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LEARNING THROUGH PLAYING FOR OR AGAINST EACH OTHER? PROMOTING COLLABORATIVE LEARNING IN DIGITAL GAME BASED LEARNING

Margarida Romero
ESADE Business School

Mireia Usart
ESADE Business School

Michela Ott
Coventry University

Jeffrey Earp
ITD-CNR

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Romero, Margarida; Usart, Mireia, Esade, Av. Pedralbes, 60-62, 08034, Barcelona, Spain, {Margarida.Romero, Mireia Usart}@esade.edu

Ott, Michela; Earp, Jeffrey, ITD-CNR Via de Marini, 6, 16149, Genova, Italy, {ott, jeff}@itd.cnr.it

de Freitas, Sara; Arnab, Sylvester, Serious Games Institute, Coventry University, UK, {s.defreitas, s.arnab}@coventry.ac.uk

Abstract

The process of learning through Game Based Learning (GBL) presents both positive aspects and challenges to be faced in order to support the achievement of learning goals and knowledge creation. This study aims to characterise game dynamics in the adoption of multi-player GBL. In particular, we examine the multi-player GBL dynamics may enhance collaborative learning through a relation of positive interdependence while at the same time maintaining a certain level of competition for ensuring multi-player GBL gameplay. The first section of the paper introduces collaborative GBL and describes the combination of intragroup dynamics of cooperation and positive interdependence and an intergroup dynamic of competition to maintain gameplay. The second part of the paper describes two multi-player GBL scenarios: the multi-player game with interpersonal competition and the multi-player game with intergroup competition. For each scenario a case analysis of existing collaborative games is provided, which may help instructional and game designers when defining the collaborative GBL dynamics. Technological requirements and best practices in the use of collaborative GBL are described in the last sections.

Keywords: Game Based Learning, Serious Games, Multi-player Games, Collaborative Learning, Positive Interdependence, Competition.

1 Introduction

In recent years games have been used in the traditional classroom to enhance active learning processes and active problem solving. Kim, Park and Baek (2009, p. 801) define Game-Based Learning (GBL) as a learning strategy "focused on achieving the particular objectives of given educational content through game play". Serious Games (SG), also called computer-based games or digital games is a form of electronic games intended for educational purposes that support student-centered learning. In digital GBL, educators "use digital games with serious goals (i.e. educational objectives) as tools that support learning processes in a significant way" (Sica, Delli Veneri, & Miglino, 2011, p. 108). Serious games are designed so as to achieve a balance between fun and educational value (Zyda, 2005). In the context of computer-based GBL, a distinction should be made considering the number of players engaged in the gameplay. Digital GBL environments can either expect interaction on the part of an individual player or prescribe multiplayer interaction. When the latter are used with the pedagogical intention to promote collaborative learning between players, we can say that the approach being adopted is collaborative GBL. Collaborative GBL involves more than one player in gameplay with the pedagogical intention to promote cooperative learning between those engaged in the game. Following Dickey (2007), collaborative games play an important role as engaging learning environments. Considering engagement fostered through multi-player games and the growing development of collaborative learning at all educational levels in recent decades, this study focuses on the use of digital multi-player GBL and the cooperation and competition mechanisms for ensuring its effectiveness for achieving educational objectives. In this investigation of multi-player GBL, we start by characterising collaborative learning in general and multi-player GBL dynamics specifically, considering those dynamics that could promote collaborative learning and student engagement. Thereafter, we describe two multi-player GBL scenarios: the multi-player game with interpersonal competition and the multi-player game with intergroup competition.

1.1 Collaborative Learning

Collaborative Learning is a learning situation in which more than one student participates in a common learning activity engaging them in pursuit of a common goal. This collective learning situation has been identified by various names such as team learning, cooperative learning, collaborative learning or learning communities (Dillenbourg, Baker, Blaye, & O'Malley, 1996; Dooly, 2008). Collaborative learning has also been defined as a process of participating in knowledge communities (Bruffee, 1983; 1995). In these scenarios, knowledge can be built through the development of collective understanding. In a community of learners, the main activity is participation in a collaborative process of sharing and distributing expertise; learning by generating, maintaining and expanding a community of research practice. Nowadays, it is generally accepted that such common learning activities have the explicit pedagogical intention of fostering collaborative learning processes, which involve students working together towards a common goal, sharing and constructing a certain level of common knowledge, understanding and expertise. Nevertheless, despite these pedagogical intentions, some group work situations lead to unsuccessful collaboration between learners, superficial or incongruent cooperation towards the common goal, or even to competitive dynamics among teammates preventing learners' from sharing and constructing knowledge and from achieving their common objectives. Recent studies have examined this situation, focusing on the conditions of success or failure of collaborative learning (Kirschner, Sweller, & Clark, 2006; Kreijns, Kirschner, & Jochems, 2003). In this paper, we use the term collaborative learning to describe collective situations in which more than one learner participates in a common learning (game) activity. This study analyses the intragroup and intergroup dynamics that can be proposed to develop a multi-player gaming situation, identifying the mechanisms of cooperation and competition.

Computer Supported Collaborative Learning (CSCL) can enhance peer interaction and group work, as well as facilitate sharing and distribution of knowledge and expertise among community members (Lipponen *et al*., 2003). Suthers (2006) describes CSCL as a field that investigates "processes of

intersubjective meaning-making and how technological affordances mediate or support such processes" (p. 332). In other words, CSCL is aimed at supporting groups of learners in acquiring content knowledge in a specific domain with the aid of computers. However, CSCL systems have some drawbacks. Key issues include the tools and means of supporting learners in a more "scalable, open, dynamic and adaptable environment" (Halimi, Seridi, & Faron-Zucker, 2011, p. 19). The effectiveness of CSCL is also influenced by external factors, such as the learners' prior experience, background, availability and expectations, the capacity of technology and technology-based delivery, financial and other resources (Davis, Little, & Staward, 2008). Therefore, it is important that considerations about the learning environment should include "the intended learning outcome" and "the needs of targeted learners" (p. 123). These two vantage points can be bridged and matched by technology infrastructure.

Taking this into account, collaborative learning should include a variety of educational practices in which interactions among peers constitute the most important factor in learning, although without excluding other factors such as interaction with learning material and teachers (Dillenbourg, Järvelä & Fischer, 2007).

2 Collaborative Game Based Learning

Collaborative GBL involves the use of a multi-player game designed and/or used with the intention to develop collaborative learning amongst the learners' engaged in the game. In this section we start describing collaborative learning and then develop the potentiality of multi-player games according to the learning modality (on-site, blended learning or distance learning) and the number of players engaged in the multi-player game (a dyad, small group or Massive Multi-player Online Game).

Collaborative learning is seen as an approach that enhances development of interpersonal competencies such as negotiation, collaborative decision-making and creative problem resolution. Collaborative Game Based Learning (GBL) can be considered a powerful educational technique aimed at enhancing collaborative learning through the use of GBL. The collaborative GBL situation allows a realistic collaborative "learning by doing" approach that avoids real-life risks (Leemkuil *et al*, 2003). According to Herz (2001), collaborative GBL can transform knowledge into social capital because peer acknowledgement appears to be a powerful incentive for students. Despite the advantages of collaborative learning in terms of motivation (Järvelä, & Volet, 2004) and development of higher-order cognitive skills (Stahl, 2007), some potential shortcomings must be recognised. Firstly, some learners may have preferences for individual learning (Jeffrey, 2009; Yang, & Tsai, 2008). Secondly, interactive environments such as games, simulations and adventures sometimes lack effectiveness when no instructional measures or support are added to guide the learning process (Leemkuil *et al.*, 2003). Students collaborating in groups must be able to monitor and adapt their cognitive and metacognitive processes to the changes in their motivational state, and determine how much social support may be needed to perform a task (Azevedo, 2008).

From the context modality, we should consider that a multi-player GBL activities may be played in different situations, from on-site classroom based situations (e.g. with *eFinance Game*, Padrós, Romero, & Usart, 2011) to distance learning environments, such as the *Maple Story* studied by Ang, Zaphiris and Mahmood (2007), where players are geographically distributed and interact in real time. Furthermore, multi-player games can contain a number of synchronous communication channels, meaning that the traditional turn-taking problem of groupware applications does not apply. In this case, players do not need to wait their turn; they can continue to act and interact using various channels. If talking is not feasible, they may choose to communicate by jumping up and down or performing some other non-verbal action instead (Bluemink *et al*., 2010).

From the number of players involved in the game, we should consider that multiple-players may engage just two players in a dyad (Romero, Usart, & Almirall, 2011), a small group (Stahl, 2004), or even a large player community playing a Massively Multiplayer Online Game (MMOG) (Ducheneaut *et al.*, 2006). Figure 2 shows the range of players in collaborative GBL, from 2 players (dyads), small groups comprising generally between 3 and 9 players (Valacich, Dennis, & Nunamaker, 1992), and MMOGs, including an unlimited number of players.

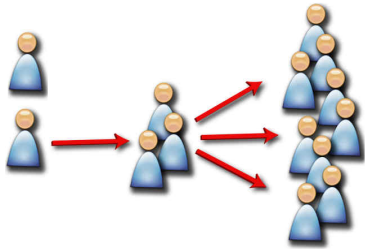

Figure 1: Collaborative GBL depending on group size: dyads, small groups and MMOGs

The capacity of a game platform to support multi-players offers strong potential for supporting collaborative activities for learning in different forms, Using multi-player games for educational purposes has the potential to enhance collaborative learning by developing social communities (Dickey, 2011; Dunwell, Christmas, & de Freitas, 2011) and taking advantage of the role-playing opportunities (Mathevet *et al*., 2007) and the social skills development potential (Pivec, & Dziabenko, 2004). However, few studies have clearly identified the main factors behind the effectiveness of collaborative learning with multi-player games. Further research needs to be undertaken to develop design metrics for ensuring all participants collaborate and learn efficiently in these computer-based environments. Online games of different types are currently available which allow multiple players to actually collaborate or compete on an individual or small-group basis. The term Massively Multiplayer Online Games (MMOG) encompasses all those games that have the common aim of gathering multiple users and engaging them at a distance in collaborative/competitive gaming activities. They are not necessarily played on personal computers but also on game consoles, including *PlayStation*, *Xbox*, *Nintendo Wii*, etc. One example is *Code of Everand*, a game designed to *improve* road crossing behaviour, which has been played by about 100,000 11-16 year-olds online and in groups. One of the most common sub-types of MMOGs is the Massively Multiplayer Online Role-Playing Games (MMORPGs). This is a genre of role-playing game in which a very large number of players interact with one another within a virtual game world on an individual or team basis. Here players assume the role of a character/protagonist and take control over many of that character's actions. Another emerging sector where gaming activities are at the core of intra-personal inter-group collaboration are "social games". With the advent and spread of social technologies, gaming activities are frequently carried out in the framework of social networks. Thus, the term "social network game" (or "social game" for short) has recently been coined to identify online games played on social networks; these typically feature both multiplayer and asynchronous gameplay mechanics. MMOG, MMORPGs and social games may feature both intragroup dynamics (which some authors call in-group dynamics) of cooperation and positive interdependence between teammates and intergroup dynamics of competition (also called out-group dynamics by some CSCL researchers). This corresponds to what Bateman and Boon (2006, p. 27) define as "performance oriented stimulation", which engages the subject in a playful experience.

3 Methodology

In order to characterise the game dynamics of positive interdependence and competition in multi-player GBL, this study has considered a literature review using two bibliographic databases: SAGE

and ScienceDirect. The databases were searched with the following strategy: the terms 'collaboration', ‘cooperative’, ‘teamwork’ and ‘group learning’ where combined to the terms ‘game’, ‘GBL’, ‘serious game’, ‘digital game’, ‘social game’, ‘MMOG’ and ‘MMORPG’. Only the papers related to collaborative games or individual games used in collaborative situations have been considered. Mindful of the impact of group size on collaborative learning dynamics and of the characteristics of small group dynamics (Stahl, 2004), our exploration of multi-player GBL dynamics considers both games that can be played by a limited number of learners (dyads or small groups) as well as games with an unlimited number of potential players such the MMOG.
The results of the literature review are introduced in the following sections of the paper by introducing firstly the multi-player intragroup and intergroup relationships, and then the scenarios of interpersonal competition and intergroup competition. Subsequently, case analyses of existing multi-player games for each scenario are introduced. Finally, technological requirements and best practices in the use of multi-player GBL for collaborative learning purposes are described in the last sections.

4 Multi-player intragroup and intergroup relationships

In the following sections, we examine two different types of multi-player relationships that characterise intragroup and intergroup dynamics: positive interdependence and competition.

4.1 Multi-player intragroup relationships: positive interdependence

In interdependent collaborative learning situations, the students are responsible not just for their own learning but also for that of others (Gockhale, 1995). Thus, the success of one student can help others to be successful (Johnson & Johnson, 1986). In interdependent situations teammates are critically dependent on each other; they need their peers’ knowledge to complete their own part of the task and finally reach the group’s goal (Lipponen *et al*., 2003; Dillenbourg, 1999). In collaborative learning, individuals may be responsible for their actions, including learning, and need to respect the abilities and contributions of their peers (Panitz, 1997). Help among different groups and information flow can be defined and guided, for instance by multi-player GBL dynamics or by game rules. Positive interdependence is also related to the incentives system implemented in intragroup and intergroup dynamics.

The underlying premise of collaborative learning is based upon consensus building through cooperation among group members (Bruffee, 1995). This is in contrast to competition, in which individuals or groups seek to outplay other individuals or groups in accordance with the game rules proposed by the collaborative GBL environment. We consider the positive interdependence dynamics that could be generated among students involved in a multi-player learning activity in terms of players’ need to collaborate with other teams in order to achieve their learning goals. In this respect, multi-player GBL has the potential to enhance collaborative learning by supporting an intragroup dynamic of cooperation and positive interdependence between teammates.

There are multi-player games that are not based on a competitive dynamic. For instance, a game called *Course sans Gagnant* (Moisant, 2005) is a game-based activity played in small groups in which high school students collaborate towards a common final goal, implying that they positively depend on each other. Such a learning approach could lead to positive outcomes in terms of team competences and academic achievement. Developed by a mathematics teacher, this SG simulates a car race and pursues the maximum positive interdependence for a game activity (see Figure 1); that is, teams can only win if all the players arrive at the finish at the same time. In order to reach this goal, students collaborate within the group and share different strategies and maths knowledge in order to calculate the different speeds required to finish the race together.

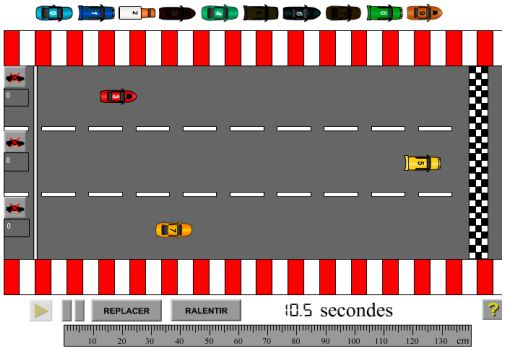

Figure 2: Course sans Gagnant (Moisant, 2005).

Social games or MMOGs also adopt the interdependence mechanism as one of the main aspects for engaging players in the game. Yee (2006) identifies teamwork as a social component of player motivation in MMOGs, where team member derives satisfaction from being part of a group effort and being positively related to teammates. In studies of MOOG addiction, the belonging component related to interdependence has been found to be a stronger factor than the competition factor (Hsu, Wen, & Wu, 2009). This suggests that interdependence in the intragroup relationship is one of the strongest motivators for the use of MOOGs. Players in MMOGs may be organized in teams that cooperate together, such as the guilds in the MOOG *Guild Wars* or the clans in the *World of Warcraft* (WoW). Some studies have explored the pedagogical interest of WoW. In their study, Pirius and Creel (2010) proposed students' organising themselves into an interdependent and cooperative clan to investigate the topics of subjective culture, personal and group identity, gender and stereotypes, language, citizenship, and technology. The students showed strong engagement in the game but the professors faced a challenge in managing the class and dealing with the distributed and dispersed knowledge developed through the use of this MOOG.

Multi-player intergroup relationships: competition

The potential for enhancing collaborative learning through positive interdependence in multi-player GBL needs to be weighed against situations where students are in a complete win-win position; if the player always and inevitably wins, the resulting lack of challenge could result in a critical loss of engagement. Prensky (2001, p.106) considers "conflict, competition, challenge and opposition" components of the game as ways to provide the player with adrenaline, and promote engagement. In order to maintain the principle of competition and the positive interdependence ideally found in multi-player learning situations, we consider both intragroup cooperation and dynamic of competition that can be seen in most commercial games (Moreno-Ger *et al*., 2008) played out at the intergroup level. In these situations, members within small teams cooperate together with the objective of beating the other groups. Following Dillenbourg (1999), we define small teams as groups ranging from two peers (dyads) to five students. Bruffee (1983) affirms that competition motivates students to play a game, permits active learning approaches and also encourages collaborative learning in which students can share their knowledge and develop their competences in a safe environment. In the context of collaborative GBL, the dynamic of intergroup competition can enhance group cohesion and coordination, leading to an increase in-group performance (Erev, Bornstein, & Galili, 1993; Bornstein, 2003).

One example of intergroup competition is *eScape*, a SG experience designed by Bluemink and colleagues (2010). Groups of four students engage in a virtual competition with five other groups through a voice-enhanced activity. The goal of the game is to escape from an ancient prison; in order to win the game, each team must collaborate to solve five problems or quests before the other groups do. These activities were designed to permit positive interdependence among the group members. The authors observed that intergroup dynamics could engage students in a constructive collaborative

activity by promoting both cohesion and development of the teams. In addition to intragroup cooperation, intergroup competition can enhance engagement in the activity.

Intergroup competition is one of the basic mechanisms of MOOGs such as World of Warcraft where players are organised in clans that cooperate together against other clans. As mentioned earlier, competition seems to be a less important factor than cooperation for provoking MOOG engagement, and in extreme cases, addiction. We did not manage to identify educational uses of MOOGs where the educational purposes of competition where promoted. However, some studies highlight the existence of competitive behaviour in MOOG. Kristensen (2009) made a discourse analysis study of World of Warcraft , observing that in a male dominated community discourse is task-oriented and competitive, and woman are perceived as annoying and disturbing. Kristensen discusses competitive male discourse following the work of Holmes (2006), who observed that male humour is competitive and challenging, while feminine humour is supportive.

5 Multi-player GBL Dynamics

In this section we describe the results of the literature review study of the two main multi-player GBL dynamics, inter-individual competition and inter-group competition dynamics. In both cases we describe intragroup interdependence, inter-individual competition and intergroup competition.

5.1 Multi-player GBL dynamics 1: Playing against other individual players

Individuals playing against other individuals are engaged in an inter-individual competition. This dynamic can be considered as extraneous to collaborative GBL, as it entails competition among individuals to reach the final individual goal. In this case, the game provides a multi-player situation, but the game rules of inter-individual competition avoid the collaborative learning dynamics to be developed within the teammates' in situation of rivalry.

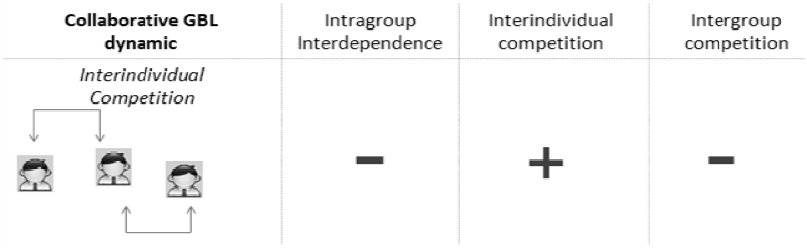

Figure 3. Inter-individual competition dynamics

As represented in Figure 3, we could consider this game dynamic as counterproductive for intragroup interdependence and knowledge sharing because of the concurrent game and learning objectives of each individual player in this multi-player GBL situation. Inter-individual competition in this situation is high, as individuals compete against each other.

This is a typical situation of game-play within social network games. An example is the *Play the News* game (Zapusek, Cerar, & Rugelj, 2011). This multi-player GBL is a web-based activity of interactive gaming on world news. Although users access the game and play it individually, there is a virtual community around the game where players can comment and access their rankings. The game's purpose is to help players create a snapshot of the socio-political profile over time on a range of different issues.

The computer-based design techniques for this SG modality are based on learners' awareness of other players' performance and situation in the game; without these tools, players have the impression of

being alone and have no cues for preparing their competitive game strategy. Learners develop awareness of their teammates' knowledge and state, but they compete against each other without developing the sharing meanings and common objectives that requires collaborative learning.

5.2 Multi-player GBL dynamics 2: playing against other groups

Playing together (intragroup) against other groups (intergroup) is the second dynamics we consider in multi-player GBL. This dynamic corresponds to gaming activities in which students play in a group against other groups, applying the dynamics of intragroup cohesion and the intergroup hostility principle in line with the Realistic Conflict Theory of intergroup relations (LeVine & Campbell, 1972; Sherif, & Sherif, 1953). Some games are designed to get students to collaborate with their teammates in order to compete against other teams. This type of GBL enables both collaboration and competition processes and is expected to create a higher sense of community inside one's group but also higher motivation for winning the game (Romero, 2011). In this multi-player dynamics, the group pursue collaboration for a final, common objective. That is, there is a totally positive interdependence factor at the intra-group to compete at the inter-group level. As represented in Figure 4, we could consider this game dynamic as enhancing intragroup interdependence and knowledge sharing within the teammates' of the same group. The inter-individual competition within the members of the group is low, but the intergroup competition is as its peak.

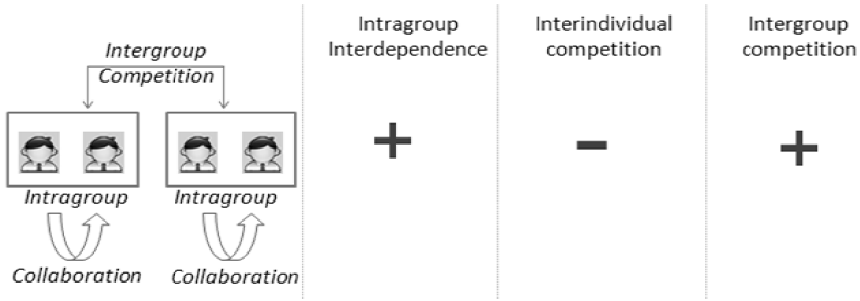

Figure 4. Intragroup cooperation and intergroup competition dynamics

6 Technological requirements for Collaborative GBL

In addition to the environment where students can collaborate, following Silverman (2001), there is a need for tools to help students focus on the creative parts of learning and problem-solving, especially in multi-player GBL. This statement implies that students cannot be left alone while playing; teachers and designers should find ways to support students' learning processes and, where possible, to allow the integration of learning tools and materials into activities. Therefore, in all the previously-mentioned dynamics found in multi-player GBL environments, we assume the need for technical tools and widgets that not only provide support but also enhance the learning process. These scaffolds will differ according to the category of game and must be designed or adapted to the objective of each game and to the players' interdependence within it. In the next section, we describe the specific requirements for supporting multi-player management in GBL, and the Group Awareness supports that could be considered for supporting the cooperative and competitive GBL dynamics.

There is evidence in the literature (e.g. de Freitas *et al*., 2010) that negative learning transfer may occur with some learners. In particular some game players find learning in virtual worlds problematic, and an expectation for high fidelity environments may also be associated with negative learning transfer. To avoid this, frameworks such as the four-dimensional framework and similar techniques can be adopted to get the right balance between fun and instructional design (de Freitas, & Oliver, 2006).

6.1 Technology supporting multi-player management

Multi-player learning environments designed to foster knowledge sharing and construction through playing should feature clearly separate communication zones for individual, intergroup and intra-group dynamics. An individual must have a private space but, at the same time, be able to communicate both to teammates and see how the other groups are performing. Multi-player games, especially those played in teams, must have tools that help and scaffold the group from its outset.

Firstly, the nature of the environment for the face-to-face or virtual activity has implications for techniques. As a form of Computer Mediated Communication (CMC), a computer-based game requires tools to make the player aware of others' evolution and results in the gaming process; this promotes student engagement and interaction (Repman, Zinskie, & Carlson, 2005). When playing in teams, the first element to be taken into account is the history of the group. Team genesis can differ depending on whether the team members are classmates or strangers. For this reason, multi-player SG should also present group creation tools, which help players in this process. Secondly, the nature of temporal interaction leads to differentiation between synchronous and asynchronous multi-player games. In the latter category, students have more freedom to access the game but need cues for acknowledgement of their teammates' progress or to have a clear image of where the other players or groups are in the game. Nova and colleagues (2007) focused on research into the possible effects of these tools on performance and on the representation that the individual players builds of his partners' knowledge, plans and intentions. The authors found that using awareness tools had a significant effect on improving task performance.

6.2 Technology supporting intragroup interdependence

From the examples and research outlined herein, we can postulate the need to support intragroup interdependence. This should be achieved through the design of techniques aimed at increasing common knowledge and setting the context for students to share different kinds of information in multi-player GBL activities.

While face-to-face game activities present a natural field for interaction, in computer-mediated multi-player GBL, contextual cues diminish and less information about peers' characteristics is available (Kiesler, Siegel, & McGuire, 1984). Research results in CSCL demonstrate that awareness tools providing information about highly cooperative group members encourage participants to trust one another and minimise the risk of being exploited (Cress, & Kimmerle, 2007).

Group Awareness (GA) is an important factor in collaborative online environments; it is defined as (Gutwin, & Greenberg, 1995) the updated knowledge of our peers' activities which is required for each individual to coordinate and complete his part of a group task. GA could therefore allow groups to be more effective. For collaborative GBL, small widgets have been specifically designed in order to permit GA (Romero, Usart, & Almirall, 2011; Usart, Romero, & Almirall, 2011).

The lack of contextual cues in computer-mediated multi-player GBL is a challenge to develop sound GA of teammates' knowledge. Computer-mediated knowledge can be very ambiguous and students tend to mirror their level of knowledge with their peers' knowledge (Nickerson, 1999). These aspects could hamper common learning objectives. Knowledge Group Awareness (KGA) is a representation of peers' knowledge that co-learners build in order to create a shared understanding of a task, a state of being informed about partners' knowledge and sharing this state of being informed. There is a need for compensation cues that can give real information about the knowledge of other group members, thereby providing KGA. KGA tools can also provide feedback about peers' knowledge and provide new insights into both the influence processes of group awareness and the connection of these processes to specific personality traits with respect to contribution behaviour (Dehler, Bodemer, Buder, & Hesse, 2011). Feedback has a special role to play in effective game-based learning environments, and immediate feedback may be one of the central reasons for efficacy (Dunwell, & de Freitas, 2011).

6.3 Technology supporting inter-individual and intergroup competition

Technology for enhancing the different kinds of awareness possibly involved in successful interactions in computer-mediated multi-player GBL should not be limited to intragroup communication. Awareness of other teams' performance in an intergroup competition environment must also be taken into account in the design and adaptation of SG. In contrast with collaboration tools, intergroup communication widgets are designed with the aim of promoting interaction with opponents, results and feedback, conflict situations including competition, challenge, opposition and conversation (Garris, Ahlers, & Driskell, 2002; Prensky, 2001; Zapusek, Cerar, & Rugelj, 2011). The outcomes related to the use of these tools are challenge, selection of an appropriate level of difficulty and better regulation of the probability of success or failure in competitive situations according to the players' competences (Vorderer *et al*., 2004).

A SG format in which these tools are typically used is races, where awareness of where other players or teams is important in order to know our own possibilities of winning the game. Additionally, players in virtual world activities often have access to maps and can view the position of the other players. An example can be seen in the multi-player SG *EnerCities* (Figure 5). This game was first developed for the web, but was ultimately deployed in *Facebook* so as to allow formation of a community of players who compete for the highest scores and share their experiences of the game. It has a scoring system that allows players to compare their scores and rankings with friends and build energy-saving cities.

Figure 5: EnerCities ranking

7 Lessons learnt in the use of multi-player GBL

Given the novelty of the multi-player GBL field, illustration of the techniques adopted for fostering players' awareness of different aspects of the game comes from single, fairly isolated examples. Significant attempts have been made, for instance, by Zea and colleagues (2009) to introduce collaborative activities into educational video games; they propose a set of design guidelines to make this introduction easier without losing playability. However, to the best of our knowledge, no complete collaborative GBL design exists that has a full set of communication tools. According to Nadolski and colleagues (2008), existing toolkits for commercial games present strong shortcomings when applied to SG, therefore a SG-specific tool set may be required. Ideally, implementation should account for both individual and group awareness and, as we have explained, should facilitate collaboration and competition.

Considering the importance of intragroup cooperation and the sense of belonging as one of the key factors of motivation and engagement in multi-player GBL (Bruffee, 1995; Hsu, Wen, & Wu, 2009;

Yee, 2006), game designers and educators using SG should consider this important mechanism to foster collaborative learning. These practice need to be analysed by researchers in order to better characterise the interdependence mechanisms in the different components of game mechanics, such as group composition, group organisation and role distribution, and the cooperative incentives of game rules. Further research into intragroup collaboration dynamics in SG must focus on design and implementation of tools that foster communication among teammates, both for synchronous and asynchronous scenarios. One aspect that should be taken into account is group history. It has been shown in studies that these are key elements for the solid evolution of a group of persons as a team in a process of team development. Distance between people and team development could be supported through interpersonal communication that promotes immediacy (Annetta, 2010). Therefore, tools designed for collaboration processes could help to improve learning outcomes in intragroup GBL scenarios.

For intergroup relationships, lessons learnt from CSCL and CSCW research can be used in order to implement a complete, collaboration-aware environment focused on enhancing competition aspects through information and knowledge sharing, considering both group history and individual and collaborative game performance. An example of this is *MetaTutor* (Azevedo *et al*., 2009), a metacognitive tool for enhancing self-regulated learning. It is based on a reward system which promotes sports-like competition among students (an approach that is increasingly being identified as "gamification") and aims to foster creativity through the exchange of knowledge.

With the careful implementation of tools supporting collaboration, pursuit of learning outcomes could be better guided right through the game activity. Therefore, SGs should be designed or adapted from both the pedagogical and technical points of view to ensure the monitoring of actions for each player and the group. In order to help learners reach their learning goals with less effort, optimize their time-on-task and enhance learning quality (Romero, & Barberà, 2011), we should consider support for collaborative learning from Group Awareness tools supporting (meta)knowledge elicitation and knowledge sharing processes. In addition to the multi-player design requirements related to the Group Awareness support, we should consider the level of internal and external regulation provided by the teacher. Multi-player games used with collaborative learning purposes can be externally regulated by a teacher, or could allow the player to a more self-regulated and co-regulated process during the game. Depending on the collaboration skills of the learners', the teacher should consider the level of external regulation more appropriate for the collaborative learning purposes. Following de Freitas and Jarvis (2006), the challenges related to the development of an effective SG can be accomplished if developers work with instructional designers, educators and learner groups, profiting from research findings to create more collaborative and interdisciplinary design approaches.

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