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Woodment: Web-Based Collaborative Multiplayer Serious Game

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Recently, a lot of research has been investigated in the field of Collaborative Learning. On the other hand, Massively Multiplayer Online Games and browser games are a popular and commercially successful game genre. However, Browser Games commonly do not use the latest 3D web technology. Our simple idea is to combine learning concepts from the field of Serious Games with promising game technology for the development of browser-based Multi-User Learning Environments. Based on a brief introduction and state of the art analysis summarizing the latest trends in Collaborative Learning and Multiplayer (Online) Games in Chapter 1 and 2, in Chapter 3 we introduce methods and concepts of Woodment as a browser-based Serious Multiplayer Game to teach and explore a customizable learning content in a game-based and playful manner. Chapter 4 provides technical aspects and features of a first prototypical implementation of Woodment. Finally, in Chapter 5 the main achievements and first evaluation studies are summarized and further Research and Technology Development steps are pointed out.

1 Motivation

Millions of people interact with each other every day using online virtual environments known as Massively-Multiplayer Online Role-Playing Games (MMORPGs). The average MMORPG gamer is 26 years old and spends about 22 hours each week in these online worlds [1]. A current trend in the video game industry is towards Browser Games, which are mostly Massively-Multiplayer Online Games (MMOGs) [2] running in a browser. With first Browser Games emerging, which make use of 3D-graphics technology, thus increasing the attractivity of Browser Games, it seems sound to utilize this technology to create platform-independent, attractive Serious Games.
In this paper the authors introduce a new approach to Serious Games based on a 3D virtual world game running in a browser. The Woodment[1] project based on the Unity3D[2] game engine is such an environment including a collaborative

[1] www.woodment.com
[2] http://unity3D.com

Multiplayer Serious Game. It has been created in a practical course on game-based edutainment applications and is currently being further developed. We used design principles and patterns of commercial MMOGs [3–5] to increase the user's long-term motivation. As it runs in a browser, Woodment's architecture is platform-independent, thus being accessible for a wide target audience. The use of a Multi User Virtual Environment (MUVE) like Woodment has a lot of advantages, like the freely customizable learning content, an immersive experience, a strong social context, an interactive environment, and the possibility to learn with others in a collaborative way.

2 Related Work

A lot of research has been done in the field of Serious Games during the last years. In [6] Encarnação provides an encouraging overview over the chances and the future of Serious Games. Computer- and video games include a lot of fundamental gaming principles [7–9] which, combined with a scientific approach from the field of Computer-Supported Collaborative Learning (CSCL), can systematically increase the motivation to learn and teach knowledge of specific subjects. Among others, Prensky [10], Herz [3], and Mansour and El-Said [11] campaign for a merging of computer games and learning to Digital Educational Games (DEGs) and state first positive results. McFarlane et al. [12] warn of mismatches between game and curriculum content and provide interesting design issues concerning DEGs.

There are manifold examples of Serious Games and Digital Educational Games (DEGs), which contributed to an increasing public awareness for Serious Games. However, the majority of those games are single player games like 80Days [13] or the Eduventure II [14], based on the Oblivion[3] game engine, which is a good example of a Serious Game making use of a quite up-to-date 3D game engine. Among the multiplayer games, most approaches are based on modified game engines which originally were created for pure fun games, like the Neverwinter Nights 2[4] editor, the CryEngine[5] or the Unreal3[6] Game Engine. Apart from these, some DEGs have been placed in MUVEs like Second Life[7]. Especially concerning (Massive) Multiplayer Online Games a lot of research has been investigated. Achterbosch et al. provide an interesting overview concerning MMORPGs. Steinkühler [15], Delwiche [16], Childress and Braswell [17], and Voulgari and Komis [18] each provide very promising experimental examinations of MMO(RP)Gs for use as Serious Games. Another promising Serious Game settled in Second Life is Geoworlds [19].

In the field of collaboration, Johnson et al. [20] investigated cooperation and collaboration among students, whereas Dillenbourg [21] offers a promising

[3] http://www.oblivion-game.de/
[4] www.atari.com/nwn2
[5] www.crytek.com
[6] unrealtechnology.com
[7] secondlife.com

overview over collaborative learning. Based on these thoughts, Hämäläinen et al. [22] investigated the effects of collaboration in a 3-D virtual game environment. Zagal et al. [23] adopted collaborative gaming aspects from board games and created useful design guidelines for the creation of collaborative multiplayer games like "Players must be able to trace payoffs back to their decisions" Furthermore, they warned of pitfalls in the creation of collaborative multiplayer games like "to avoid the game degenerating into one player making the decisions for the team, collaborative games have to provide a sufficient rationale for collaboration" or "players need to care about the outcome and that outcome should have a satisfying result". In Woodment we adopted these guidelines among others. First examples of collaborative Multiplayer Games [24–26] indicate the effectiveness of collaborative learning in MOGs.

3 Game Concept

When registering with Woodment via the web platform, users first select an avatar to represent themselves in the virtual world. This avatar is developed throughout the games played and visualizes a player's progress via a level and an Experience Points (XP) display similar to the mechanisms in ordinary RPGs.

Woodment represents an educational game, thus it contains educational as well as gaming elements. The gaming elements are designed to increase the players' motivation through fun. The learning elements are included in a way such that learning does not make a counterpart to the gaming elements but are included rather seamlessly. In Woodment, answering questions, which is a learning element, directly influences the gaming part of the game by providing bonuses for the one who solved the question and increasing his/her avatars's level which describes another additional motivation.

3.1 Mission

A Woodment match is played team versus team, each with three players. The players have to manage a virtual logging company. The human resources manager for example has to employ workers, who search for trees, cut them down and carry the wood to the team's main house. Workers are paid from the team's shared capital, as well as the occupations of the other character classes. Team behavior is supported by the fact, that each team owns a collective balance of the games resources (wood and gold). When starting a game, the players must select one of the following character classes: Risk Manager, Human Resources Manager or Procurement Manager. There can only be one player of each character class within a team. As the three different roles offer completely different tasks and challenges inside the team, they support a collaborative approach towards learning according to [27]. The main goal in Woodment is to collaborate as a team in order to lead a virtual enterprise, that tries to lumber the island as fast as possible. As soon as all trees are cut down, the game is over and the winning team is the one that gathered more wood.

The possibility to advance one's virtual character from game to game is an additional motivation to repeatedly play the game. Furthermore, players can unlock awards by reaching a specific level or other achievements like for example more than ten hours playing time. These awards are displayed within the web platform as well as ingame.

3.2 Gameplay

The player views his/her avatar in a third person perspective and leads it through the virtual world using the keyboard and the mouse. Woodment uses near-realistic 3D graphics. The gaming area is bounded in a natural way, as it takes place on an island. Woodment players can engage in the following activities:

- explore the island's 3D world (e.g. look for hidden learning content)
- manage the company
- react to unexpected events
- fight for the victory of the team (e.g. by disrupting the other team's workers)
- communicate with others via in-game chat
- level up (by answering questions collaboratively or alone
- create learning content using the web interface

3.3 Communication

As the most important tool for communication, the in-game chat also represents a crucial design element for collaboration. It should be easy to exchange ideas, strategies and knowledge. Woodment implements two different layers of real-time messaging: the Global Chat and the Team Chat, the latter only visible to members of one's own team. Text-based communication can lead to increasing reflection, because one can take a look at older messages any time. It is also a fairly slow kind of communication, which can be very useful to focus on certain aspects of a discussion and to understand every argument of a discussion as explained in [28].

3.4 Graphical User Interface

The Graphical User Interface is divided in five parts as shown in Figure 1. On the top left side, the statistics of the team members are displayed (name, team role, level and XP). On the top right a box containing information over recent game events is placed. In the top center, the global variables like available gold or the comparison of cut down timber is displayed. On the bottom left side, a chat window is placed with tabs for a global chat, a team chat or both. On the bottom right side, the players statistics provide information about his/her current level and an experience bar visualizing the progress towards the next level. In the bottom center, various buttons for the role-specific actions are placed. All these elements are permanent GUI elements and are placed over the 3D-world. If a question is triggered or a player wants to make some role-specific adjustments

Fig. 1. Woodment, prototypical implementation

by clicking one if the buttons on the bottom, an additional window is displayed containing the question or the adjustment possibilities.
When moving through the world, other players can be seen as well as information about their name and level. This way, other players can easily identify one's knowledge and learning strength by looking at the level. These information are also visible on the web-interface. This supports the formation of balanced teams, clans, guilds and other self-organized groups and has a greater emotional value for users, than a plain score-list [3].

3.5 Collaboration

Collaboration is one of the key elements of Woodment. The teams compete for victory but winning is only possible as a team. Therefore, every member of a team has to work with its team members. The players can choose between improving their own performance or the team's many times (like for example spending game money for a personal benefit or for the company). Concerning learning, the players also are never forced to collaborate, but can always choose

to act competitively or on their own. Most players will realize though, that they fail when working alone and in most cases it will be easier to solve questions as a team. Woodment users should learn about the benefits from collaboration. For this reason, the game rewards collaborative behavior. For instance, solving (difficult) questions as a team is generally higher rewarded than solving (easy) questions alone.

3.6 Learning

Multiple-Choice Platforms are placed at certain points of the gaming area. Those platforms serve as spawn points for Multiple-Choice Questions (MCQs) which the players can trigger and solve on their own or collaboratively (see 1). Thereby, players can gain experience points and gold. The question window includes a "Learn"-Button, that can display background knowledge, and furthermore an information panel, showing the team members that take part in answering it. Every time a player triggers an MCQ, his/her team members can decide whether they want to collaborate with him. If a question is solved as a team, the amount of rewarded experience points is significantly increased. Considering the complexity and the amount of knowledge needed to learn the given content, the players have to decide for themselves, whether they want to solve MCQs collaboratively or alone. Players receive knowledge when playing the game in two ways. Firstly, when a question can not be solved, the players are provided with the necessary background information to learn the content via the "learn"-button. As solving a question is rewarded in the game, there is always the motivation to learn something in order to be able to answer the question correctly on the next try. Furthermore, when discussing a question in a group, players can acquire knowledge from their fellows and additionally they can practise communication skills like debating or negotiation.

3.7 Authoring

The virtual world of Woodment is a platform, that needs to be filled with learning content. We offer an intuitive web framework, that has hardly any restrictions for a tutor to insert User Generated Content (UGC). Tutors can insert content via the web portal[8] in form of scripts, PDFs, video- and audio files or images. Further, they can include their own questionnaires in form of MCQs. When starting a server, one or more sets of learning content and related questions can be selected to be available in the game, thus forming the learning focus of the game. This way learning content and questions can easily be re-used and, if wished so, even made accessible to others.

The creation of more sophisticated learning content for virtual worlds as web applications needs standardized data formats and modular course-parts. However, combined with an authoring tool for Serious Games (like StoryTec [29]), the creation of more profound learning content variations for special teaching purposes is conceivable and commercially promising.

[8] http://woodment.com/

4 Prototypical Implementation

Woodment was designed to be platform independent. For this reason we use the Unity3D Game Engine which provides a browser plugin allowing to display content of the Unity3D game engine inside the browser window. The minimal system specification for Woodment requires a computer with an average hardware of today (2010) with an average graphics card and a browser that supports JavaScript and the freely available Unity Web Player[9], like Internet Explorer, Firefox, Safari and almost every other Mozilla-based browser.

4.1 Networking

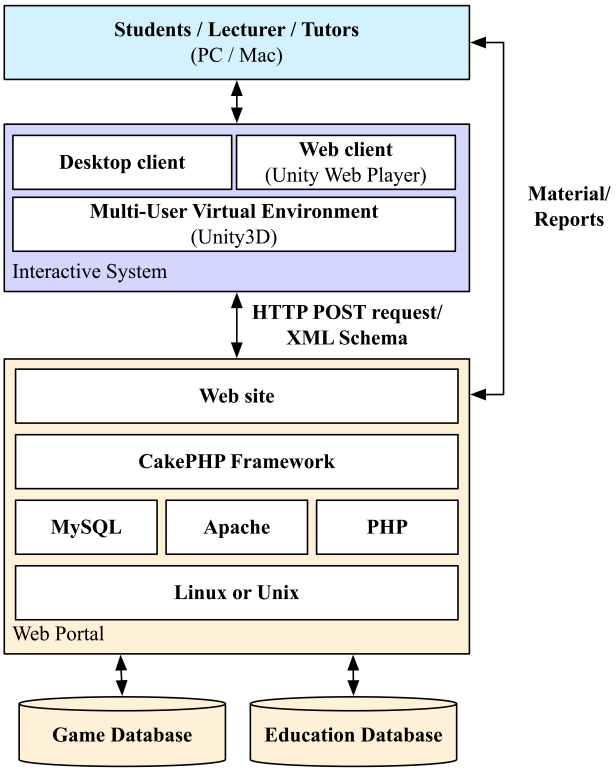

Fig. 2. Woodment architecture

As mentioned before, we used the Unity3D Engine[10] to implement the interactive environment, which allows us to make use of an integrated networking API

[9] http://unity3d.com/webplayer/
[10] http://unity3d.com/unity/

for MOGs. Moreover, a connection with an Apache[11] server hosting a MySQL[12] database containing learning content and MCQs is possible. Whenever a client triggers an MCQ, an HTTP POST request is sent to the Apache server. A CakePHP[13] framework handles that request, loads the needed question data from the education database and sends a resulting XML file back to the client. The XML file is then used by the client (see Figure 2) to display an MCQ window within the 3D environment. Woodment's web portal is programmed using the open-source CakePHP framework utilizing the MVC (Model View Controller) design pattern.

4.2 AI

All Non-Player Characters (NPCs) are navigated through the online world using a state-based game Artificial Intelligence (AI). We implemented Finite State Machines because they are easy to code, easy to understand and debugger-friendly as shown in [30]. Pathfinding is solved using an out-of-the-box A* pathfinding system[14]. This system is easy to set up, it automatically scans the environment and creates a path network.

4.3 Architecture

Architectures for MOGs have to be constructed in a way, that reduces latency and satisfies the player's expectations concerning this issue [31]. Traditionally, most MOGs implement a client-server architecture with only one authoritative server [32]. Woodment also uses a client-server architecture, but we use a non-authoritative approach to structure network gaming. In an authoritative approach, the server has to calculate the effect of every user input and send the updated game status to each client. Our network engine handles all input locally and updates only very important data via the server. The task of Woodment's server is mainly to transfer messages between the different clients, therefore reducing server load.

An ad-hoc game server can be created either by a tutor or a player, the creator of the server then acts as host. The server automatically gets registered with a central Unity3D server at which potential clients can lookup games with free slots. This way other players can find open game servers. Such a client-server architecture also creates anonymity for users, as clients are never connected directly and no IP addresses have to be revealed. From a developer's point of view, this approach is easier to implement than an authoritative server, because the clients calculate their own physics and events and send only the final result to the server which also reduces network traffic. The server-client architecture of Woodment can be seen in Figure3.

[11] www.apache.org
[12] www.mysql.com
[13] http://cakephp.org/
[14] www.arongranberg.com/unity/a-pathfinding/

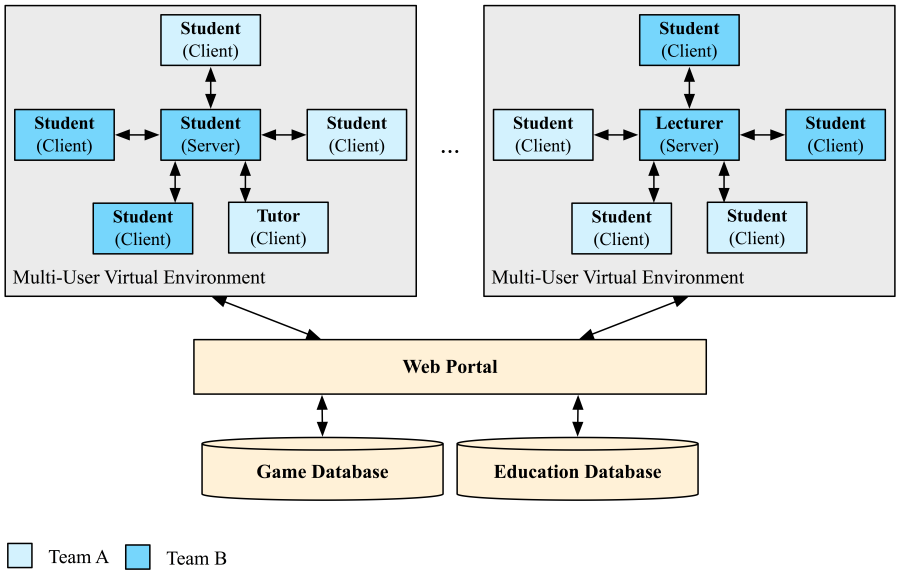

Fig. 3. Client-server network example

5 Conclusion

The authors introduced Woodment as a browser-based Multiplayer Serious Game based on latest game technology including various collaborative learning concepts and a customizable learning content. A first prototype has technically proven that using 3D web technologies for collaborative Multiplayer Serious Games is a promising approach. First evaluation studies encourage to further development of the game. Especially the fact, the learning and assessment parts directly integrated within the 3D world as well as the possibility for online-collaboration are very well received. Based on that, the next steps will be to decorate the game world with more attractive features in order to increase fun and to create an authoring environment in order to provide teachers/trainers using Woodment with the ability to include customizable learning content. To make the game applicable for a lot of additional fields of knowledge we intend to provide potential authors with various types of tasks beyond the scope of multiple choice tests like a support of math related questions or gap texts. Moreover, further evaluation of the effectiveness of the implemented collaborative concepts is necessary. Therefore, an evaluation with a larger number of users will be performed for an assessment of playability and effectiveness of learning in Woodment.

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