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Collaborative Learning by means of Multiplayer Serious Games

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Abstract. The field of collaborative learning has been researched for many years with a focus on evaluation of the circumstances under which collaborative learning provides better learning effectiveness compared to individual learning. Traditional collaborative learning has been taking place as group work or discussions in a class. Recently, Serious Games for learning and Digital Educational Games (DEGs) have been established as a promising alternative to the traditional one-to-many teaching as it is still standard in today's classrooms and with the uprising technology of Multiplayer Online Games (MOGs), new ways of collaborative learning are possible. In this paper we examine various chances and challenges for collaborative learning which arise by the use of Multiplayer Serious Games. Section 1 motivates this work, followed by a description of some important aspects of MOGs and collaboration in Section 2. In Section 3 the concept of collaborative learning is explained and important concepts and methods for a collaborative game design are analyzed and discussed in Section 4, using some examples of collaborative Serious Games. Finally, we briefly introduce our own approach of a collaborative Serious MOG in Section 5. In Section 6 the results are summarized and further work is pointed out.

1 Motivation

Although novel learning methods and E-Learning are used more often in today's classrooms, the traditional learning concepts with a teacher explaining and students consuming and repeating knowledge or learning by heart are still very common. However, as Prensky [1] showed, motivation is an essential prerequisite for successful learning. If designed properly, games can help to provide this motivation. Serious Games and Digital Educational Games (DEGs) try to combine the fun aspects of games with learning content from school curriculums or other fields of interest in order to increase the motivation to learn. Today various multiplayer games exist, which are being played by thousands or even millions (World of Warcraft¹, Everquest II², Farmville³) of players. While those games are primarily played for fun, it can be observed that players spend a lot of time to

¹ www.worldofwarcraft.com

² <http://everquest2.station.sony.com/>

³ <http://www.farmville.com/>

learn the game-specific skills needed to successfully play the game, thus acquiring deep game knowledge. Moreover, different examinations [1–5] have shown that many of those games foster the development and improvement of various soft skills, like communication, collaboration, or negotiation. In this paper we show that multiplayer Serious Games can be used to effectively enhance collaborative learning. It is essential to create Serious Games which are both motivating and fun and to prove their effectiveness, as for Serious Games there is still no "public acceptance of being generally a value-add" [6]. Therefore, we will depict some requirements and design guidelines found in literature for creating good and meaningful multiplayer Serious Games. Furthermore, we will describe state of the art work and evaluate it according to those requirements and design guidelines. Then we will briefly describe our own approach to implement those design guidelines. Finally, we will sum up the work and provide a brief outlook and some future work.

2 Collaborative Aspects in Multiplayer (Online) Games

In this section we will provide some fundamentals like a definition of collaboration, a discussion of different MOG types, and their suitability for Serious Games, as well as an explanation of the different kinds of interaction in MOGs, which each have a different impact and advantages for different kinds of learning.

2.1 Collaboration

When talking about collaborative learning, collaboration should be defined first. Here, literature distinguishes between collaboration and cooperation. Cooperation (lat.: "co operare") means "to operate together" i.e. a contribution or participation. It is a form of dividing the work among the co-operators. In contrast, collaboration (lat.: "co laborare") which means "to work together" is more than just a separation of work. Instead it can be seen as a "a coordinated effort to solve a problem together" [7]. In this context, collaboration creates a synergy effect, which underlines that which is achieved is more than the sum of the contributions.

2.2 Appropriateness of MOG Types for Serious Games

In Massive Multiplayer Online Roleplay Games (MMORPGs) like World of Warcraft or Eve Online⁴ or Virtual Online Worlds like Second Life⁵ the majority of time is spent playing in groups, chatting or working together with real people, using complementary (fighting) abilities to master the game in a team. A lot of research was carried out trying to use MMOPRGs for learning [3, 8–11] with quite good results regarding the learning behavior itself. However, some problems

⁴ www.eveonline.com

⁵ <http://secondlife.com>

were criticized [12], like the fact that due to the open game design a teacher has nearly no control over the game process. Furthermore, almost no helpful logging or protocol functions for a later evaluation of the students progress are available to the teacher. In [2] a Multi-Players Role-Playing Educational Serious Game was developed to teach about British history. An evaluation has proven the positive influence on the students' learning performance as well as a positive effect on communication and other interaction skills. Moreover, many efforts have been taken [11, 13, 14] to use Virtual Online Worlds for teaching or business meetings. Corporate business meetings and even entire lectures have been delivered in Second Life [8].

Online Browser Games, mainly implemented as 2D games played inside a web-browser, differ from the previous types of games in the way they are played. Most players play only for a few minutes at a time but do this once or more a day. Consequently, communication between the players in such games must rely on email-like services or forum discussions. The limited communication capability of this game type hardly allows a deeper form of collaboration.

Apart from the Massive MOGs, there are those MOGs with only a small number of players, either playing in two or more teams or every player on his/her own. Due to this small number of players and the ability to be played in a LAN-mode, those games are especially suitable for use in classroom or university courses. An interesting example which was already used for teaching purposes is a "Sid Meiers Civilization IV" scenario, settled in the Roman age at the time of Vespasian, developed by Dr. Shawn Graham, a professional archaeologist and professor in order to teach how the history of that time could have been different⁶. We will analyze some examples of this genre more closely in Section 4.

3 Collaborative Learning

Collaborative learning contains manifold aspects. In its simplest form it is learning in a group. However, other facets are joint problem solving, discussions, mutual explaining and reversed teaching. People learn collaboratively whenever they use their skills or knowledge to supplement with other peers, thus achieving results they could not have achieved alone, at least not as easily, in the same time, and to the same amount.

3.1 Chances and Challenges

Many research approaches indicate the positive effect of collaborative learning. In [15], Dillenbourg stated that, "under certain conditions, peer interaction produced superior performances on individual post-test than individual training". Moreover, Johnson & Johnson state that "the vast majority of the research comparing student-student interaction patterns indicates that students learn more effectively when they work cooperatively" [16]. Yet, there are some challenges

⁶ <http://planetcivilization.gamespy.com/View.php?view=Articles.Detail&id=33>

to be overcome. A well working collaboration is built upon an extensive engagement of the peers. If, however, there is an unequal participation of the peers or a peer lacks the necessary engagement, the whole process fails. In contrast, this could lead to frustration and anger at the other peers. Furthermore, there is still a need for the development of models of collaborative learning both in psychology and in computer science, as shown in [15].

3.2 Concepts and Guidelines for Game Design

With respect to collaborative learning, it is not enough to tell people to "work together" and to collaborate when placed in a group. Instead, one has to find ways to encourage collaborative behavior. Collaborative learning is not a single mechanism, but rather a situation where particular forms of interaction among people are expected to occur, which would trigger learning mechanisms. There are different ways to increase the probability of such interaction, like carefully designing the whole situation (set up initial conditions), adjusting group size or group constellation (e.g. gender), knowledge distribution or the group heterogeneity. Monitoring is essential to enhance collaborative behavior and related interactions. Supervisors should be able to intervene to offer some hints to lead the group into the right direction. Therefore, monitoring tools to record the interactions occurring at different places have to be provided.

Group members should have common goals instead of conflicting goals, which facilitate a competitive behavior [17]. To prevent competitive interactions to take place, Rauterberg [18] introduced the concept of a Shared Social Space which summarizes the features of a networked multi-player game that promotes coalitions [10]. Players have to work together if they want to achieve a common goal, as each player only holds a single piece of necessary information/knowledge to attain the common objective. The "heterogeneity of resources" [19] seems to be a positive factor for the amount and quality of interactions. Interaction rules can be reinforced by including them in the development and design of the medium, like semi-structured interfaces (communication via pre-defined buttons) can help the players to stay more focused on the task at hand and produce less unrelated comments [17, 20].

Zagal et al. [21] introduce some design-related lessons and pitfalls from analyzing a collaborative board game. They state that "a collaborative game should introduce a tension between perceived individual utility and team utility". Choosing a selfish action (high utility for oneself) must result in a situation where everyone is worse off, because success in a collaborative situation "requires concentration on team utility over perceived individual utility". This matches the definition of a social dilemma [22]. "Players must be able to trace payoffs back to their decisions" [21]. This helps to identify wrong decisions in the long run. Players need to experience "expectation failure", so that they are able to understand the consequences of their actions, not only the actions and decisions which affect themselves but also the actions/decisions which affect others. "Cooperation rate increases significantly as the benefits to others from ones cooperation increase", they state further.

To prevent a single person from taking control of the group (e.g. performing all actions, commanding others), players can be put into different roles in such a way that only good coordination leads to a successful solution. Another way is to make problems adequately difficult so players need to cooperate to solve them. Generally speaking, the integration of higher risk tasks with higher penalties foster collaboration and prevent individual attempts [10].

Players need to be interested in the outcome of the game, otherwise they will not be motivated to help each other or to improve results. Collaborative games should enable the players to contribute to the outcome of the game [21].

"For a collaborative game to be enjoyable multiple times, the experience needs to be different each time and the presented challenge needs to evolve" [21]. Only through practice people are able to learn new skills, hence replayability is important for the success of collaborative (serious) games. The repeatability of the game can be enhanced by introducing random elements through the course of the game (e.g. obstacles, events, etc.), but too much randomization leads to a lack of stable information about the game and it will be hard to develop and discuss strategies. Furthermore, the game needs to adapt to the player's abilities in order to remain enjoyable [21], e.g. presenting the problems in a meaningful order, like stated in the learning principles of Gee (Incremental Principle) [4]. An example for this is shown in the 80Days demonstrator [23].

Face-to-face promotive interaction gives players the opportunity to help each other to solve problems. Important cognitive activities and interpersonal dynamics only occur when students promote each others learning (e.g. explaining how to solve problems, teaching knowledge, discussing learned concepts). A positive ancillary effect is the establishment of social relations between group members [24]. However, there is a pitfall in collaborative learning groups, if one group member does not contribute as much as the others, there is the risk of "hitchhiking" on the work of others. To prevent this Johnson and Johnson [25] propose a component called Individual and Group Accountability. The group must be accountable for its actions and achievement of its goals, as well as every individual group member must be accountable for his/her contribution to the group.

Interpersonal and small group skills (social skills) are needed to carry out group work and must be developed between group members. Leadership, decision-making, trust-building, communication, and conflict-management skills empower students to manage both teamwork and taskwork successfully. If group members develop those social skills, group projects will run more smoothly and efficiently. Hence, the game should support the development of these skills among players.

4 First Studies

A wide range of approaches to learning and scaffolding of learning activity exists today. Further, we present some examples of collaborative Serious Multiplayer Games / Multiplayer DEGs, which enhance learning or the acquisition of soft

skills and provide an analysis according to the methods and concepts described in Section 3.2.

The Lake Simulation [26] is a simulation based on the well known Prisoners Dilemma. In this game, eight groups representing eight different industrial plants, situated around a common natural resource (a lake), have to maximize their profit while maintaining high quality of the water. Communication is allowed only between members of the same group. Only at two occurrences the groups are able to talk to each other and to agree upon their actions. A supervisor is managing the simulation, being able to see all decisions/actions of the participants. At the end, the simulation results are discussed and the supervisor shows the results that would have been achieved if all the players had played collaboratively.

Americas Army⁷ is a free-to-play online multiplayer tactical shooter published by the United States Army. Although it is not an educational game, we categorize this game as a Serious Game because it is more than just a fun game, but instead aims at developing tactical and collaborative team playing skills. Players can choose out of four different roles inside a team like Rifleman, Grenadier, or Squad Leader with different equipment associated with each role and each role only once available per team. After picking a role, a short tactical briefing between the team leader and the other member commences. Achieving victory is only possible when working and coordinating as a team, following orders, and making use of the ingame voice commands and the ingame voice chat.

"Leoncio and friends" [24] is a collaborative educational video game, designed for children between the ages of three and four. The goal of the game is to improve the interaction skills of the children, as well as their ability to write vowels. Each player gets an individual tool (role), but all tools have to be used/shared in common challenges. Group goals can only be achieved by working together. The definition of a common goal (rescue Leoncio's friends) helps to support positive interdependence. Each player's client displays an individual score and a group score. The individual score is modified by a player's performance (individual accountability) and the group score is modified by group activities (positive interdependence). The group is able to decide on spending common points (rewarded by challenges) to buy life for a player who has lost all his individual life (face-to-face promotive interaction, helping each other, positive interdependence). Throughout the game, the players have to consent with each other in deciding in which order their tools should be used to solve different problems (face-to-face promotive interaction). The group performance is evaluated in its entirety during the common (group) challenges (group processing). Apart from adjusting the difficulty of the different stages the game offers no way to increase the replayability and due to the young age of the participants its still needs to be clarified whether collaboration is really taking place and the participants are able to grasp the concept of working together to improve their effectiveness.

⁷ www.americasarmy.com

5 Our Approach

Based on the comprehensive analysis summarized above, we approach the problem of the creation of a meaningful Serious Multiplayer Game for collaborative learning from various sides. In a first approach Woodment⁸, a collaborative and competitive MOG, was created. In Woodment, two teams consisting of three players each lead a wood logging company, settled on an island, to success. Woodment uses the gameplay as a motivation to learn. The underlying game is a collaborative and competitive simulation and could be played without answering any questions. However, by answering questions, players gain game relevant bonuses (like higher worker speed), which are significant advantages over the opposing team. By this design decision we motivate the players to answer as many questions as possible. If a question cannot be answered correctly the players are provided with background information, so that they can answer the question next time, thus having learned something. Woodment was first described in [27]. In this paper, however, we focus on the collaborative features of Woodment concerning both learning and gameplay. In Figure 1, a screenshot of Woodment is shown with the players debating about a question. All over the island there are question spheres which trigger such questions.

Although competition exists between the two teams, the members of one team have the common goal of leading their company to victory. A "heterogeneity of resources" concerning actions is implemented. This means that each player has a different set of actions available throughout the game complementary to the actions of his/her team members.

We also added a "tension between perceived individual utility and team utility" by adding a player level similar to the one in an RPG. This way the players have to choose between their personal profit and the good of the team. They can, for example, solve a question alone, gaining more experience points or solve it with the whole team, receiving more money for the company.

By dividing all available actions among the three players, we prevent one player from taking control of the whole group. For example, only the Human Resource Manager can hire or fire workers, whereas only the Procurement Manager can spend money to build houses to increase the workers' performance.

In order to increase the replayability of Woodment, the questions can be chosen from a set of learning topics which can be created and customized by teachers/trainers including multiple choice questions, cloze texts, or math questions. This way, each game can be started with a different set of questions. Furthermore, every registered player has a global player level which increases between games according to the success in the games.

All questions are attributed with a difficulty level, so that the questions can be adapted to the players' level and thus to their knowledge.

Face-to-face promotive interaction is included especially in the learning part as players of one team are not only allowed to solve questions together, but rather they are encouraged to do so, as solving a question together means a

⁸ www.woodment.com



Fig. 1. Players debating about a question in Woodment

higher profit for the team. Using the in-game chat, players are able to discuss questions or to explain them to each other. This may be the most important aspect of collaborative learning implemented in Woodment. Furthermore, it helps training a variety of social skills. Next steps will be:

- Development of an in-game editor for question sets and level settings.
- Inclusion of a gamemaster mode so that a teacher/trainer can observe the players' behavior and performance and trigger some events ad-hoc if necessary or to adjust the level of difficulty manually.
- An evaluation of the effectiveness of such a game for learning, especially of the collaborative aspects.

6 Conclusion and Future Work

In this work we stated that Multiplayer Serious Games are a chance for new applications of collaborative learning. Games provide the motivation which is necessary to make learning a more enjoyable occupation. By creating Multiplayer Serious Online Games this motivation can be transferred to collaborative learning. However, such games must be created according to a variety of design guidelines. We pointed out those guidelines and discussed them using

the example of some Multiplayer Serious Games. Furthermore, we explained our own approach of a Multiplayer Online Game for collaborative learning and how we implemented the design principles mentioned before. Next steps include first evaluations of the effectiveness of the collaborative learning concepts implemented in our game by making the game accessible to the target audience, as well as an integration of an authoring environment in order for teachers/trainers to create their own sets of questions and to customize the game world.

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