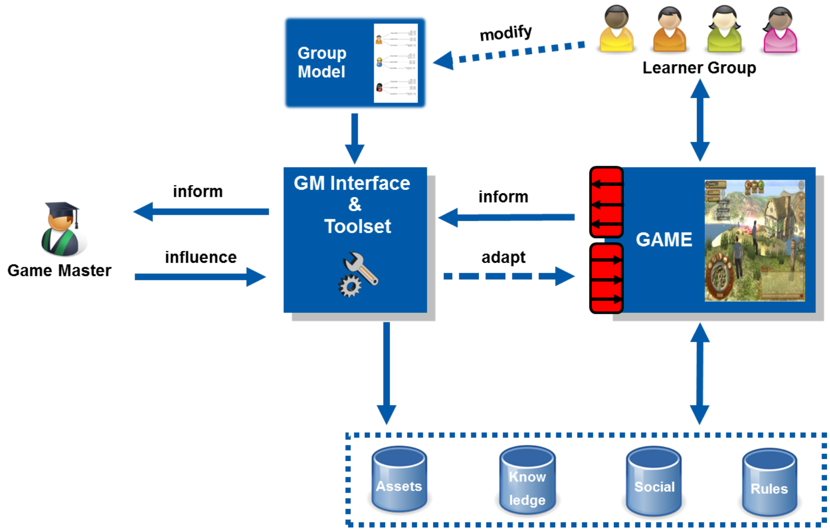

Fig. 3. Game Master interface

4 Prototypical Implementation

4.1 Escape From Wilson Island

We implemented an instance of our Game Master Interface as an extension to the existing Collaborative Serious Game *Escape From Wilson Island* (EFWI). EFWI is a 3D 3rd person multiplayer Serious Game for collaborative learning and teamwork. The collaborative learning features and the game design decisions have been presented in [8]. The narrative context of EFWI is a 'Robinson Crusoe'-like setting. Four players stranded on a lonely island. Their goal is to flee from there. Therefore, they first need to ensure their surviving by gathering food and building a log hut for shelter. After that they need to build a raft to reach a neighboring island where they can lit a signal fire on top of a mountain. The game was designed to foster collaboration. Therefore, several tasks were designed which can only be solved as a team. Additionally, team members have heterogeneous resources, so that they depend on each other.

4.2 Game Elements

The game world consists of the terrain (two islands and surrounding water), static 3D objects like trees and bushes, objects to interact with, and one NPC, an eremite living on the island providing information and help to the players. Objects include palms (can be felled), berry bushes (berries can be gathered), an empty bottle (can be collected), a geyser (to get gas), herons (can be hunted), a fire and a log hut(needed to rest).

Players are represented by their avatars. The relevant attributes are health, saturation, and fitness. Health is decreasing, when a player is drowning or suffering from hunger. Players can increase it through eating and resting. Saturation is decreasing consistently over time and can be restored by eating. If saturation value is too low, health is decreasing. Fitness is decreasing consistently over time and through running or working (like felling palms). If one player's health reaches zero, the game is lost for the whole team. If the value is too low, the player suffers from several penalties, like not being able to run anymore. It can be increased by resting. Furthermore, players have an inventory where they can put game relevant items like tools, food or wood.

Player interactions happen in various ways. Players interact with each other at collaborative tasks. We implemented the following collaborative tasks in the game:

– Carrying palms
– Gathering gas
– Hunting herons

Furthermore, players interact with each other by using the shared inventory, a box which is accessible by every team member. Finally, players interact by chatting with each other. Therefore, we implemented a chat system where players can choose with whom they want to chat. Via checkboxes, they can define who receives their chat messages. Thus, it is possible to talk only to one player, to two other players, or to the whole team.

4.3 Group Model

Our group model at this moment is limited to the player model and the interaction model. As EFWI does currently not contain any direct learning content in form of questions and answers, we have not implemented a learning model so far.

We use a modified version of the player model of Bartle, where we do exclude the player type 'killer' as their are hardly any parts of the game which can be overcome by playing in an aggressive manner. However, we can capture an explorer behavior, an achiever behavior, and a socializer behavior. We introduce three variables, one for each of the player model dimensions we capture. $PM_e(i)$ shows to which extent player i is an explorer, $PM_a(i)$ and $PM_s(i)$ respectively for the achiever and socializer dimension, whereas

$$0 <= PM_e, PM_a, PM_s <= 1 \tag{1}$$

The variables will be influenced by different player actions, like moving around will increase the explorer value as well as finding special hidden places all over the island. Getting much wood or gathering many berries is an indicator for the achiever. Chatting with fellow players or the NPC will improve the socializer value. Normalizing those values between 0 and 1, improves comparability of the three dimensions.

For the social model, we capture the chat logs and analyze them in terms of which player is talking to which other player(s) how often. Second, we capture which players are solving collaborative tasks together. Third, we capture how long the players' avatars are in spatial proximity to other avatars (exploring the island together, etc.).

4.4 Information

All of the information described above needs to be presented to the Game Master. Therefore, we implemented a Game-Master-View (see 4) which contains different view modes.

1. The GM's camera is freely movable, so that the GM can 'fly' over the island.
2. The GM's camera follows one player.
3. The GM splits his/her camera into four screens, each following one player.

Additionally, the GM can jump to several important locations around the game world and can define such spots himself. The GM has can see all players' attributes like health, saturation, and fitness in form of bars. The GM can see all important game variables. Those are: time, tasks solved (log hut build, raft built, etc.), number of food available, number of palms felled. Additionally, the GM is provided with a list of 'action notifications'. Whenever something notable happens (e.g. a player felled a palm), a notification with timestamp is sent to the GM. The GM can view a minimap of the whole game world displaying players' and the NPC's position. Finally, the GM can can see the chat log and a graphical representation of the player and the interaction model (see 5).

4.5 Control

The GM is provided with various tools for controlling the game. These control mechanisms are divided into

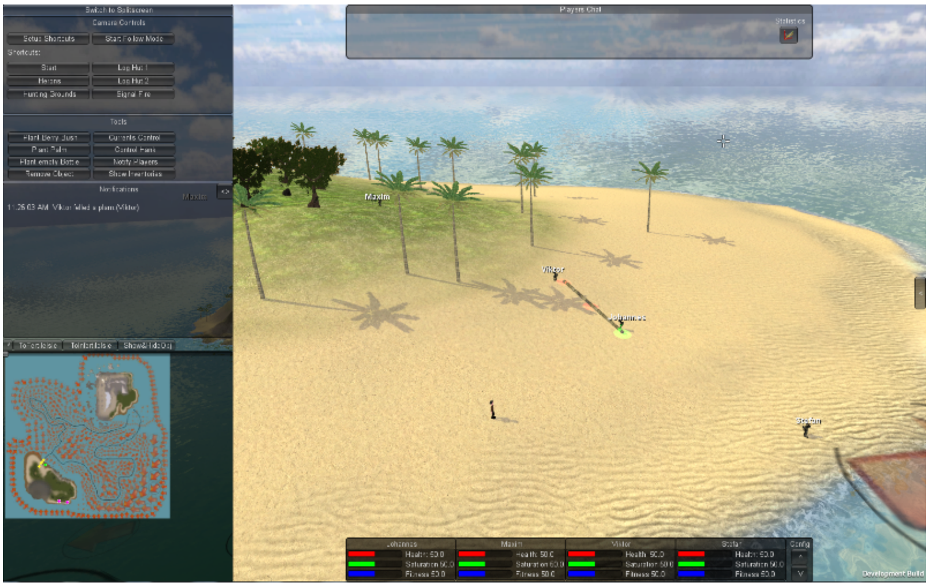

Fig. 4. Screenshot of the Game Master view

1. character manipulation
2. game world manipulation
3. NPC control

Regarding character manipulation, the GM is able to influence the way character values change directly. The GM can adapt the rate with which saturation and fitness decrease over time. Furthermore, it is possible to adapt the rate with which health, saturation, and fitness increase or decrease when eating/sleeping/receiving damage through a multiplicative factor.

Regarding game world manipulation, the GM can place and remove interactable objects, like palms, berry bushes, or empty bottles. Furthermore, the GM can give items to players (food, empty or gas-filled bottles, wood). The GM can also influence the degree of difficulty at various collaborative tasks, like setting the strength of currents in the water, or like the size of the movement circle when carrying palms.

Finally, the GM can control the NPC in various ways. He/she can create custom dialogues ad-hoc or chat through the NPC with players. Also, whenever a players triggers the NPC, the GM is asked if he/she wants to control the dialogue.

5 Conclusion

First evaluation studies with students show, that our concept is feasible. It is possible to implement a Game Master component into a 3D 1st/3rd person

Fig. 5. Screenshot of the detailed communication overview

multiplayer Serious Game providing an instructor with a comprehensive overview and tools to control the game. An instructor can use our GM interface to assess the playing/working progress inside the game having a comprehensive overview over the players, their actions and the game itself. The GM also is able to influence the game in terms of difficulty or give assistance. Due to its generality, our concept is reusable for similar collaborative learning games. However, further studies including professional instructors and educators are necessary in order to evaluate the impact a GM can have on collaborative learning settings using 3D multiplayer Serious Games. Our next step will be to plan and conduct such studies and use the findings to further support instructors at orchestrating digital collaborative games.

References

1. R. Hämäläinen. Designing and Evaluating Collaboration in a Virtual Game Environment for Vocational Learning. *Computers & Education*, 50(1):98–109, 2006.
2. W.L. Wong, C. Shen, L. Nocera, E. Carriazo, F. Tang, S. Bugga, H. Narayanan, H. Wang, and U. Ritterfeld. Serious Video Game Effectiveness. In *Proceedings of the international conference on Advances in computer entertainment technology*, pages 49–55. ACM, 2007.
3. A. McFarlane, A. Sparrowhawk, and Y. Heald. Report on the Educational Use of Games: an Exploration by TEEM of the Contribution which Games Can Make to the Education Process. Technical report, TEEM, Cambridgeshire, UK, 2002.
4. R. Sandford and B. Williamson. Games and Learning. *A handbook. Bristol, UK: FutureLab*, 2005.
5. P. Dillenbourg, S. Järvelä, and F. Fischer. The Evolution of Research on Computer-Supported Collaborative Learning. *Tech.-enhanced learning*, pages 3–19, 2009.

6. P. Dillenbourg and P. Jermann. Technology for Classroom Orchestration. *New science of learning*, pages 525–552, 2010.
7. R. Hämäläinen and K. Oksanen. Challenge of Supporting Vocational Learning: Empowering Collaboration in a Scripted 3D Game - How Does Teachers' Realtime Orchestration Make a Difference? *Comp. and Educ.*, 59:281 – 293, 2012.
8. V. Wendel, M. Gutjahr, S. Göbel, and R. Steinmetz. Designing Collaborative Multiplayer Serious Games for Collaborative Learning. In *Proceedings of the CSEDU 2012*, 2012.
9. K. Squire. Video Games in Education. *International journal of intelligent simulations and gaming*, 2(1):49–62, 2003.
10. J.C. Herz. Gaming the System: What Higher Education Can Learn From Multiplayer Online Worlds. In *The Internet and the University: Forum*, pages 169–291, 2001.
11. Aaron Delwiche. Massively Multiplayer Online Games (MMOs) in the New Media Classroom. *Educational Technology & Society*, 9(3):160–172, 2006.
12. S. Mansour and d M. El-Said. Multi-Players Role- Playing Educational Serious Games: A Link between Fun and Learning. *The International Journal of Learning*, 15(11):229–240, 2008.
13. Constance A. Steinkuehler. Learning in Massively Multiplayer Online Games. In *ICLS '04: Proceedings of the 6th international conference on Learning sciences*, pages 521–528. International Society of the Learning Sciences, 2004.
14. A.I. Wang, T. Øfsdahl, and O.K. Mørch-Storstein. Collaborative Learning Through Games–Characteristics, Model, and Taxonomy. online, 2009.
15. B. De Wever, H. Van Keer, T. Schellens, and M. Valcke. Structuring Asynchronous Discussion Groups: the Impact of Role Assignment and Self-assessment on Students' Levels of Knowledge Construction Through Social Negotiation. *Journal of Computer Assisted Learning*, 25(2):177–188, 2009.
16. Natalia Padilla Zea, José Luís González Sánchez, Francisco L. Gutiérrez, Marcelino J. Cabrera, and P. Paderewski. Design of Educational Multiplayer Videogames: A Vision From Collaborative Learning. *Advances in Engineering Software*, 40(12):1251–1260, 2009.
17. I. Kollar. *The Classroom of the Future: Orchestrating Collaborative Learning Spaces*, chapter Turning the Classroom of the Future Into the Classroom of the Present, pages 245–255. Sense, 2012.
18. R. Azevedo, D. Moos, F. Winters, J. Greene, J. Cromley, E. Olson, and P. Godbole Chaudhuri. Why Is Externally-Regulated Learning More Effective Than Self-Regulated Learning with Hypermedia? In *Proceeding of the 2005 conference on Artificial Intelligence in Education: Supporting Learning through Intelligent and Socially Informed Technology*, pages 41–48. IOS Press, 2005.
19. K. Kreijns, P.A. Kirschner, W. Jochems, and H. Van Buuren. Measuring Perceived Sociability of Computer-Supported Collaborative Learning Environments. *Computers & Education*, 49(2):176–192, 2007.
20. A. Tychsen, M. Hitchens, T. Brolund, and M. Kavakli. The Game Master. In *Proceedings of the second Australasian conference on Interactive entertainment*, pages 215–222. Creativity & Cognition Studios Press, 2005.
21. R. Bartle. Hearts, Clubs, Diamonds, Spades: Players Who suit MUDs. *Journal of Virtual Environments*, 1(1):19, 1996.
22. S. Göbel, V. Wendel, C. Ritter, and R. Steinmetz. Personalized, Adaptive Digital Educational Games using Narrative, Game-based Learning Objects. In *Proceedings of Edutainment 2010*, Aug 2010.