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MULTIPLAYER SERIOUS GAMES AND TEAM EFFECTIVENESS: THE IMPACT OF DIFFERENT MEDIA ON TEAM DYNAMICS

Departmental Coordinator: Prof. Laura FORMENTI, Ph.D.
Tutor: Dr. Fabrizia MANTOVANI, Ph.D.

PhD Dissertation by Luca ARGENTON
Personal ID no: 774782

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To my family and Laura

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Abstract

Introduction. Networking and team working are becoming the foundations of human performance in educational, organizational and recreational settings. Both the rapid development of Information and Communication Technologies (ICTs) and changes in the actual scenario have led to salient changes in the manner in which groups work, solve problems and communicate (Olson & Olson, 2003). People collaborate in virtual and dispersed teams with alternative non-hierarchical forms of leadership (Pearce, Conger, & Locke, 2008) so that nowadays, with rare exceptions, all organizational teams are virtual to some extent (Martins, Gilson, & Maynard, 2004). Thus, Virtual Teams (VTs), or geographically distributed groups who rely primarily on computer-mediated technologies to communicate, are becoming critical for the long-term competitiveness of organizations (Driskell, Radtke, & Salas, 2003; Schiller & Mandviwalla, 2007).

All of the major research in this area contends that VTs must use some type of Computer Mediated Communication (CMC). Among the different technologies that can support these processes, Serious Games (SGs) are acquiring a prominent role. By fostering continuous learning experiences blended with ludic and engaging affordances, SGs have in fact been able to shape new opportunities for individual and collective learning and training, showing a discrete effectiveness in different areas, such as education, industry, architecture, engineering, military and medicine. Further, SGs have been capable of influencing both individual and interpersonal experiences by fostering positive emotions, promoting engagement, as well as enhancing social integration and connectedness.

Aim. Despite the impressive growth of Serious Games applications, only a few of them have been tested and scientifically considered from an empirical point of view. Specifically, there is not much work reported concerning the effects of SGs on collaboration and team effectiveness, nor is there much evidence for the impact of different media on game-based team training. Moreover, as digital technologies continue to play an increasingly important role to foster both human learning and training processes, scholars have attempted to explain how user's perception of different media are formed and how media themselves influence performance outcomes

(Erdogan, 2009; Schilit, Golovchinsky, & Price, 1998). To address this challenge, authors have referred to the media-dependent perspective, claiming that the mechanical characteristics of media are the primary factors that may influence learning, task performance and communication (Daft & Lengel, 1984; a. R. Dennis & Valacich, 1999; Yoo & Alavi, 2001). Yet, there is not much work reported concerning the evaluation of the impact different communication settings and media conditions have on team processes and effectiveness. Further, multiplayer and collective game experiences are rarely taken into account.

Similarly, within the media-dependent perspectives, social and contextual factors are rarely considered (Yoo & Alavi, 2001). Therefore, a second trend of research has been focused on a more general social construction perspective of technology (Fulk, 1993; Guzzo, Yost, Campbell, & Shea, 1993; Klein & Kleinman, 2002; Kreijns, Kirschner, & Jochems, 2002). Here, researchers have evaluated how social factors influence user's perception of media, arguing that factors like cohesion among groups, group climate and organizational culture deeply influence the way in which media are used and selected (Agrell & Gustafson, 1994; Chin, Salisbury, Pearson, & Stollak, 1999; Kanawattanachai & Yoo, 2002). However, they have rarely considered the role of different media conditions. Therefore, while these two categories focus and address different aspects of communication media choice and use, a grater understanding can be gained by considering these findings together (Carlson & Zmud, 1999; Chidambaram, 1996; Yoo & Alavi, 2001).

Accordingly, the aim of the present work is to contribute to digital and SGs literature, synthesising these two perspectives, firstly by presenting the design and development of Mind the Game™, a multiplayer decision-making SG developed for a target of adult individuals to create a socio-technical environment (Fisher, Giaccardi, Eden, Sugimoto, & Ye, 2005) where the interconnection between humans and technology encourages the emergence of collaboration and team working. The game was developed from a scientific point of view, matching game design guidelines with the social psychological literature that focuses on inputs, processes and outputs (I-P-O) that influence group performance.

Secondly, we aimed at evaluating the potential of the game on group dynamics and game experience considering different media conditions. In a first empirical study, we will discuss the differences between digital SG technologies and paper-based application, with a specific focus on subjective game experience and group dynamics, like team cohesion and team potency. In a second study we will compare the effects of SGs played in face to face (FTF) and CMC situations, by deepening performance effectiveness in terms of collaborative problem-solving.

Method. In the first study, a total of 95 Italian students who attended a postgraduate specialization in sport medicine were randomly divided in 19 zero-history groups. While 10 groups played the digital version of Mind the Game, 9 experienced the paper-based version of the game. The *Game Experience Questionnaire* (GEQ) developed by Poels, De Kort, & Ijsselsteijn (2007, 2008) was used to assess users' subjective gaming experience. Other self-report questionnaires, like the *Team Potency Scale* (Guzzo et al., 1993), the *Perceived Cohesion Scale* (PCS) (Bollen & Hoyle, 1990; Chin et al., 1999), the *Group Climate Questionnaire* (GCQ) (Costantini et al., 2002) and the *Group Performance Evaluation Questionnaire* (GPEQ) (Comunian, 2004) were used to measure team dynamics.

In the second study, a total of 100 students, randomly divided in 20 groups of five people, played the game. Groups played Mind the Game in a FTF or in a CMC environment. Self-report psychometric scales, like the *PANAS* (Watson, Clark, & Tellegen, 1988) and the *VAS-A* (Hornblow & Kidson, 1976), were used to evaluate the impact the game had on players emotions, along with the *Social Presence Scale* (Gunawardena, 1995). To assess discourse management strategies, all the verbal transactions related to a specific game task were transcribed from the audio replay of all sessions. They were then segmented into individual communication acts and then coded by two coders according to the function they fulfilled in the group problem-solving processes using the Poole and Holmes (1995) *Functional Category System* (FCS).

In both studies, group performance measures, like *game scores* and the *time* needed to complete each task and the game as a whole, were considered too.

Results. In the first study, people who played the digital version of the game experienced higher level of immersion than players who experience the paper-based version of game. Secondly, digital players experienced higher level of positive affects and lower negative feelings than players who experienced the paper-based version of game. Thirdly, a positive relationship between social presence and group processes, with particular regard to team potency, sense of belonging and feelings of morale, was found.

In the second study, groups who played the game in the FTF condition focused more on orientation and solution development than players who experienced the CMC condition. Aligned with the *functional theory* (Li, 2007), that states that several critical task requirements have to be performed for a group to achieve high-quality decision making, results confirm differences in communication patterns between CMC and FTF groups while solving problems in terms of discourse management strategies (Condon & Cech, 1996; Hedlund, Ilgen, & Hollenbeck, 1998). However, results were controversial when considering team performance. On the one hand, groups who played the game in FTF conditions took shorter to complete the game than CMC groups and exhibited an higher frequency of communication. On the other, no relationship was found between the two conditions and the successful conclusion of the game. Similarly, no relationship was observed between the two conditions and the quality of the answers given by each groups.

Conclusion. Our research supported the media dependent and the social construction perspective as they showed that not only media conditions, but also social factors influence the way that group members perceive and use technology (Yoo & Alavi, 2001). The sociability of the game and sense of social presence are potential factors in the emergence of positive and engaging game experiences, at least in the context of collaborative games. Results also confirmed that games can elicit several emotional states (Anolli, Mantovani, Confalonieri, Ascolese, & Peveri, 2010) but also that digital technologies can empower the quality of emotional experiences (Botella et al., 2012; Serino, Cipresso, Gaggioli, & Riva, 2013; Wiederhold & Riva, 2012).

Further, they seemed to support researchers who have claimed that decision-making supported by computer-mediated systems can be as effective as it is in FTF settings when dealing with choosing and negotiating tasks (Pridmore & Phillips-Wren, 2012; Schmidt, Montoya-Weiss, & Massey, 2001).

Finally, the present work confirms that Mind the Game can be an optimal device to be used to assess, train and conduct experimental research on individuals and groups. On the one hand, it might be considered as a tool to both train and assess individual and social skills. Team and individual measures may be considered along with outcome and process measures. The game can , therefore, be used within training and empowerment programs that aims at facilitating team work and collaborative problem-solving. On the other, it can be used to maintain high levels of ecological validity and experimental control, giving the researcher the possibility to manipulate specific variables in everyday life environments. Therefore, it will represent an helpful resource for future studies and research not only in the field of SGs, but also for those who want to investigate small group performance and behaviours.

Introduction

Serious games (SGs) are digital games used for purposes other than mere entertainment. Since their infancy in the late 1990s, they have found important applications in different areas, such as education, industry, architecture, engineering, military and medicine, acquiring a prominent role in the actual knowledge society (Bergeron, 2006; Ritterfeld, Cody, & Vorderer, 2009). By fostering continuous learning experiences blended with ludic and engaging affordances, SGs have been able to shape new opportunities for individual and collective learning and training, showing a discrete effectiveness (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Girard, Ecalle, & Magnan, 2013; Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013). Therefore, they have supported the creation of socio-technical environments (Fisher et al., 2005), where the interconnection between humans and technology encourages the emergence of innovative ways of thinking, creative practices, and both individual and collective development.

In particular, SGs have provided successful answers to two specific challenges of education and training in the 21st century (Bekebrede, Warmelink, & Mayer, 2011; Prensky, 2003): (a) the presence of a new generation of learners and trainees grown up in a fully digitalized society and (b) the need for a more engaging and motivating way of imparting skills, knowledge, or attitude that can be used in the real world (Bergeron, 2006).

Both the rapid development of Information and Communication Technologies (ICTs) and changes in the actual scenario have led to salient changes in the manner in which people work, solve problems and communicate (Olson & Olson, 2003). Networking and team working are becoming the foundations of human performance in educational, organizational and recreational settings. Moreover, people collaborate in virtual and dispersed teams with alternative non-hierarchical forms of leadership (Pearce, Conger, & Locke, 2008) so that nowadays, with rare exceptions, all organizational teams are virtual to some extent (Martins, Gilson, & Maynard, 2004). Thus, Virtual Teams (VTs), or geographically distributed groups who rely primarily on computer-mediated technologies to communicate, are becoming critical for the long-term competitiveness of organizations (Driskell, Radtke, & Salas, 2003; Schiller & Mandviwalla, 2007).

All of the major research in this area contends that VTs must use some type of CMC. Gassmann and Von Zedtwitz (2003) defined VTs as groups of people and sub-teams who work across links strengthened by information, communication, and transport technologies. Similarly, Hertel et al. (2005) and Piccoli, Powell, & Ives (2004) suggest that VTs are distributed work teams whose members are geographically, organizationally and/or time dispersed, who coordinate their work predominantly with electronic information and communication technologies (e-mail, video-conferencing, telephone, etc.). Martins et al. (2004) argued that virtual are teams whose members use technology to varying degrees in working across locational, temporal, and relational boundaries to accomplish an interdependent task.

In the last twenty years, numerous SGs have been designed to promote team performance and collaboration in different fields, both for FTF and CMC groups. The military sector has led the way in the use of SGs for training team dynamics, first through an analysis of the opportunities related to the use of entertainment games, followed by the development of tailored SGs like *America's Army* (Bergeron, 2006). Within this field, military operational team training is increasingly conducted in flexible simulation training solution for scenario training and mission rehearsal.

Similarly, the training of first aid teams and emergency managers has been deeply supported by SGs solutions and applications (Harz, Stern, & Sparks, 2008). The same has happened in the medical field where many authors have acknowledged the role SGs have in the training of medical teams (Graafland, Schraagen, & Schijven, 2012; Mann et al., 2002; Michael & Chen, 2006; Peng, Lee, & Heeter, 2010).

Other good examples of SGs specifically designed for team training can be found in the field of organizational management and education (Bozanta, Kutlu, Nowlan, & Shirmohammadi, 2012; Hakkinen, Bluemink, Juntunen, & Laakkonen, 2012).

However, despite the impressive growth of SGs applications, only a few of them have been designed, tested and scientifically considered from an empirical point of view, especially by analysing their impact on team processes (Mayer, van Dierendonck, van Ruijven, & Wenzler, 2013). This is a major challenge for future research and investigation. Moreover, as digital technologies continue to play an increasingly important role to foster both human learning and training processes, scholars have attempted to explain how user's perception of different media are formed and how media themselves influence performance outcomes (Erdogan, 2009; Schilit, Golovchinsky, & Price, 1998). To address this challenge, authors have referred to the media-dependent perspective, claiming that the mechanical characteristics of media are the primary factors that may influence learning, task performance and communication (Daft & Lengel, 1984; a. R. Dennis & Valacich, 1999; Yoo & Alavi, 2001).Yet, there is not much work reported concerning the evaluation of the impact different communication settings and media conditions have on team processes and effectiveness. Moreover, multiplayer and collective game experiences are rarely taken into account.

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Accordingly, the aim of the present work is to contribute to digital and SGs literature, synthesising these two perspectives, firstly by presenting the design and development of Mind the Game™, a multiplayer decision-making SG developed for a target of adult individuals to create a socio-technical environment (Fisher, Giaccardi, Eden, Sugimoto, & Ye, 2005) where the interconnection between humans and technology encourages the emergence of collaboration and team working. As a new medium aimed at facilitating change (Riva, Castelnuovo, & Mantovani, 2006), the game generates a virtual environment where groups can express their potential, dealing with a reality that constantly redefines the balance between challenges and skills. This was studied to create a virtuous circularity that promotes collective experiences and high levels of perceived effectiveness, both in an individual and collective sense (Argenton et al., 2016).

Secondly, by evaluating the potential of the game on group dynamics and game experience considering different media conditions. Therefore, in a first empirical study, we will discuss the differences between digital SG technologies and paper-based applications, with a specific focus on subjective game experience and group dynamics, like team cohesion and team potency. In a second study we will continue our analysis, exploring another area that has not yet been deeply discussed within the SG literature. Despite the large body of literature on cooperative or collaborative behaviours, there is not much work reported comparing the effects of SGs played in face to face (FTF) and computer mediated communication (CMC) situations with a specific focus on collaborative problem-solving tasks. The study will aim at evaluating the impact of different media conditions on communication processes and performance in small group problem solving settings, studying how CMC and FTF situations affect emotions and social presence while playing the game.

Hence, the thesis will be divided in two main sections. The first one (chapter 1 and 2) will aim at presenting the theoretical framework used for the development of our research paradigm; the second will introduce Mind the Game™ (chapter 3) and two empirical researches (chapter 4-5).

Chapter 1 will discuss the main characteristics and effects of SGs on human education and training. By using the latest simulation and visualization technologies, SGs are in fact able to contextualize the player's experience in stimulating and realistic environments (situated cognition) (Bellotti et al., 2013) that foster practical learning experiences blended with ludic and engaging affordances. Here we will see how a key challenge within the SGs literature is to develop a workable classification of outcomes and impacts of playing games with respect to engagement, learning and other individual and collective skills. Specifically we will focus on affective, motivational and knowledge acquisition/content understanding, followed by perceptual and cognitive skills, behaviour change, and social/soft skills outcomes. Further, we will discuss how SGs can assist people to increase their well-being, physically, mentally and socially (Brooks et al., 2014) and why they can be considered as positive technologies.

In *chapter 2* we will focus on Virtual Teams (VTs), geographically distributed groups who rely primarily on computer-mediated technologies to communicate, are becoming critical for the long-term competitiveness of organizations (Driskell, Radtke,

& Salas, 2003; Schiller & Mandviwalla, 2007). The aim of the chapter is to deepen their nature and to discuss the main features of VTs considering the recent adaptations (Hedlund, Ilgen, & Hollenbeck, 1998; Marks & Panzer, 2004) of the input-process-outcome (I-P-O) framework, originally developed by McGrath (1964) and analysing which technologies can support VTs dynamics. We will see how VTs have specific strategic advantages and disadvantages. For instance, on the one hand, VTs can be organized according to members' expertise instead of local availability; they can work around the clock by having team members in different time zones, improving speed and flexibility in response to market demands and reducing travel expenses (Gassmann & von Zedtwitz, 2003; Lurey & Raisinghani, 2001). On the other hand, potential challenges may include difficulties to supervise team members' activities and to prevent unproductive developments in time, along with additional costs for appropriate technology, issues of data security, and additional training programs. Feelings of isolation and decreased interpersonal contact, increased chances of misunderstandings and conflict escalation, and increased opportunities of role ambiguity and goal conflicts due to commitments to different work-units, are elements that have to be taken in to account too (Algesheimer, Dholakia, & Gurau, 2011).

The *third chapter* will firstly introduce concrete examples of SGs that have been designed to promote team dynamics, focusing on different areas, like military, emergency and business. Secondly, it will discuss SG design practices, considering different guidelines or frameworks for designing multiplayer SGs (Sung & Hwang, 2013). In particular, we will analyse the model developed by Johnson and Johnson (2002) who identified five factors that are able to promote collaboration and collaborative learning (Barron, 2000) in a multiplayer environment: positive interdependence, individual accountability, promotive interaction, social skills and group processing. Eventually, it will introduce Mind the Game™, a multiplayer SG designed and developed to enhance team working and ingroup dynamics. Both the structure and the narrative affordances of the artefact will be deepened, considering game design practices. Embedding the potential of serious gaming, Mind the Game™ aims to expand the range of resources that groups can access in daily contexts, allowing a greater awareness of the skills possessed both individually and as a whole, and implementing an experiential learning process that supports shared optimal experiences.

Hence, the game can be considered as a useful tool to promote collaboration and team working among individuals, both for virtual and FTF teams.

The aim of the *fourth chapter* is to contribute to digital and serious games literature, synthesising the media-dependent and the social construction perspective of technology, evaluating the potential of digital game technologies compared to paper-based applications not only on individuals, but also among groups. This will allow our research to focus both on subjective game experience and group dynamics, like team cohesion and team potency. Specifically, the study will be developed with the aim of analysing a situation of zero-history groups interacting in a face-to-face (FTF) setting, where players deal with a multiplayer SG presented in a digital or a paper-based form. The research will have two main goals: (i) studying the impact different media have on game experience, group dynamics and performance; (ii) evaluating the relationship between social presence, game experience and group dynamics.

The *last chapter* will compare the effects of SGs played in FTF and CMC situations with a specific focus on collaborative problem-solving tasks. Therefore, in the study, we will compare communication patterns within zero-history groups that are supposed to collaboratively solving problems within a multiplayer SG via FTF interactions and via audio conferences, and therefore via CMC. The research will be based on two main goals: (i) evaluating the impact of different media conditions on communication processes in small group problem solving settings; (ii) studying how CMC and FTF situations affect emotions and social presence. Moreover, the study will use an empirical approach, supported not only by self-reported measures, but also by discourse analysis.

To conclude, this work present three specific areas of innovation. Firstly, it will present the design and implementation of a SG, developed considering both game design frameworks and guidelines, as well as the social psychological literature, with a particular focus on the inputs, processes and outputs (I-P-O) that influence group performance.

Secondly, it will evaluate its impact from an empirical point of view. While more of the studies that take into consideration SGs and the role of different media conditions within collaborative activities mainly used a qualitative and sociological perspective (Bowers, 1994; Harper & Sellen, 1995; Luff, Heath, & Greatbatch, 1992), our studies will use an empirical approach based not only on self-report measures, but also on discourse analysis. Further, multiplayer and collective game experiences are rarely taken into account.

Finally, it will contribute to digital and SGs literature, synthesising the media-dependent and social construction perspective of technology with a deep focus on how the medium impacts on game experience and group processes.

As a consequence, Mind the Game appears as an optimal device to be used to assess, train and conduct experimental research on individuals and groups. On the one hand, it might be considered as a tool to both train and assess individual and social skills. Team and individual measures may be considered along with outcome and process measures. Moreover, within an assessment perspective, the SG could be considered as an assessment tool itself, allowing an on-line evaluation of human behaviours, or it can be integrated with other assessment instruments.

On the other hand, it can be used to maintain high levels of ecological validity and experimental control, giving the researcher the possibility to manipulate specific variables in everyday life environments.

1. Serious Games for Individual and Group Flourishing: main characteristics and effects

Serious Games (SGs) are digital games used for purposes other than mere entertainment (Susi, Johanesson, & Backlund, 2007). By fostering continuous learning experiences blended with entertaining affordances, SGs have been able to shape opportunities for human training and empowerment. They have in fact supported the creation of socio-technical environments (Fisher et al., 2005), where the interconnection between humans and technology encourages the emergence of innovative ways of thinking, creative practices, and both individual and collective development.

Further, SGs are able to match real and virtual experiences building contexts that impart knowledge or skills in an engaging and motivating way (Zyda, 2005; Michael & Chen, 2006) to a new generation of learners grown up in a fully digitalized society. The use and effectiveness of SGs have been acknowledged in different areas, such as education, health, business and military both by the scientific literature and the concrete experience of players (Connolly et al., 2013; Wouters et al., 2013).

SGs are also able to address another important issue for the actual knowledge society: promoting health, wellness and happiness among individuals as well as proving to be strongly related to maintaining and restoring good health (Brox et al., 2011; McCallum, 2012; Stapleton, 2004; Wattanasoontorn et al., 2013). Thus, SGs can assist people to increase their well-being, physically, mentally and socially (Brooks et al., 2014). That is why they can be considered as "Positive Technologies" (Argenton, Pallavicini, & Mantovani, 2016; Argenton, Triberti, Serino, Muzio, & Riva, 2014).

Positive Technology is an emergent field based on both theoretical and applied research, whose goal is to investigate how Information and Communication Technologies (ICTs) can be used to empower the quality of personal experience (Botella et al., 2012; Serino, Cipresso, Gaggioli, & Riva, 2013; Wiederhold & Riva, 2012). Based on Positive Psychology theoretical framework (Seligman & Csikszentmihalyi, 2000), Positive Technology approach claims that technology can increase emotional, psychological and social well-being. Positive technologies can influence both individual and interpersonal experiences by fostering positive emotions, and promoting engagement, as well as enhancing social integration and connectedness.

Considering SGs as Positive Technologies opens a totally new perspective in the traditional digital gaming literature that has deeply investigated the negative impact of gaming, with respect to violence (Anderson et al., 2003; Gentile & Anderson, 2003; Wouters et al., 2013), addiction (Van Rooij et al., 2010; 2011) or social isolation (Colwell & Payne, 2000; Pezzeca, 2009).

Starting from an introductory analysis of the nature of SGs, this chapter will reflect on their main mechanisms and effects. Moreover, it will discuss how they can support, and train the optimal functioning of both individuals and groups, by contributing to their well-being.

1.1 Beyond learning: from edutainment to Serious Games

Edutainment and instructional computer games were once perceived as the saviour of education because of their ability to simultaneously entertain and educate (Charsky, 2010). Edutainment is in fact a neologism developed to indicate the attempt to support educational opportunities through the potential of entertaining solutions (Okan, 2003). Edutainment involves media programs that intentionally embed one or more educational issues in an entertainment format in order to influence audience members' knowledge, attitudes and behaviours (Papa et al., 2000). Chang (2011), for example, referred to edutainment as a set of activities that are based on a significant amount of visual materials, narrative solutions, ludic formats and informal teaching methods with the aim of implementing learning.

Within this framework, the use of video and computer games has soon acquired a prominent role. Scholars have started to talk of *game-based learning* and, more specifically, of *digital game-based learning* (DGBL). DGBL is a competitive activity in which students are set educational goals intended to promote knowledge acquisition (Erhel & Jamet, 2013a). Digital games may either be developed to promote learning or the empowerment of cognitive skills, or else take the form of simulations allowing learners to practice their skills in a virtual environment.

Mayer and Johnson (2010) argued that a DGBL environment should feature four main characteristics: (a) a set of rules and constraints, (b) a set of dynamic responses to the learners ' actions, (c) appropriate challenges enabling learners to experience a feeling of self-efficacy, and (d) gradual, learning outcome-oriented increases in difficulty. Similarly, Prensky (2003) highlighted that one of the medium's key characteristics is the “ *coming together* ” of serious learning and interactive entertainment: digital learning games can be regarded as an entertainment medium designed to bring about cognitive changes in its players.

The types of learning possible through digital games cover a broad spectrum. In particular, according to Prensky (2003b), games can promote learning and education by working of five specific aspects.

- The first level, known as *learning how*, leads players to discover informational, attitudinal or behavioural elements and to reflect on their parallelism between virtual and real environments.
- On a second level, players learn what to do instead (*learning what*). They understand and follow the rules that define the game progresses.
- Subsequently, users can focus on why (*learning why*), trying to identify the best strategies on how to proceed, balancing long and short-term outcomes, taking into consideration the consequences of their actions, being challenged to use their creativity and learning the importance of persistence.
- On the fourth level, the main element is concerned with the position (*learning where*): exploring the virtual environment players can become aware of cultural metaphors and images taken right from the real world.
- Finally, learning is focused on when and whether (*learning when / whether*). Here, players are challenged to make moral decisions and to define a hierarchy of values that will determine the progress of the game.

SGs seemed to perfectly fit these challenges. Stressing how gaming experience could be approached both in a serious or casual way, Abt (1987) pointed out that SGs are in fact games that have an explicit and carefully designed educational objective and that are not intended to be played primarily for amusement. They can leverage the power of computer games to captivate and engage end-users for a specific purpose, such as to develop new knowledge and skills (Corti, 2006). Hence, SGs applications can foster engaging and immersive learning experiences, working as cognitive tools that users can discover and manipulate in order to make learning more productive stimulating and to stimulate the achievement of specific goals (Whitton, 2010). They are in fact able to situate meaning in a multimodal space through embodied experiences that help players not only to solve problems and to think about the plots and intrigues of the virtual world, but also to develop a deeper understanding of personal identity and social relationships of the real world (Gee, 2003).

1.1 Nurturing the educational purpose of Serious Games

The educational purpose of SGs does not necessarily have to be in the game's design, but can be assigned to the game by the context it is used or embedded in. What this means is that for example a board game originally designed for fun can be used in a military training context to teach strategic thinking and the principles of tactical warfare (Breuer & Bente, 2010). While the learning process takes place via the game, the effect intended by it may well be an exogenous one. This has brought three significant changes: (a) the shift from a teacher-centred approach to a learner-centred approach, (b) the shift from a model of instruction based on listening to a model of instruction based on doing and interaction, and (c) the shift from a concept of learning based on memory to a concept of learning based on the capacity to find and use information (Guillén-Nieto & Aleson-Carbonell, 2012). However, the simple use of gaming affordances does not make an educational process more effective. For this to happen a number of criteria must be satisfied:

- Building a intrinsically motivating and inspiring format based on elements capable of tickling curiosity and imagination, that users can control and master (Lindley, 2005)
- Establishing an experiential frame where users are actively challenged to learn by doing (Kolb, 1984). The underlying mechanisms of edutainment are in fact focused on a drill-and-practice dynamism rather than on simple understanding (Stapleton, 2004), conveying a form of learning, which promotes the acquisition, retention and deployment of a wide range of skills. Concrete experience triggers a virtuous circularity that initially engage users in developing reasoning, making inferences and hypotheses, and showing a *reflective observation*. By an *abstract conceptualization* these cognitive inputs are anchored to the semantic structures present in the mnestic apparatus, eliciting specific mental associations. In this way, the knowledge can be act in concrete behavioural outcomes and users have the opportunity to put into practice what they have learned and to learn from the practice itself (Clark, 2007).

- Promoting the contact with a new semiotic domain, that increases the possibility of learning by experiencing the world in a different way, accessing participatory and collaborative dynamics, directly acquiring learning resources and the ability to solve complex problems (Gee, 2003).
- Paying attention to the target, demonstrating flexibility and the ability to structure stimulating challenges on the basis of capacity perceived (Csikszentmihalyi, 2000).

1.2 Beyond edutainement: a new focus on training and change

The widespread diffusion edutainment has known since the 90s, largely in tertiary education and in high school, seems to have limited its opportunities and advantages to academic settings only. Further, despite some authors are using the concepts of edutainment and SGs as synonyms (Ulicsak, 2010), there are scholars that prefer to refer to SGs as category that is not fully exhausted by edutainment (Bergeron, 2006; Girard et al., 2013; Marsh, 2011). For example, according to Corti (2006), the motivational virtues of video games are what initially entice training and development professionals to turn to game-based approaches, but there is a lot more to game based learning/SGs than simply using fun as a means to engage learners. Similarly, Michael and Chen (2006) disagree and postulate that SGs are more than just edutainment. While all edutainment games are certainly SGs, the body of SGs extends beyond edutainment, enveloping almost every digital game that has a purpose in addition to entertainment (Ritterfeld, Cody, & Vorderer, 2009).

SGs are in fact a genre that goes beyond traditional modes of teaching and learning as stated before, focusing on training and change. While early attempts in edutainment focused on teaching facts mainly through rote memorization, SGs have a broader potential (Michael & Chen, 2006). The term "SG" itself came into wide use with the emergence of the SGs Initiative in 2002 (Susi et al., 2007). The web-site of the serious games initiative provides the following description of SGs: "The SGs Initiative is focused on uses for games in exploring management and leadership challenges facing the public sector. Part of its overall charter is to help forge productive links between the electronic game industry and projects involving the use of games in education, training, health, and public policy."

Similarly, Marsh (2011) defined SGs as digital games, simulations, virtual environments and mixed reality/ media that provide opportunities to engage in activities through responsive narrative/story, gameplay or encounters to inform, influence, for well-being, and/or experience to convey meaning. According to this view, edutainment games then become those games within the SGs family which are mainly developed for use in K-12 education, have a focus on the conveyance of curricular textbook knowledge and rather pursue additive combinations of entertainment and education in a motivator or reinforcement paradigm as described above (Breuer & Bente, 2010).

1.3 Serious Games as socio-technical environments

SGs use their characteristics to provide users not only with an authentic learning experience where the entertainment and learning are seamlessly integrated (Gee, 2003, 2005; Prensky, 2001), but also by training their main skills. By fostering continuous learning experiences blended with entertaining affordances, SGs have been able to shape opportunities for human training and empowerment. They have in fact supported the creation of socio-technical environments (Fisher, Giaccardi, Eden, Sugimoto, & Ye, 2005) where the interconnection between humans and technology encourages the emergence of innovative ways of thinking, creative practices, and both individual and collective development.

Moreover, SGs are able to match real and virtual experiences building contexts that impart knowledge or skills in an engaging and motivating way (Zyda, 2005; Michael & Chen, 2006) to a new generation of learners grown up in a fully digitalized society. In particular, SGs have provided successful answers to two specific issues of education and training in the 21st century (Bekebrede, Warmelink, & Mayer, 2011; I. S. Mayer, van Dierendonck, van Ruijven, & Wenzler, 2013; Prensky, 2003a) : (a) the presence of a new generation of learners and trainees grown up in a fully digitalized society and (b) the need for a more engaging and motivating way of imparting skills, knowledge, or attitude that can be used in the real world (Bergeron, 2006).

The use and effectiveness of SGs have been acknowledged in different areas, such as education, health, business and military both by the scientific literature and the concrete experience of players (Connolly et al., 2013; Wouters et al., 2013). Drawing on the literature of SGs over the last decade, they have particularly emphasized three main reasons for the ever-increasing use of SGs (Bellotti, Kapralos, Lee, Moreno-Ger, & Berta, 2013; Bergeron, 2006; Guillén-Nieto & Aleson-Carbonell, 2012): (a) they use actions rather than explanations and create personal motivation and satisfaction, (b) they accommodate multiple learning styles and abilities, and (c) they foster decision-making and problem-solving activities in a virtual setting. Some of the potential advantages of using SGs in professional and educational contexts have also been examined by Ritterfeld et al. (2009). These are: (a) massive reach, (b) experiential learning, (c) enquiry-based learning, (d) self-efficacy, (e) goal setting, (f) cooperation, (g) continuous feedback, (h) enhanced brain chemistry, and (i)time on task.

2. Serious Games: their impact on human mind and behaviour

It is clear that playing digital games leads to a variety of positive outcomes and impacts but it is also acknowledged that the literature on games is fragmented and lacking coherence (Connolly et al., 2012). For example, a key challenge within the SGs literature is to develop a workable classification of outcomes and impacts of playing games with respect to engagement, learning and other individual and collective skills. According to the meta-analysis developed by Girard et al. (2013), the most frequently occurring outcomes reported were affective and motivational and knowledge acquisition/content understanding, followed by perceptual and cognitive skills, behaviour change, physiological outcomes and social/soft skills outcomes.

2.1 Motivation

Previous reviews, (Garris, Ahlers, & Driskell, 2002), argued that SGs motivate players to continue and subsequently it is alleged that this feature can be useful for the purpose of learning but recent research on motivation is scant and controversial.

According to Prensky's (2001), the new generations of learners is more willing to spend time training with video games and SGs because they are used to and enjoy playing, given that VGs have been part of their everyday lives since a young age. In other words, people today are fascinated and stimulated by virtual words, which are engaging and entertaining to play (Anderson et al., 2003; Bekebrede et al., 2011; Connolly et al., 2012; Wrzesien & Raya, 2010). They are therefore more motivated by game-based than by traditional learning methods. For example, according to some authors (Girard et al., 2013; Wrzesien & Raya, 2010), SGs boost intrinsic motivation in players (desire for challenging, independent mastery and curiosity) that are consequently more engaged in the learning process and learn more than they do using traditional teaching methods. Tuzun, Yilmaz Soylu, Karakus, Inal and Kizilkaya (2009) compared a group playing SGs with traditional school learning on intrinsic and extrinsic motivation. They found some evidence that students in the game group were more intrinsically motivated, whereas students in the traditional school setting were more extrinsically motivated. Papastergiou (2009) compared a non-game version and a game version of two equivalent applications, finding that students in the experimental group not only considered the game-based application to be more attractive and more educationally effective, but also acquired more knowledge than the students in the control group. In a study made by Parchman et al. (2000) within the military field, a motivation questionnaire was used to compare trainees' motivation of four groups: a game group, classical instruction, and computer-based practice-and-drill or enhanced instruction. Subjects within the game group were more attentive to the contents than the classical instruction and computer-based practice-and-drill group. However, no differences were observed between the game and computer-based enhanced instruction groups (Wouters et al., 2013). Similarly, despite some authors (Wijers, Jonker, & Kersgens, 2008) highlighted that students found a game motivating for learning maths, others observed that students did not find a mobile game motivating for learning history (Akkerman, Admiraal, & Huizenga, 2009).

Further, the results of meta-analysis made by Wouters et al. (2013) show that SGs are not more motivating than the instructional methods used in the comparison group. The authors identify three plausible arguments to explain such a result.

- Firstly, an essential difference between leisure computer games and SGs is that the former are chosen by the players and played whenever and for as long as they want, whereas the type of game that is used and the playing time are generally defined by the curriculum in the case of SGs. Since autonomy supports intrinsic motivation (Ryan & Deci, 2000), conditions that limit the sense of control or freedom of action may undermine intrinsic motivation (Deci, Koestner, & Ryan, 1999). In serious games, the level of control is twofold: it is applicable to actions and decisions within the game but also to the instructional context, where decisions about issues such as the type of game and when to play the game have to be made.

- Secondly, authors argue that the lack of motivational appeal can be a reflection of the fact that the world of game design and that of instructional design are not yet integrated. Several dimensions that have to be resolved in order to create really engaging SGs, such as learning versus playing or freedom versus control, have been outlined and they do not facilitate users' immersion within the game (Nacke & Lindley, 2009).
- Finally, the third explanation discusses the methods that are commonly used for the measurement of motivation, generally based only on questionnaires and surveys after game play. Physiological or behavioral measures such as eye tracking and skin conductance seem to be more appropriate methods, because they can be collected during game play and further research needs to be done.

2.2 Knowledge acquisition

Numerous SGs have been developed to support the acquisition of knowledge across a range of different curricular areas (Bellotti, Berta, De Gloria, & Zappi, 2008; Connolly et al., 2012; DeSmet et al., 2014). While Papastergiou (2009) highlighted the improvement in performance on computer memory concepts, Miller et al. (2011) tested the power of a web-based forensic science game noting that gain scores from pre-test to a delayed post-test indicated significant gains in content knowledge on a sample of more than 600 students. Similarly, Brom, Preuss, & Klement (2011) observed that game-playing improved retention of knowledge practiced by a game developed to reinforce part of the knowledge learnt during a lecture on the topic of animal training.

Also Beale, Kato, Marin-Bowling, Guthrie, & Cole (2007) found better performance on cancer-related knowledge following use of a SG for adolescents and young adults with cancer. However, these results are not always confirmed by the literature. For example, Sward and colleagues (Sward, Richardson, Kendrick, & Maloney, 2008) found no difference in performance between students using an online game and students using computerised flash cards in their mastery of paediatric knowledge, although students preferred learning with the game and enjoyed it more. Erhel and Jamet (2013) found that introducing a competitive game-based approach into a knowledge acquisition game about the physiology and functions of the human heart did not in itself lead to improved performance, but including feedback about the accuracy of response did. Meluso and colleagues (2011) investigated the effects of collaborative and single game player conditions on science content learning and science self-efficacy. Results indicated that there were no differences between the two playing conditions; however, when conditions were collapsed, science content learning and self-efficacy significantly increased. Future research should focus on the composition of collaboration interaction among game players to assess what types of collaborative tasks may yield positive learning gains.

2.3 Perceptual, motor and cognitive skills

With regards to the digital gaming literature, there is strong evidence that players of digital entertainment games display a range of visual, perceptual and attentional advantages compared with non-game players. Barlett and colleagues (2009) highlighted the impact of games on a broader range of cognitive skills: they found that playing video games for even a short time could enhance performance on working memory, auditory perception and selective attention tasks. Similarly, Terlecki and Newcombe (2005) found that the use of computers including computer games mediated gender differences in mental rotation ability, while

Hogle et al. (2008) compared a group who practiced laparoscopic skills using a simulator with a group who did not. They found mixed results with performance enhancement on depth perception and operative performance but no difference on four other measures. They also found that students with experience of playing video games learned faster but did not perform better than non-video game players. Accordingly, Stefanidis and colleagues (2008) found improvements in students' performance with a simulator but that achieving automaticity on a secondary task required a long training period.

2.4 Soft Skills

Despite authors such as Dondlinger (2007) and Dede (2000) have suggested that games have the potential to support soft skills, the literature is still lacking scientific evidences. Backlund and colleagues (2008) found that a driving simulator increased self-efficacy in driving compared with a control condition.. Assmann and Gallenkamp (2009) found that perceptions of leadership trustworthiness were affected by culture, high self-disclosure and intensive use of communication media. Hämäläinen, Oksanen and Hakkinen (2008) carried out a qualitative analysis of the functions of utterances between game players in a virtual 3D online SG while they worked together in a team to solve problems about work safety in construction work. This paper was interesting in showing how structured support can be used in games to prompt players about what to do next at different phases in the game. It also demonstrated the use of games in an activity which would not have been possible in a traditional classroom setting.

2.5 Behaviour change

SGs are emerging as a new medium for social change. A comprehensive model of learning for behaviour change in video games is based on social cognitive theory (SCT) and the elaboration likelihood model and includes the following steps: attention, retention, production, and motivation (Petty & Cacioppo, 1988). The elaboration likelihood model proposes that gaining and maintaining a person's attention is the first step in getting a person to process the information in a message to promote behaviour change. SCT proposes that behaviour change is a function of enhanced skills and confidence (self-efficacy) in doing the new behaviour, while modelling and feedback are keystones for learning skills (Bandura, 1986). Games blend all these elements with the component of fun and entertainment, showing a discrete effectiveness in promoting behaviour change (Baranowski, Buday, Thompson, & Baranowski, 2008).

Hence, while games for learning have been developed to teach various subjects and high-level cognitive skills (Prensky, 2003b), there are SGs that focus on behavioural change. These are games for health and for social change. The former have been developed to promote health-related behavioral changes (Lieberman, 2006; Peng & Liu, 2008). These games are set in a variety of health domains, including promoting healthy nutrition (Amaro et al., 2006), safe sexual behaviors (Wattanasoontorn et al., 2013), anti-smoking (Lieberman, 2001), injury prevention (Goodman, Bradley, Paras, Williamson, & Bizzochi, 2006), and early treatments for heart attack (McCallum, 2012). We will deepen them in the final part of the chapter.

The latter focus on persuasion, such as forming or changing attitudes about political or religious agendas, or simply increasing awareness of social issues. For instance, *PeaceMaker* is a political game in which players can take the role of either the Israeli Prime Minister or the Palestinian President to deal with a variety of events, including diplomatic negotiations, suicide bombers, and interaction with eight other political leaders, so as to reach a peaceful agreement for both sides. By facilitating role-taking from both sides, this game intends to provide a unique opportunity to inform people of the issues in the region and influence their attitudes toward the other side. Using an empirical approach, Jouriles et al. (2009) evaluated whether a SG could enhance the effects of role plays designed to help college women resist sexual attacks. Sixty-two female undergraduate students were randomly assigned to either a Role Play (RP) or Virtual Role Play (VRP) conditions.

A multi-method assessment strategy indicated that their innovative virtual reality, role-playing game helped young women to develop behavioural strategies for resisting untoward sexual advances. Peng, Lee, & Heeter (2010) studied the effects of a SG on role-taking and willingness to help of people plying *The Darfur is dying*. Game playing resulted in greater role-taking and willingness to help than game watching and text reading. Lavender (2008) developed a game "*Homeless: It's No Game*" to determine whether people could be persuaded to become more sympathetic to the plight of the homeless by playing the role of a homeless woman. Results were mixed, with some indicators showing an increase in sympathy towards the homeless and others showing no significant effect.

3. Serious Games as Positive Technologies

SGs have also been capable of supporting wellness and promoting positive emotions. That is why they can be considered as "positive technologies" (Argenton et al., 2014). Positive Technology is an emergent field based on both theoretical and applied research, whose goal is to investigate how Information and Communication Technologies (ICTs) can be used to empower the quality of personal experience (Botella et al., 2012; Riva, Baños, Botella, Wiederhold, & Gaggioli, 2012; Wiederhold & Riva, 2012). Based on Positive Psychology theoretical framework (Seligman & Csikszentmihalyi, 2000), Positive Technology approach claims that technology can increase emotional, psychological and social well-being. This assumption opens a totally new perspective in the traditional digital gaming literature that has deeply investigated the negative impact of gaming, with respect to violence (Anderson et al., 2003; Gentile & Anderson, 2003; Wouters et al., 2013), addiction (Van Rooij, Meerkerk, Schoenmakers, Griffiths, & van de Mheen, 2010; Van Rooij, Schoenmakers, Vermulst, Van Den Eijnden, & Van De Mheen, 2011) or social isolation (Colwell & Payne, 2000; Pezzeca, 2009). The aim of this paragraph is to discuss the role of SGs as positive technology, analysing how they can influence both individual and interpersonal experiences by fostering positive emotions, promoting engagement, as well as enhancing social integration and connectedness.

3.1 From Positive Psychology to Positive Technology

Positive Technology is the scientific and applied approach to the use of technology for improving well-being and the quality of personal experience (Botella et al., 2012). This approach is strongly based on Positive Psychology framework that emerged as the scientific study of positive personal experience, positive individual traits, and positive institutions (Seligman & Csikszentmihalyi, 2000; Seligman, 2003). By focusing on human strengths, healthy processes, and fulfillment, Positive Psychology aims to improve the quality of life, as well as to increase wellness, and resilience in individuals, organizations, and societies (Delle Fave, Massimini, & Bassi, 2011; Seligman, Steen, Park, & Peterson, 2005). Rather than representing a new formal sector or a new paradigm, Positive Psychology is a novel perspective to studying human behavior where the link with accurate and scientific methodological practices (Seligman et al., 2005) has become the engine of interventions to study and promote the optimal expression of thought, emotions and behaviors. In particular, Keyes and Lopez (2002) argued that positive functioning is a combination of three types of well-being: (i) hedonic or emotional well-being, (ii) eudaimonic or psychological well-being, and (iii) social well-being. This means that Positive Psychology is mainly focused on three characteristics of personal experience: affective quality, engagement/actualization, and connectedness.

Based on Positive Psychology assumptions, Positive Technologies can be used to manipulate the quality of human experience through its structuring, augmentation and/or replacement in order to generate well-being at these three key levels (Botella et al., 2012; Wiederhold & Riva, 2012). As a consequence, Positive Technologies can be classified as follow:

- *Hedonic technologies*: mood-altering devices, which use ICTs to induce positive and pleasant experiences;
- *Eudaimonic technologies*: systems designed to support individuals in reaching engaging and self-actualizing experiences;
- *Social /interpersonal technologies*: technologies that seek to improve the connectedness between individuals, groups, and organizations.

The hedonic side of Positive Technology analyzes the ways technologies can be used to produce positive emotional states. Unlike negative emotions that are essential to provide a rapid response to perceived threats, positive emotions can expand cognitive-behavioral repertoires and help to build resources that contribute to future success, as highlighted by the "broaden-and-build" model (Fredrickson, 2000, 2001). According to Fredrickson, positive emotions broaden, on the one hand, the organism's possibilities with undefined response tendencies that may lead to adaptive behaviors and mitigate the impact of negative stressors. The elicitations of positive emotions, for example, make attentional processes more holistic and gestaltic (Fredrickson & Branigan, 2005), stimulate a more flexible, intuitive, receptive and creative thinking (Fredrickson, Mancuso, Branigan, & Tugade, 2000). Moreover, by encouraging a broadened range of actions, positive emotions build over time enduring physical, psychological, and social resources. For example, correlation with a faster recovery from cardiovascular diseases (Fredrickson & Levenson, 1998), an increase of immune function and lower levels of cortisol have been highlighted (Tugade & Fredrickson, Fredrickson, 2004). Moreover, the presence of positive emotions is an effective predictor of the level of happiness of individuals (Fredrickson & Joiner, 2002) and longevity (Pressman & Cohen, 2005), triggering a virtuous circle, that implements the possible use of other positive experiences.

Different devices have proven to be effective from this point of view. For example, the Butler Project, a technological e-health platform designed to deliver health care to the elderly (Botella et al., 2009) appeared to be effective in promoting positive emotions and decreasing negative feelings. The platform is able to support user experience on three levels: diagnosis (mood monitoring, alert system, management reports), therapy (training in inducing positive moods, memory work), and entertainment (e-mail, chat, video, photo albums, music, friend forums, accessibility to the Internet). Other studies explored the potentiality of emerging mobile devices to exploit the potential of positive emotions (Serino et al., 2013). For instance, Grassi, Gaggioli, & Riva (2009), showed that relaxing narratives supported by multimedia mobile phones were effective to enhance relaxation and reduce anxiety in a sample of commuters. Further, the role of emotions in human-computer interaction has been deepened by emerging trends such as engineering aesthetics (Liu, 2003; Locher, Overbeeke, & Wensveen, 2010; Sonderegger & Sauer, 2010). Since aesthetic experiences are those that are immersive, infused with meaning, and felt as coherent and complete (Parrish, 2009), this approach is focused understanding how interfaces on the creation of artifacts that are attractive and pleasurable. In a study made by Sonderegger & Sauer (2010), two functionally identical mobile phones were manipulated with regard to their visual appearance (highly appealing vs not appealing) to determine the influence of appearance on perceived usability, performance measures and perceived attractiveness. Results showed that the visual appearance of the phone had a positive effect both on and the perception of usability and performance, leading to reduced task completion times for the appealing models.

On the basis of Russell’s model, many researchers have acknowledged the possibility to modify the affective quality of an experience by manipulating the “core affect” (Russell & Barrett, 1999; Russell, 2003). This is a neurophysiological state corresponding to the combination of hedonic valence and arousal that endows individuals with a sort of “core knowledge” about the emotional features of their emotional experience. The "core affect" can be experienced as freefloating (mood) or attributed to some causes (and thereby begins an emotional episode). In this view, an emotional response is the attribution of a change in the core affect given to a specific object (affective quality).

Recent researches showed that the core affect could be manipulated by Virtual Reality (VR). In particular, Riva and Colleagues tested the potentiality of Virtual Reality (VR) in inducing specific emotional responses, including positive moods (Riva et al., 2007) and relaxing states (Villani, Lucchetta, Preziosa, & Riva, 2009; Villani, Riva, & Riva, 2007). Other studies have combined Mood Induction Procedures (procedures designed to provoke transitional mood states in non-natural situations in a controlled manner) (Velten, 1968) with Virtual Reality to induce positive emotions, like happiness and relaxation (Baños et al., 2006). As noted by Serino and colleagues

(Serino et al., 2013), the potential advantages of using VR technology in inducing positive emotions are essentially two:

- *Interactivity*, to motivate participants, including video and auditory feedback;
- *Manipulability*, to tailor each session in order to evaluate user's idiosyncratic characteristics and to increase task complexity as appropriate.

The second area positive technologies are strongly connected is eudaimonic well-being. Eudaimonic well-being is associated with the possibility to fully realize human potential through the exercise of personal virtues in pursuit of goals that are meaningful to the individual and society (Delle Fave et al., 2011). Thus, this approach focuses on the growth of individuals as a whole, rather than merely emphasizing the pursuit to pleasure and comfort. Happiness no longer coincides with a subjective form of well-being, but with a psychological one. This is based on 6 elements (Diener, 2000; Diener, Sapyta, & Suh, 1998; Pavot & Diener, 2008):

- *Self-acceptance*, characterized by awareness and a positive attitude towards personal qualities and multiple aspects of the self, including unpleasant ones;
- *Positive relationships with others*, determined by the ability to develop and maintain social stable relationships and to cultivate empathy, collaboration and mutual trust;
- *Autonomy*, reflected by the ability of seeking self-determination, personal authority, or independence against conformism;
- *Environmental Mastery*, based on the ability to change the external environment, and to adapt it to personal needs or goals;
- *Purpose in life*, marked by the presence of meaningful goals and aims in the light of which daily decisions are taken;

  Personal growth, achievable throughout a continuous pursuit of opportunities for personal development.

Another author that has fully interpreted the complexity of the eudaimonic perspective is Positive Psychology pioneer Mihaly Csikszentmihalyi who formalized the concept of flow . The term expresses the feeling of fluidity, and continuity in concentration and action reported by most individuals in the description of this state

(Csikszentmihalyi, 1991). In particular, flow, or optimal experience, is a positive, complex and highly structured state of deep involvement, absorption, and enjoyment (Jackson & Csikszentmihalyi, 1999). The basic feature of this experience is a dynamic equilibrium perceived between high environmental action opportunities (challenges) and adequate personal resources in facing them (skills). Additional characteristics are deep concentration, clear rules and unambiguous feedback from the task at hand, loss of reflective self-consciousness, control of one's actions and environment, alteration of temporal experience, and intrinsic motivation.

Scholars in the field of human–computer interaction are starting to recognize and address the eudaimonic challenge too. For example, Rogers calls for a shift from ''proactive computing'' to ''proactive people,'' where ''technologies are designed not to do things for people but to engage them more actively in what they currently do''(Rogers, 1990). Moreover, the theory of flow has been extensively used to study user experience with Information and Communication Technologies. It is the case of internet (Chen, Wigand, & Nilan , 2000), virtual reality (Sanchez-Vives & Slater, 2005), social networks (Mauri, Cipresso, Balgera, Villamira, & Riva, 2011), and video-games (Admiraal, Huizenga, Akkerman, & Dam, 2011; Jegers, 2007; Nacke & Lindley, 2009). In fact, all these media are able to support the emergence of a flow state, as they offer an immediate opportunity for action, and the possibility to create increasingly challenging tasks, with specific rules, as well as the opportunity to calibrate an appropriate and multimodal feedback.

In addition, some researchers have drawn parallels between the experience of flow and the sense of presence, conceived as the subjective perception of "being there" in a virtual environment (Slater, 1999). Both experiences have been described as absorbing states, marked by a merging of action and awareness, loss of self-consciousness, and high involvement and focused attention on the ongoing. On these premises, Riva and colleagues postulated the power of "transformation-of-flow"-based strategies (Riva et al., 2012). They can be conceived as individuals' ability to draw upon an optimal experience induced by technology, and to use it to promote new and unexpected psychological resources and sources of involvement.

At the third level, the challenge for Positive Technology is concerned with the use of new media to support and improve the connectedness between individuals, groups, and organizations, and to create a mutual sense of awareness. This is essential to the feeling that other participants are there, and to create a strong sense of community at a distance. Short and colleagues (Short, Williams, & Christie, 1976) introduce the term "social presence" to indicate the degree of salience of the other person in a mediated environment and the consequent salience of their interpersonal interaction. On this point, Riva and colleagues (Riva et al., 2007) argued that an individual is present within a group if he/she is able to put his/her own intentions (presence) into practice and to understand the intentions of the other group members (social presence). Techniques to promote such a "sense of being with another" throughout a medium have a long history, going back to the first stone sculptures that evoked a sense of some other being in the mind of an ancestral observer.

Assembling these basic concepts with the potential of the World Wide Web in its most recent version (web 2.0), enterprise 2.0 was born in the business context. It implies the emerging use of social software platforms within companies to facilitate the achievement of business objectives (McAfee, 2009). Thus, Enterprise 2.0 allows to work on reputation, (by both monitoring the internal reality of the organization, and identifying the dynamics implemented by external stakeholders and audiences), collaboration (by developing internal communities), communication (by stimulating the development of interactive exchanges), and connectedness (by enriching the relational and logical transmission of information).

Other interesting phenomena linked to the interpersonal dimension are crowdsourcing and Collaborative Innovation Networks (COINs). The former represents an online, distributed problem-solving and production model that indicates the procurement of a set of tasks to a particularly broad and undefined group of individuals, called to collaborate through Web 2.0 tools (Estelles-Arolas & Gonzalez-Ladron-de-Guevara, 2012). The latter, indicates a "cyber-team of self-motivated people with a collective vision, enabled by the Web to collaborate in achieving a common goal by sharing ideas, information and works" (Gloor, 2007).

The aforementioned technologies can promote the development of a peak collaborative state experienced by the group as a whole and known as “networked flow” (Gaggioli, Riva, Milani, & Mazzoni, 2013). Sawyer (2003, 2008), who referred to this state with the term of group flow, identified several conditions that facilitate its occurrence: the presence of a common goal, close listening, complete concentration, control, blending egos, equal participation, familiarity, communication and the potential for failure. As noted by Gaggioli and colleagues (2013), networked flow occurs when high levels of presence and social presence are matched with a state of "liminality". In particular, three pre-conditions have to be satisfied:

- Group members share common goals and emotional experiences so that individual intentionality becomes a *we-intention* able to inspire and guide the whole group;
- Group members experience a state liminality, a state of "being about" that breaks the homeostatic equilibrium previously defined;
- Group members identify in the ongoing activity the best affordances to overcome the situation of liminality.

3.2 Serious Games to promote well-being

As noted by the World Health Organization (1948), health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. SGs have proven to be strongly related to maintaining and restoring good health (Brox et al., 2011; McCallum, 2012; Stapleton, 2004; Wattanasoontorn et al., 2013). For example, according to the taxonomy proposed by Wattanasoontorn and colleagues (2013), they can support patients by monitoring health, detecting irregular symptoms, treating physical and mental issues and contributing to the rehabilitation process. Further, SGs can assist people to increase their well-being, physically, mentally and socially (Brooks et al., 2014). As a consequence, they are able to address the three main challenges identified by Positive Technology.

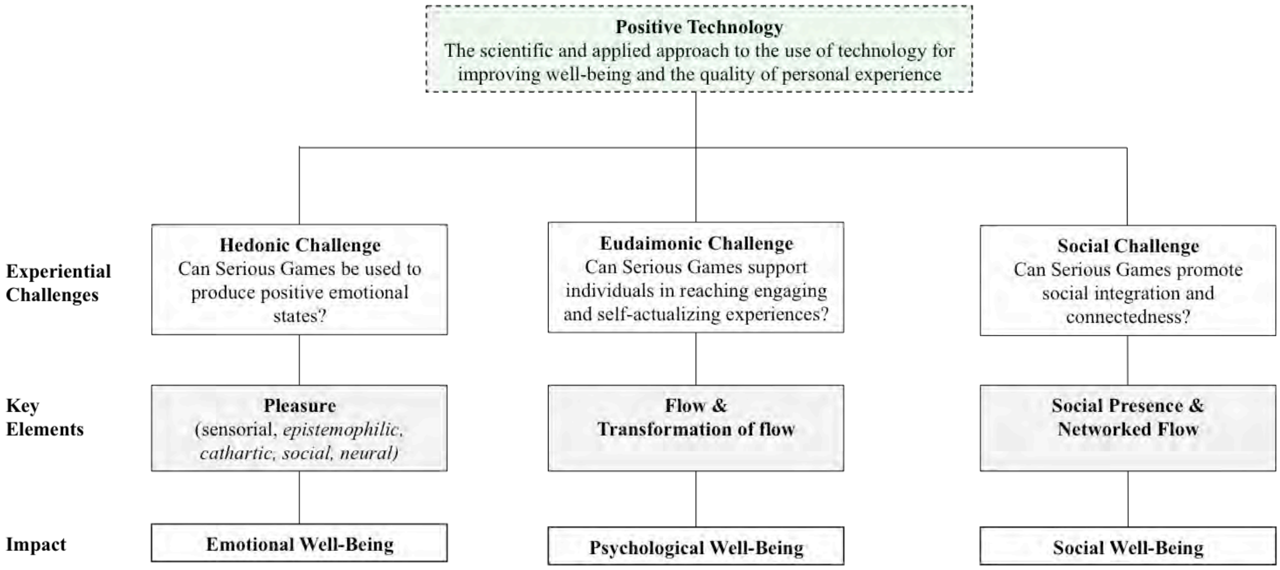


Fig.1 Serious Games as Positive Technologies

The hedonic challenge

Games can elicit several emotional states (Anolli, Mantovani, Confalonieri, Ascolese, & Peveri, 2010). Many representations of players' affective states have been used in previous studies like anxiety, frustration, engagement, distress scales, and the valence-arousal space (Anderson & Ford, 1986; Freeman, 2004). However, SGs and games in general are strictly connected to positive emotions, and to a wide variety of pleasant situational responses that make gameplay the direct emotional opposite of depression (McGonigal, 2010).

At first, SGs can evoke a *sensorial pleasure* throughout graphics, usability, game aesthetic, visual and narrative stimuli.

Secondly, SGs foster an *epistemophilic pleasure* by bridging curiosity with the desire of novelty within a protected environment where individuals can experience the complexity of their self, and developing mastery and control. In other words, they are able to recreate a "magic circle" (Huizinga, 1950) that enforces individual agency, self-confidence and self-esteem (Anolli et al., 2010), by sustaining a process of acknowledgement of personal ability to perform well, solve problems, and manage with difficulties. Hence, empowered by new media affordances and possibilities, SGs can promote a dynamic equilibrium between excitement and security.

Thirdly, SGs promote the *pleasure for victory* and, by supporting virtual interactions with real people, they nurture a *social pleasure*, promoting collaborative and competitive dynamics, communication and sharing opportunities, even outside the context of the game (Anolli et al., 2010).

Games have also been traditionally recognized as marked by a *cathartic pleasure* as they represent a relief valve for emotional tensions, anger and aggressiveness (Wouters et al., 2013).

Finally, pleasure has a *neural* counterpart. An interesting example is that of dopamine, a neurotransmitter that affects the flow of information in the brain and that is often involved in pleasant experiences, as well as in different forms of addiction and learning. In a classic study made by Koepp and colleagues to monitor the effects of video games on brain activity, a significant increase of dopamine (found in a quantity comparable only to that determined by taking amphetamines) was measured (Koepp et al., 1998).

Good examples of SGs explicitly designed to foster positive emotion are *The Journey to Wild Divine* and *Eye Spy: the Matrix*, *Wham!,* and *Grow your Chi*!, developed in Dr Baldwin's Lab at McGill University. In *The Journey to Wild Divine* the integration between usable biofeedback sensors and a computer software allows individuals to enhance their subjective wellbeing throughout a 3D graphic adventure. Here, wise mentors teach the skills to reduce stress, and increase physical and mental health. *Eye Spy: the Matrix*, *Wham!,* and *Grow your Chi*! are indeed projects whose goal is to empower people with low self-esteem respectively by working on ignoring rejection information, throughout positive conditioning, or by focusing on positive social connections (Baccus, Baldwin, & Packer, 2004; Dandeneau & Baldwin, 2004).

Another great example is *Mindlight,* developed by the GainPlay Studio in collaboration with the PlayNice Institute and Radboud University. The game realized for children aged 8-12, has been created on evidence-based principles of intervention with anxiety-disordered children and adults through the use of biofeedback. In the game, the main character, Little Arthur, has to deal with a scary and dark mansion where his grandmother has succumbed to shadows. In order to bring her back, Arthur has to use a Magical Hat, a neurofeedback headset the player wears when playing the game. Through the help of the Magical Hat, players learn to modulate their arousal by specific relaxation and mindfulness techniques that directly impact the game. Everything in the game (the environment, threats and puzzles) in fact responds to how the player is allocating his/her cognitive and emotional resources.

Knowledge and awareness of hedonic principles can be fundamental to enhance learning effectiveness and retention (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). For example, in the field of software engineering typical lectures allows only passive learning and both projects and practice exercises are not enough to help students to cope with many of the issues the will face when working on real-world software engineering processes (Armarego, 2002). To address this problem, Baker, Navarro and van der Hoek (2005) developed *Problems and Programmers*, an educational card game that simulates the complexity of software engineering process. The authors emphasized the role of both pleasure for victory and social pleasure by making the game highly competitive: each player wears the shoes of project manager that has to complete the project before any of the opponents do. To achieve such a complex goal, users have to manage a complex range of resources, including time, money and the client's demands regarding the reliability of the produced software. Secondly, sensorial pleasure has been taken in deep consideration too. Entertaining character descriptions, humorous character illustrations, and unexpected situations further add to this quality. Another good example is the one presented by Coller and Scott (Coller & Scott, 2009) that used the hedonic affordance of a video-game during a course in mechanical engineering. Students were given the task of writing computer programs to race a simulated car around a track. Results showed that students using the game demonstrated deeper learning and spent roughly twice as much time, outside of class, on their homework.

The eudaimonic challenge

Bergeron (2006) defined SGs as interactive computer applications, with or without a significant hardware component, that (i) have challenging goals, (ii) are fun to play with and/or engaging, (iii) incorporate some concepts of scoring, (iv) impart to the player skills, knowledge, or attitude that can be applied in the real world. Interestingly, all of these aspects can be easily overlapped to Csikszentmihalyi's theory of flow. Games are in fact "flow activities" (Csikszentmihalyi, 1991; 2000) as they are intrinsically able to provide enjoyable experiences (McGonigal, 2010), creating rules that require the learning of skills, defining goals, giving feedback, making control possible, and fostering a sense of curiosity and discovery.

In addition, the intrinsic potential of flow that characterizes SGs can be even empowered by (i) identifying an information-rich environment that contains functional real world demands; (ii) using the technology to enhance the level of presence of subjects in the environment, and (iii) allowing the cultivation, by linking this optimal experience to the actual experience of the subject (Ijsselsteijn & Riva, 2003). SGs should stimulate a mental focus on in-game dynamics, by providing a set of engaging, differentiated and worth-attending stimuli that limit the influence of external variables. Along with other aspects, concentration can result in hyperlearning processes that consist of the mental ability to totally focus on the task by using effective strategies aligned with personal traits (Csikszentmihalyi, 1991).

In order to develop a SG able to induce in players high level of immersion, it is important to look at game design elements, including for example (see also Fullerton, 2014; Baranowski, 2013; Sweetser & Wyeth, 2005):

- *Challenge:* as noted by Gee (Gee, 2003), who claims that the game experience should be "pleasantly frustrating", challenges have to match players' skills/level and to support their improvement throughout the game. During specific stages of the game, "Fish tanks" (stripped down versions of the real game, where gameplay mechanisms are simplified) and "Sand boxes" (versions of the game where there is less likelihood for things to go wrong) can support this dynamism;
- *Clear goals:* games should provide players with specific, measurable, achievable, responsible and time-bounded goals;
- *Storyline:* the targeted content needs to be intrinsically coupled with the fantasy context (or story) of the game in order to improve motivation, emotional attachment (Malone and Lepper 1987), and cognitive load (Sweller 1994). The storyline needs to be developed according to the specific skills to train in the target to player types audience (Bartle, 2003);
- *Feedback:* players have to be supported by feedback on the progress they are making, on their action, and the on-going situations represented in the virtual environment;
- *Control:* it is fundamental for players to experience a sense of control over what they are doing, as well as over the game interface, and input devices; players should feel a sense of control through endogenous feedback, in order to increase their motivation and engagement in the game (Paras, 2005).

On the one hand, numerous case studies have confirmed the usefulness of flow as SGs quality measure (Bellotti et al., 2013; Kiili et al., 2014; Kiili et al., in press).

Moreover, results indicated that flow is an appropriate construct to assess the quality of game experience (Ermi & Mäyrä, 2005; Oksanen, 2014) and that its measurement can facilitate game evaluation and design practices (Bergeron, 2006; Kiili et al., 2014), especially for eudaimonic SGs.

On the other, there are SGs that have directly addressed the eudaimonic challenge. An example is *Reach Out Central* (ROC), developed by ReachOut.com. It is a Cognitive-Behaviour therapy game that encourages players to develop psychological well-being. Studied for young people aged 14-24, ROC is a single-player role play game with innovative 3D graphics and real-life scenarios and characters. Here, players can see how their decisions and reactions affect their moods, and apply skills they learn offline in their day-to-day lives. An evaluation conducted by Shandley and colleagues (Shandley, Austin, Klein, & Kyrios, 2010; Shandley, Klein, & Austin, 2008) found that ROC reduced psychological distress, alcohol use, and improved life satisfaction, resilience, and problem-solving abilities. Another great example is *SuperBetter,* developed by Jane McGonigal. *SuperBetter* helps people their life goals by working on personal resilience. The application of the aforementioned elements supports people being curious, optimistic and motivated and promotes high levels of user engagement.

In the field of Engineering and Architecture Education, the flow model has also been explicitly used by Mildner et Al. (2012). The game is commonly used in classrooms to deliver architectural knowledge to young students. The player starts the game in the role of a young student who has to write an essay on stylistic eras of architecture and looks for the advice of a professor in the neighbourhood. Before the professor can explain anything relevant a lab accident happens in which the student gets trapped in a time machine the professor possesses. The student then travels through different time epochs where he can directly experience 3D models of building and architectures. In order to travel back to the present time the player has to collect energy modules to fully repair the time machine. In contrast to other educational games where learning and fun phases are strictly separated, the game avoids this distinction: the knowledge itself is implicitly embedded into the game's story line. This is fundamental to foster flow in terms of concentration, control, and immersion. Further, the game was developed to dynamically adapt task difficulty to the player's skill level. A tutoring system was chosen so that the player can actively ask for help if he or she is stuck at a certain point. Similarly, the game can automatically detect if a player needs help by acquiring specific performance measure, like the time the player needs for solving a task.

In the same field, *Capture Game*, realized by T-Xchange, referred to the challenge and skills balance to develop challenging issues for young architects who wanted to train their managerial skills. In the SG, complexity comes from multiple interactions between operational needs, capability and services that are aligned with the quality of the action given by the player.

The social challenge

At the social level, the challenge for Positive Technology is concerned with the use of new media to support and improve the connectedness between individuals, groups, and organizations, and to create a mutual sense of awareness. Cantamesse, Galimberti, & Giacoma (Cantamesse, Galimberti, & Giacoma, 2011) examined the effect of playing the online game World of Warcraft (WoW), both on adolescents' social interaction and on the competence they developed on it. The in-game interactions, and in particular conversational exchanges, turn out to be a collaborative path of the joint definition of identities and social ties, with reflection on in-game processes and out-game relationships. Other good examples of specifically designed SGs can be found in the field of organizational management and education. For instance, *Everest V2* (2011), was developed by the Harvard Business School to promote leadership and team working, and *Woodment* (2010) was presented as an educational web-based collaborative multiplayer SG. Another example is *TeamUp* (2013) developed by The Barn in collaboration with the Delft University of Technology and Accenture (Mayer et al., 2013). SGs have shown to be effective also in supporting participative approaches.

In these games, social presence and networked flow are fundamental (Brom et al., 2014). These principles have been also used to support Participatory Design practices (Sanders, 2002), with users and other stakeholders playing a key role in all the stages relating to design, development and evaluation of a specific project (Corrigan, Zon, Maij, McDonald, & Mårtensson, 2014). Participatory Design can improve communication, control of the project, innovation and creativity. Connoly and colleagues (Connolly, Stansfield, & Hainey, 2007) presented *SDSim Game*, a SG where a team has to manage and deliver a number of software development projects. In the game each player has a specific role, such as project manager, systems analyst, systems designer or team leader with specific tasks. During the game, the team is provided with background information and must produce an high-level product that addresses the clients' requirements and manage a limited amount of resources. To do so, players must move through game-levels, interact among them and ‘talk’ to the nonplayer characters (NPCs) in the game.

Some studies have addressed the relationship between social presence and immersion in games finding controversial results (Cairns, Cox, Day, Martin, & Perryman, 2013; Oksanen, 2014; Sweetser & Wyeth, 2005; Yoo & Alavi, 2001). On the one hand, there are those who claim that the presence of others, even mediated via online play, would require players to think about the other players and so draw their attention away from the thinking about the game, determining low level of immersion (Sweetser & Wyeth, 2005). Other studies have indeed highlighted the opposite. For example, Cairns et al. (2013) run three experiments that showed that players were more immersed when playing against another person than playing against a computer and that there was not significant different in the levels of immersion whether the other person was present in the room or not. Similarly, Oksanen (2014) found that the sociability of the environment strengthen the emergence of social presence and that it can also contribute to the formation of positive game experiences. Moreover, social presence has a specific role, particularly in collaborative games, to open communication, critical thinking, group cohesion, supportive interaction and negotiation (Kreijns, Kirschner, & Jochems, 2003, 2002). High levels of social presence are predictors of learning (Gunawardena, 1995) and they are correlated to high levels of enjoyment (Gajadhar, de Kort, & IJsselsteijn, 2008), social interaction (Tu & McIsaac, 2002) and group cohesion (Yoo & Alavi, 2001).

Conclusion

SGs are digital games used for purposes other than mere entertainment. By using the latest simulation and visualization technologies, SGs are able to contextualize the player’s experience in stimulating and realistic environments (situated cognition) (Bellotti et al., 2013) that foster practical learning experiences blended with ludic and engaging affordances. In this chapter we discussed the role of SGs for human education and training.

Despite some authors are using the concepts of edutainment and SGs as synonyms (Ulicsak, 2010), there are scholars that prefer to refer to SGs as category that is not fully exhausted by edutainment (Bergeron, 2006; Girard et al., 2013; Marsh, 2011). For example, according to Corti (2006), the motivational virtues of video games are what initially entice training and development professionals to turn to game-based approaches, but there is a lot more to game based learning/SGs than simply using fun as a means to engage learners. While early attempts in edutainment focused on teaching facts mainly through rote memorization, SGs have a broader potential (Michael & Chen, 2006). It is clear that playing digital games leads to a variety of positive outcomes and impacts but it is also acknowledged that the literature on games is fragmented and lacking coherence (Connolly et al., 2012). For example, a key challenge within the SGs literature is to develop a workable classification of outcomes and impacts of playing games with respect to engagement, learning and other individual and collective skills. According to the meta-analysis developed by Girard et al. (2013), the most frequently occurring outcomes reported were affective and motivational and knowledge acquisition/content understanding, followed by perceptual and cognitive skills, behaviour change, and social/soft skills outcomes. Further, SGs can assist people to increase their well-being, physically, mentally and socially (Brooks et al., 2014). As a consequence, they are able to address the three main challenges identified by Positive Technology.

According to Positive Psychology theoretical framework and Positive Technology approach, we explored how these applications are able to promote hedonic well-being, eudaimonic well-being and social well-being. First of all, SGs can foster positive emotional states by enhancing the different forms of pleasure they are intrinsically made of. In particular, we discussed the importance of sensorial, epistemophilic, social, cathartic and neural pleasure. Secondly, serious applications for computer game technologies can be associated with flow experiences and, thus, with eudaimonic well-being. Throughout high level of presence and flow, SGs can, in fact, promote optimal experiences marked by absorption, engagement, and enjoyment. Numerous studies have been realized to analyze the usefulness of flow as SGs quality measure (Bellotti, Kapralos, Lee, Moreno-Ger, & Berta, 2013; Kiili, Lainema, de Freitas, & Arnab, 2014; Kiili, Perttula, Lindstedt, Arnab, & Suominen, in press). Results indicated that flow is an appropriate construct to assess the quality of game experience (Ermi & Mäyrä, 2005; Oksanen, 2014) and that its measurement can facilitate game evaluation and design practices (Bergeron, 2006; Kiili et al., 2014), expecially for eudaimonic SGs. Finally, SGs are able to increase connectedness and integration. To achieve such a complex goal they have to work on a mutual sense of awareness, as well as social presence and situations of liminality. In this way, groups can access high levels of social interaction and peak creative states, known as networked flow experiences, that are based on shared goals and emotions, collective intentions, and proactive behaviors. These experiences have a specific role, particularly in collaborative games, to open communication, critical thinking, group cohesion, supportive interaction and negotiation (Kreijns et al., 2003, 2002). High levels of social presence and networked flow are predictors of learning (Gunawardena, 1995) and they are correlated to high levels of enjoyment (Gajadhar et al., 2008), social interaction (Tu & McIsaac, 2002) and group cohesion (Yoo & Alavi, 2001).

On the one hand, knowledge and awareness of hedonic, eudaimonic and social principles can be both fundamental to enhance learning effectiveness and retention (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). For example, in the field of engineering and architecture typical lectures allows only passive learning and both projects and practice exercises are not enough to help students to cope with many of the issues the will face when working on real-world challenges (Armarego, 2002). An effective balance of the three levels can support students not only to become active and engaged learners, but also to improve their well-being and contribute to the development of sustainable communities of practices. On the other, the concrete application of Positive Technology principles may be fundamental to improve user-centered design models. One of the most important aspects to analyse when considering serious and computer games from a scientific point of view is game experience (Poels, De Kort, & Ijsselsteijn, 2007; Sweetser & Wyeth, 2005; Takatalo, Nyman, & Laaksonen, 2008). Attempts to clearly define the construct are indeed scarce and the wide variety of games genres and the complex, subjective and dynamic nature of the idea of experience (Takatalo et al., 2008) makes it hard to find a common definition. However, many authors agree (Coller & Scott, 2009; De Kort, Ijsselsteijn, & Poels, 2007; Ermi & Mäyrä, 2005) on the importance of elements like positive affects, flow and social presence that are central in the Positive Technology framework.

Despite the impressive growth of SGs applications, only a few of them have been tested and scientifically considered from an empirical point of view. This is a major challenge for future research and investigation. Positive Technology approach can address this issue not only by creating a concrete background for both theoretical and applied research, but also supporting game design processes.

2. Human interaction and performance in Virtual Teams

Networking and team working are becoming the foundations of human performance in educational, organizational and recreational settings (Barabási, 2003; Menold, 2009). Here, new communities of practice are being established to promote an engagement economy (McGonigal, 2010) that will be able to foster innovation and success by sustaining collective well-being and group flourishing.

Further, both the rapid development of Information and Communication Technologies (ICTs) and changes in the actual scenario have led to salient changes in the manner in which groups work, solve problems and communicate (Olson & Olson, 2003). People collaborate in virtual and dispersed teams with alternative non-hierarchical forms of leadership (Pearce, Conger, & Locke, 2008) so that nowadays, with rare exceptions, all organizational teams are virtual to some extent (Martins, Gilson, & Maynard, 2004). Thus, Virtual Teams (VTs), or geographically distributed groups who rely primarily on computer-mediated technologies to communicate, are becoming critical for the long-term competitiveness of organizations (Driskell, Radtke, & Salas, 2003; Schiller & Mandviwalla, 2007).

On the one hand, VTs have specific strategic advantages. For instance, VTs can be organized according to members' expertise instead of local availability; they can work around the clock by having team members in different time zones, improving speed and flexibility in response to market demands and reducing travel expenses (Gassmann & von Zedtwitz, 2003; Lurey & Raisinghani, 2001). On the other hand, potential challenges may include difficulties to supervise team members' activities and to prevent unproductive developments in time, along with additional costs for appropriate technology, issues of data security, and additional training programs. Feelings of isolation and decreased interpersonal contact, increased chances of misunderstandings and conflict escalation, and increased opportunities of role ambiguity and goal conflicts due to commitments to different work-units, are elements that have to be taken in to account too (Algesheimer, Dholakia, & Gurau, 2011).

Yet, the term "VT" is used to cover a wide range of activities and forms of technology-supported working (Hertel, Geister, & Konradt, 2005; Martins et al., 2004).

The aim of the present chapter is to deepen its nature and to discuss the main features of VTs considering the recent adaptations (Hedlund, Ilgen, & Hollenbeck, 1998; Marks & Panzer, 2004) of the input-process-outcome (I-P-O) framework, originally developed by McGrath (1964) and analysing which technologies can support VTs dynamics.

1. Virtual Teams defined

Virtual are teams a new ubiquitous form of work structure in the 21st century (Schiller & Mandviwalla, 2007; Wipawayangkool, 2009b), whose main characteristics are summarized in Tab.1. However, there is still considerable debate over the definition of what is or is not a VT and the dimensions around which virtuality should be measured (Johnson, Bettenhausen, & Gibbons, 2009).

Characteristics of VT	Key elements	References
Common Criteria	Geographic dispersion	Dafoulas and Macaulay, 2002; Shin, 2005; Wong and Burton, 2000.
	Common purpose	Bal and Teo, 2001; Shin, 2005, Hertel et al., 2005; Gassmann and Von Zedtwitz, 2003; Rezgui, 2007.
	Enabled by/Dependent on communication technologies	Bal and Teo , 2001; Nemiro, 2002; Peters and Manz, 2007.
		Lee-Kelley and Sankey, 2008
	Involved in cross-boundary collaboration	Bal and Teo, 2001, Gassmann and Von Zedtwitz, 2003.
		Rezgui, 2007; Precup et al., 2006
Other characteristics	Zero/Low Team History	Bal and Teo, 2001; Paul et al., 2005; Wong and Burton, 2000; Cascio and Shurygailo, 2003; Leenders et al., 2003.
	Team member are knowledge workers	Bal and Teo, 2001; Kirkman et al., 2004.
	Team members may belong to different companies	Dafoulas and Macaulay, 2002, Leenders et al., 2003.

Tab. 1: Defining VTs: Key Elements

Researches mainly present VTs as groups of people guided by common purpose who interact through interdependent tasks, although they are often dispersed across space, time, and/or organizational boundaries (Beranek & Martz, 2005; Söldner, Haller, Bullinger, & Möslein, 2009; Townsend, DeMarie, & Hendrickson, 1998). For instance, according to Leenders and colleagues (2003), VTs are groups of individuals collaborating in the execution of a specific project while geographically and often temporally distributed, possibly anywhere within (and beyond) their parent organization.

Even though the terms "team" and "group" are often used interchangeably in traditional and VT research literature, this duality in terminology has been questioned (Bal & Teo, 2000; Hertel et al., 2005; Schiller & Mandviwalla, 2007). A team can in fact be defined as a group of people, with complementary skills who are committed to a common purpose, performance goals and approach for which they hold themselves mutually accountable (Nijstad & De Dreu, 2002). Thus, as traditional teams, VTs are those whose members (a) are interdependent in their tasks, (b) share responsibility for outcomes, (c) see themselves and are seen by others as an intact social entity embedded in one or more larger social systems, (d) who manage their relationship across organizational boundaries.

Although many authors agree that VTs should also be geographically dispersed (Schiller & Mandviwalla, 2007) others argue that geographic dispersion is not a prerequisite of VTs (B. L. Kirkman, 2005). Specifically, Kirkman (2005) claims that, despite being geographically dispersed is likely to lead team members to use computer-mediated communication to coordinate their activities, teams that are located in the same area may also choose to use virtual means of communication. Moreover, the degree of geographic dispersion within a VT can vary widely from having one member located in a different location than the rest of the team to having each member located in a different country (Staples & Zhao, 2006). So, virtuality and the use of computer-mediated communication (CMC) become fundamental elements in defining VTs too (Johnson et al., 2009). All of the major research in this area contends that VTs must use some type of CMC. Gassmann and Von Zedtwitz (2003) defined VTs as groups of people and sub-teams who work across links strengthened by information, communication, and transport technologies. Similarly, Hertel et al. (2005) and Piccoli, Powell, & Ives (2004) suggest that VTs are distributed work teams whose members are geographically, organizationally and/or time dispersed, who coordinate their work predominantly with electronic information and communication technologies (e-mail, video-conferencing, telephone, etc.). Martins et al. (2004) argued that virtual are teams whose members use technology to varying degrees in working across locational, temporal, and relational boundaries to accomplish an interdependent task.

Further, Cascio and Shurygailo (2003) have clarified the difference forms of VTs by classifying them with respect to two primary variables: (a) the number of location (one or more) and (b) the number of managers involved (one or more). There are four categories of teams:

1. *Teleworkers*: A single manager of a team at one location
2. *Remote team*: A single manager of a team distributed across multiple location
3. *Matrixed teleworkers*: Multiple manager of a team at one location
4. *Matrixed remote teams*: Multiple managers across multiple locations

VTs are often project-focused as they are formed to fulfil specific needs and disbanded when the task is complete (Wong & Burton, 2000a). Members can enter the team when their expertise is needed and leave when the task is completed (Nijstad & De Dreu, 2002). As a consequence, this continuous configuring and reconfiguring of ad hoc teams implies that the team members have not previously nurtured a history of collaboration: they are part of zero-history teams (Johnson et al., 2009). There is not only little prior team history, but roles and responsibilities change with each VT members are assigned to.

Moreover, in VTs, the relationships between members tend to be lateral but weak. Due to the physical dispersion and the nature of the work that VT members are typically engaged in, they are often connected by lateral communication ties (McGrath, 1990). The research on virtual organizations suggests that their structures are typically non-hierarchical and decentralized (Hertel et al., 2005). Hence, virtual members primarily rely on lateral and informal information exchange to perform their work (Wong & Burton, 2000a). For example, Wong & Burton (2000) argue that VTs manifest the following characteristics (a) a set of culturally and organizationally differentiated members, (b) who are grouped together temporarily, (c) are physically dispersed, (d) connected by weak lateral ties, (e) and engaged in performing non-routine tasks.

To conclude, few pure VTs exist today. Some teams consist of members who are geographically dispersed, but are culturally and organizationally homogeneous. Other teams may contain members who transcend cultural and organizational boundaries, but are physically co-located. Whether a team is virtual maybe more in degree than in kind (Cascio & Shurygailo, 2003).

2. Team Effectiveness

The term team effectiveness refers to “how well a team accomplishes its purpose or mission” (Tannenbaum, Salas, & Cannon-Bowers, 1996, p. 505). Commonly, group effectiveness is analyzed in terms of work outcomes (González, Burke, Santuzzi, & Bradley, 2003). However, effectiveness also includes other results that should help perpetuate work outcomes over time (Tannenbaum et al., 1996), such as the extent to which the team experience enhances the capability of the members to work together in the future, and the extent to which group members’ experience on the team is satisfying (e.g., Hackman, 1987 and West et al., 1998). Being equipped with even the most advanced technologies is not adequate to make a VT effective, since the internal group dynamics and external support mechanisms must also be present for a team to succeed in the virtual world (Ale Ebrahim, Ahmed, & Taha, 2009). With regards to team effectiveness there are three basic criteria to consider (Lurey & Raisinghani, 2001): (a) team’s productivity level; (b) a team’s ability to learn and improve its functioning thus sustaining itself over time can be evaluated; (c) the extent to which a team is able to provide satisfaction to its individual members along any number of intrinsic measures is the third dimension.

While the first criterion is based on the extent to which the group’s output, product or service, meets the required standards (the actual performance), the second criterion focuses on the process of conducting the work. This dimension refers to the teams’ ability to both learn and improve themselves and their members while handling their task. The third criteria is also a process variable, but it is more significantly connected to the individuals within the team and to their level of satisfaction. A team must also care for its members and provide the right opportunities for personal development and growth. All the three criteria fit the inputs-processes-outcomes (I-P-O) model (McGrath, 1964), the dominant framework used in the study of teams to explain how they can achieve their effectiveness. Within this model. inputs represent starting conditions of a group, such as its material or human resources. Processes represent dynamic interactions among group members as they work on a group’s task. Outcomes represent task and non-task consequences of a group’s functioning (Martins et al., 2004).

2.1 The I-P-O Model: Input

Group size

While some may say that an optimal virtual team size is between three and seven members (e.g. (Cooke et al., 2003), size can vary considerably. In a study of 165 project teams, Kinney and Panko (Kinney & Panko, 1996) found that the average team size was 7.7 members. Group size has traditionally been described as critical to group performance (Steiner, 1972). Yet, it may affect VT effectiveness differently than face-to-face (FTF) teams (Martins et al., 2004). For instance, in contrast with results found in FTF groups, the number of ideas generated in VT during an electronic brainstorming session increased with group size (Gallupe et al., 1992; Valacich, Dennis, & Nunamaker, 1992).

While a large team means more resources, expertise, and ideas, it also results in greater need of coordination and may be more prone to communication breakdowns. Thus, a larger virtual team increases its complexity. In addition, a large number of members means a "higher social density" that usually leads to people getting much more information than they can assimilate and respond to (Ale Ebrahim et al., 2009). Other researchers evaluated the impact of varying group size and social presence on small-group communication (Lowry, Roberts, Romano, Cheney, & Hightower, 2006). They compared key communication factors on two different small group sizes. Results indicated that smaller groups established and maintained higher levels of communication quality, and FTF with CMC support groups had higher levels of communication quality than virtual with CMC support groups; however, no significant difference between traditional FTF groups and virtual groups with CMC support was found. Also, CMC minimized the impact of increased group size.

Increased team size may also increase the potential for free-riding and social loafing (Peters & Karren, 2009). This can be especially important with regards to virtual teams. When virtual team members are isolated from each other, motiva tion may decrease and this may increase the likelihood of social loafing (Tasa & Whyte, 2005).

However, the effect of size on VT functioning may depend on the nature of the task and the technology used. For example, in a case study of six global VTs in a field setting, Riopelle et al. (2003) found that increased size made it difficult for participants to interact effectively using a professional audio-conferencing system. Thus, technology can mitigate the negative effects of size (e.g. process losses) found in FTF decision-making or creative teams (Dennis & Valacich, 1999; Leenders et al., 2003).

Knowledge, skills, and abilities (KSAs)

VTs can bring together individuals with the needed KSAs regardless of their location (Furst, Blackburn, & Rosen, 1999). According to Piccoli et al. (2004), the KSAs crucial for the successful functioning of VTs can be discussed both at am individual and a team level.

At the *individual level*, authors identify:

- *Self-Management KSA:* they are mainly based on proactivity, self-regulation and time management (Katzenbach & Smith, 1993). On the one hand, proactivity deals with identifying required behaviors, seeking out relevant information, taking the initiative to contact team members, overcoming time and distance barriers, and staying the course without managerial intervention (Hansen, 2004). On the other hand, by enabling an individual to guide his/her goal-directed activities over time and across changing circumstances (Karoly, 1993), self-regulation processes require effective time management skills. In fact, VT member have constantly to balance the demands of the local unit with obligations to virtual team mates who may be located across many time zones (Cooke et al., 2003).
- *Communications KSAs:* research by Roebuck et al. (2004) states there are three challenges of communicating in VT: lack of FTF interaction, difficulty of building relationships and challenge of accessing and leveraging the unique knowledge of each member to reach the team's goal. Most studies found that the overall amount of communication in electronic communication is greater than in FTF communication (Hiltz et al., 1986). Although some researchers argued that communication in electronic environment has decreased due to the lack of speech acknowledgements (e.g., "hum?" "Uh-hmm") and social greetings (O'Connail et al., 1993; Sarbaugh-Thompson & Feldman, 1998), there is no doubt that electronic communication consumes more time and conversation contexts. Others suggest that a problem-solving task is not suitable for electronic communication, even if the task is low in complexity (Straus, 1996; Gallupe & McKeen, 1990).
- *Comfort with Technology and Technological Change KSAs:* each VT member must be well versed and fully comfortable with the wide range of information

technologies available to the team, including collaboration software packages, video-conferencing, and other communication media necessary for the team to work at full capacity (Staples, Hulland, and Higgins, 1999).

At team level, the main KSAs are based on:

- *Establishing VT Goals and Defining Team Roles:* establishing clear goals and well-defined member roles are fundamental team-level KSAs for building a winning VT (McClough & Rogelberg, 2003)
- *Establishing Team Norms KSAs:* successful VTs develop a code of conduct and a set of norms that guide team interactions. Norms revolve around the use of specific modes of communication, acceptable response times, document archiving in shared work spaces, and establishing task priorities among other issues.
- *Team Problem-Solving KSAs:* an important KSA for VTs is the ability to solve complex problems. Research suggests that consensus is more difficult to reach with VTs, particularly those teams working on complex non- technical issues (Hollingshead and McGrath, 1995). Consensus involves give and take, bargaining, and negotiation to arrive at a team output on which all team members can agree.
- *Team Conflict Management KSAs:* although conflict is often mentioned in the VT working literature, few have attempted to empirically examine it in its own right (for exceptions, see Hinds & Mortensen, 2002b; Joshi, Labianca, & Caligiuri, 2002; Mortensen & Hinds, 2001). Dispersion of team members is likely to have a number of different implications for conflict in the team. For instance, conflict may be more prevalent, and may not be associated with the same outcomes as in more traditional teams. Increasing distance between team members is expected to make conflict more likely in a number of ways. First, closeness and affinity between team members is inversely related to conflict (Hinds & Mortensen, 2002b). Close relationships are likely to decrease as the distance between team members increases (Festinger et al., 1950; Kiesler & Cummings, 2002), thereby increasing the probability of conflict. Second, the increased compositional diversity and lack of common social identity within many VTs is proposed to increase the likelihood of conflict (Mannix, Griffith, & Neale, 2002). Indeed, demographic, functional, and cognitive diversity have been associated with conflict in co-located teams (Williams

& O'Reilly, 1998). Third, dispersion of the team means that many team members will work in different contexts, with a number of local constraints and expectations influencing their contributions to the team. Mutual awareness of each other's context is therefore important.

Task dimensional factors

The literature on VTs has highlighted task as a key element for team effectiveness (Lin, Standing, & Liu, 2008). For example, Lipnack and Stamps (1997) have found that group members within VTs tend to be more task-oriented because of the constraints imposed by CMC. Scholars have also found that VTs often address complex tasks of significant importance (Kirkman, 2005; Leenders et al., 2003). Further, task type has been argued to be critical to the success and speed with which VTs make decisions (Wipawayangkool, 2009a). For instance, when a team's task is ambiguous, the extent of virtualness may increase the length of time needed to reach a shared goal, but may actually assist in the development of a more focused or better goal (Straus & McGrath, 1994).

Another factor that has been deeply investigated is the so-called *task-media-member compatibility* (Kirkman, 2005), described as the resulting synergy between the nature of team tasks, the available technologies, and the relative competencies of team members. Some technologies are better suited for accomplishing certain tasks than others (McGrath & Hollingshead, 1993), assuming that those technologies are aligned with team members' competencies and preferences (Cooke et al., 2003). Team tasks can range from simple to complex (Jehn, Northcraft, & Neale, 1999). Bell & Kozlowski (2002) offered a valuable taxonomy that has been used to describe task complexity:

- *Intensive interdependence* requires members to work in real time with one another and places pressures on them to continuously maintain situation awareness, monitor each other, balance workloads, and execute back-up behaviors (Van De Ven, Delbecq, & Koenig Jr., 1976). At one extreme is pooled *interdependence* in which team effectiveness is essentially the sum of the members' contributions.
- *Sequential interdependence* depicts a classic assembly line where one member' s inputs are the outputs of another. Assuming little temporal pressures, this could imply that technology of relatively low in formational value is beneficial (Bell &

Kozlowski, 2002) and might well be superior to FTF. Synchronicity of exchanges is, however, important to maintain.

- *Reciprocal interdependence* represents a situation in which work is passed back and forth between members. Depending on the time issues surrounding exchanges, these are likely to be better done with technologies of higher informational value and synchronous member interactions (Kirkman, Rosen, Tesluk, & Gibson, 2004).

Team member competencies constitute the second aspect of task-media-member compatibility (Kirkman, 2005). Team member competencies will have an impact on the success of any type of team, and virtual ones are no exception. In terms of types of competencies, however, VT members require sophistication in three general areas: (a) task work; (b) teamwork; and (c) virtuality-related knowledge, skill, ability, and other traits (KSAs). Specifically for operating effectively in virtual teams, members must be comfortable with various technologies (Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002).

The role of technology

One of the most widely applied theories of media use is ness theory. The Media Richness theory, proposed by Daft and Lengel (1984), stated that team or organization success is based on teams' ability to process information of appropriate richness in order to reduce uncertainty and clarify equivocality. Daft and Lengel (1984) argue that media capable of sending "rich" information (e.g., FTF meetings) are better suited to equivocal tasks (where there are multiple interpretations for available information), while media that are less "rich" (i.e., computer-mediated communication) are best suited to tasks of uncertainty (where there is a lack of information). In particular, richer media were those with a greater language variety (the ability to convey natural language rather than just numeric information), a greater multiplicity of cues (the number of ways in which information could be communicated such as the tone of voice), a greater personalization (ability to personalize the message), and more rapid feedback (Laker & Powell, 2011).

Media Richness Theory also argues that certain media are better able to transmit information depending upon whether the information is used in situations of uncertainty or equivocality. Uncertainty exists when a framework for interpreting a message is available, but there is a lack of information to process (i.e., there are well understood predetermined responses to potential problems). Equivocality exists when there are multiple (and possibly conflicting) interpretations for the information or the framework with which to interpret it. Equivocality requires negotiation among members converge to consensus on one interpretation. Media providing higher richness are preferred. In contrast, uncertainty requires someone in the group to provide, locate, or create the needed information; leaner media are preferred (Dennis, Fuller, & Valacich, 2008; Workman, Kahnweiler, & Bommer, 2003).

There is substantial evidence that VTs communicate less efficiently than FTF groups (McGrath & Hollingshead, 1994; Hightower & Sayeed, 1996). Although not definitive in terms of specific effects, the research in this area suggests that VTs communicate differently than FTF groups (Grosse, 2002; Hansen, 2004; Siegel, Dubrovsky, Kiesler, & McGuire, 1986; Warkentin & Beranek, 1999). Hence, the type of technology used by VTs is an important input as media richness has been found to positively impact team effectiveness, efficiency amount of communication (Andres, 2006; Hambley, O'Neill, & Kline, 2007; Sivunen & Valo, 2006) the relationships among team members (Pauleen, 2003), team commitment (Workman et al., 2003), levels of performance and trust (Olson & Olson, 2012; Suchan & Hayzak, 2001).

However, empirical results have not provided strong support for this perspective (Mennecke, Valacich, & Wheeler, 2000): media richness theory has strong face validity, but empirical evidence has provided only mixed support (Dennis & Valacich, 1999). McGrath and Hollingshead (1993) have extended media richness theory by differentiating specific task types to various communication contexts in the task-media fit model. They argue that the influence of technology on group functioning and outcomes will depend on the fit between the richness of the communication medium and the information demands of the group's task. However, the fit between task and technology is not static but dynamic and changes over time (McGrath, Arrow, & Berdahl, 2000).

Dennis and Valacich (1999) developed the Media Synchronicity Theory (MST). According to this theory, decision-making and other tasks requiring team collaboration can be divided into two communication processes: *transmission* of new information, *conveyance*, and discussion of pre-processed information, convergence (Dennis et al., 2008). These two processes require different media capabilities, and it is too broad to state that a media matches the overall task:

- *Transmission velocity*: the speed at which a medium can deliver messages to communicators

- *Parallelism*: the number of effective simultaneous transmissions
- *Symbol sets*: the number of ways in which information can be encoded in terms of multiple cues and language variety.
- *Rehearsability*: the extent to which a message can be checked and edited before transmission.
- *Reprocessability*: the extent to which a message can be reviewed and reprocessed after the message has been received.

A different approach is the social information processing perspective. It intends to explain the contradictory results obtained by previous studies and to offer explanations about what occurs over time among users of CMC with regard to the interpersonal-relationship development (Warkentin & Beranek, 1999). This perspective assumes that users in CMC, as in FTF, are driven to develop social relationships. Development of relational links is important because researchers have associated strong relational links with many positive outcomes including enhanced creativity and motivation, increased morale, better decisions, and fewer process losses (Walther & Burgoon,1992).

McGrath's Time-Interaction-Performance (TIP) theory offered a means for understanding the development of relational links in groups (McGrath, 1990). Developing relational links involves performing activities related to the member support and group well-being functions. These activities include, for example, establishing position or group status of members, defining task roles of group members, and establishing norms for group interaction. Activities that define relational development are most common after a group experiences a significant transition, such as the group's inception or a change in membership.

Further, the more recent approaches regarding the effects of CMC suggest that, over time, groups acquire experience in the use of the medium and may develop new strategies for communicating and carrying out the task. So, differences between media would disappear or decrease after a group has been working with CMC for a certain period of time (Hambley et al., 2007)

Another popular theory being used in assessing whether a particular technology can improve the performance of a task is called a Task-Technology Fit (TTF) model which has been proposed by Goodhue and his colleague for explaining perceived individual performance due to the use of information technologies (Goodhue, 1995; Goodhue, 1998) and Zigurs and Buckland (1998). The general concept is that, for a technology to be useful in enhancing performance, it must fit the nature of the tasks that the technology is designed to support. A good fit between task characteristics and technology characteristics will result in higher utilization and better performance. In addition to the fit between task and technology, other theories exist (i.e., Li and Chau 2009). A popular one is the organizational contingency theory that argues that appropriate organizational settings are critical to the successful deployment of a technology (Workman, 2005).

Virtual Team Composition

Group composition is concerned with the characteristics of the members in a group (Levine & Moreland, 1994). Authors initially argued that group composition would be less salient within VTs and empirical research has indeed found that status effects are reduced in virtual interactions (Lipnack & Stamps, 1997). For example, Dubrovsky, Kiesler and Sethna (1991) found that status inequalities were significantly reduced when groups used e-mail to communicate. Moreover, CMC allows greater access to individuals at higher seniority levels with whom scheduling FTF meetings may be difficult (Sproull & Kiesler, 1986).

Yet, not all studies have found support for status equalization in VT or that group composition influences VT decisions (El-Shinnawy & Vinze, 1998; Hollingshead, 1996). For instance, McLeod, Baron, Marti and Yoon (1997) reported that minority members were more likely to express their opinions in anonymous conditions, but their opinions were given more consideration in the FTF condition. Other researchers have found that CMC groups tend to recreate hierarchies in an attempt to preserve status differences (Owens, Neale & Sutton, 2000). Cramton (2001) found that, even in virtual student groups, coalitions were formed with outgroup members being perceived as not putting in sufficient effort and as being too aggressive in their behavior. Also, research suggests that status hierarchies may be retained due to the behaviors of high-status members such as talking more, perceiving their contribution as greater, and rating themselves more highly (Weisband, Schneider & Connolly, 1995).

2.2 The I-P-O Model: Processes and Decision Making

Team processes have been defined as “how teams achieve their outcomes” (Sivunen & Valo, 2006). Team members work together to identify and prioritize alternative solutions to problems and define the best alternative through extensive communication, analysis, deliberation, and negotiation. Further, most of the problems teams and VTs that are solved are ill-structured (Kerr & Tindale, 2004). As the direct opposite of well-structured problems, that are marked by a well-defined initial state, a known goal state, and a constrained set of logical operators, ill-structured problems have vaguely defined or unclear goals and unstated constraints; have multiple solutions, solution paths, or no solutions at all; have multiple criteria for evaluating solutions; require learners to express personal opinions or beliefs about the problem, so ill-structured problems are uniquely human interpersonal activities (Jonassen & Kwon, 2001). Hence, team processes are strongly related to decision making processes where members act interdependently to convert inputs to outcomes through cognitive, verbal, and behavioral activities directed toward organizing task-work to achieve collective goals (Marks, Mathieu, & Zaccaro, 2001).

The process of group decision-making has been studied for decades. For example, Tuckman (1965) proposed a five-stage process that includes forming, storming, norming, performing, and adjourning. Fisher (1970) identified four major steps: orientation, conflict, emergence, and reinforcement. Tubbs (1995) renamed Fisher’s model to include orientation, conflict, consensus and closure. However, research on decision-making processes in VTs is still in its early phases and findings of VT performance in the area of decision-making are mixed. Several researchers have found no differences in decision quality between virtual and co-located teams (e.g., Cappel & Windsor, 2000; Straus & McGrath, 1994), while others have found that co-located teams outperform VTs (e.g., Andres, 2002; McDonough et al., 2001).

In terms of decision-making outcomes, past research has often found different and conflicting results when comparing FTF and CMC teams (Kerr & Tindale, 2004). In some studies, face-to-face groups make better decisions, while in others no differences were found. Generally, computer-mediated teams exhibit a lower frequency of communication than face-to-face teams, although they tend to exchange more task-oriented messages as a proportion of total communication (Tasa & Whyte, 2005). Empirical research suggests that computer mediation equalizes participation since members tend to be less inhibited in their interactions, and the effects of status differences are mitigated (McGrath et al., 2000). While much research has been conducted on group decision making under same time and place conditions, there has been a paucity of research on different-time/different-place teams supported by asynchronous technology (Schmidt, Montoya-Weiss, & Massey, 2001). In the limited number of studies that have examined decision making by dispersed teams, computer-mediated systems were found to be fairly effective. Dispersed, asynchronous teams generated more diverse perspectives, conducted more in-depth analyses, and produced higher quality decisions than face-to-face groups (Pridmore & Phillips-Wren, 2012; Schmidt et al., 2001).At the same time, researchers have found evidence proving that VTs performed better than teams collaborating FTF. These findings indicate that VTs make more effective decisions (Schmidt, Montoya-Weiss & Massey, 2001), generate better ideas (Valacich, George, Nunamaker & Vogel, 1994) and more ideas (Chidambaram & Boström, 1993). One constraint of virtual work that a wide range of researchers have found is that it takes longer time to reach a decision (e.g., Archer, 1990; Galegher & Kraut, 1994). To explain such results, an integrated model proposed by Marks, Mathieu, & Zaccaro (2001) classified team decision-making processes as follow:

- *Planning or transition processes*: they encompass mission analysis, interpretation and evaluation of the team's mission, goal setting, strategy formulation, and other processes related to focusing the group's efforts;
- *Action processes:*. these are dynamics that occur during the performance of a group's task, such as communication, participation, coordination, tracking and monitoring of the group's progress;
- *Interpersonal processes:* they refer to relationships among group members and include conflict, motivation and confidence building, trust, cohesion, affect, management and social integration.

Planning processes in VTs

During planning or transitional processes teams are primarily focused on evaluation and/or planning activities to guide their accomplishment of a team goal trough mission analysis, goal specification, strategy formulation and planning (Klein et al., 2009).

At this level, team members scan the environment for cues that have the potential to affect the success of the mission (Klein et al., 2009; Zaccaro, Heinen, & Shuffler, 2009). In other words, team members assess the situation: they have to search for potential problems that the team might encounter and trying to make sense of the implications of these problems and generate initial solutions. The identification of cues or cue patterns (cue recognition), focusing on issues that might negatively impact or have already negatively impacted the mission success become a key element to manage effectively the process (Algesheimer et al., 2011; Katzenbach & Smith, 1993; Salas et al., 2008). Once identified, cues must be translated into information that is meaningful to the team by classifying or synthesizing the main elements based on existing knowledge (Cascio & Shurygailo, 2003) and developing a shared mission. It has been argued that developing a shared vision or mission may be more difficult for VTs, as it is often harder for members to establish a unified sense of purpose due to diminished member interactions (Furst et al., 1999). Nonetheless, both formalizing and sharing work processes and strategies have been found to be critical for VT performance (Lurey & Raisinghani, 2001).

Moreover, Warkentin and Beranek (1999) found that planning improved interaction processes and that teams that were given appropriate training exhibited improved perceptions of the interaction process over time, specifically with regard to trust, commitment and frank expression between members. A VT composition is also likely to run into coordination problems because of team heterogeneity. Even though some scholars have argued that diversity is an asset that supports groups with flexibility, improved group performance, and innovative behaviors (Wiersema & Bantel, 1992), there is research evidence that group diversity results in greater group conflict, lower group cohesion and lower psychological attachment (Wong & Burton, 2000b).

After the mission has been defined, the team can begin developing a course of action to achieve the desired goal and to formulate a strategy. Strategy formulation can be classified into three sub-dimensions: deliberate planning, contingency planning, and reactive strategy planning. Deliberate planning is the formulation and transmission of a principal course of action for mission accomplishment (Marks & Panzer, 2004). However, critical pieces of information may be missing or, in more dynamic environments, information critical to mission success can change after the team has engaged in deliberate planning. (Leekelley & Sankey, 2008). Moreover, team members have to organize themselves to set responsibility boundaries within the context of the mission/task This involves critically examining member resources, skills, abilities, and prior knowledge, and subsequently matching them to subtask requirements (Driskell et al., 2003; Klein et al., 2009).

Action processes

Team members actively engage in many affective, behavioral, and cognitive processes in order to successfully execute the plan outlined during plan formulation (Cascio & Shurygailo, 2003). These include coordination, mutual monitoring, back-up behavior, systems monitoring, reactive strategy planning, reactive conflict management, and affect management (Burke, Stagl, Salas, Pierce, & Kendall, 2006). At the core of action processes is coordination, described as the orchestration of the sequence and timing of interdependent actions (Marks et al., 2001). Coordination involves pacing activities within determined temporal boundaries (Salas et al., 2008; Zaccaro et al., 2009). Coordination is a team level process, and can take place explicitly, implicitly, or in some combination of the two (Burke et al., 2006; Entin & Serfaty, 1999).

Further, coordination is strongly based on team communication and participation (Warkentin & Beranek, 1999). It has been argued that efficiency in computer-mediated-communication (CMC) is lower than FTF communication due to the lack of speech acknowledgements and the fact that CMC consumes more time in explaining the conversation context (Borges, Brézillon, Pino, & Pomerol, 2007; Lin et al., 2008). For example, in an experiment utilizing undergraduate students who were given the task of reaching consensus on a choice-dilemma problem, CMC groups exchanged fewer remarks than did FTF groups (Siegel et al., 1986). When CMC relies heavily on text significant information is often not communicated within a message. Successful communication demands the foundation of mutual knowledge and parties typically use physical and linguistic expression to make inferences about others' knowledge (Hollingshead, 1998) that is difficult to communicate with text alone. In addition, text messages may take more time to comprehend for the recipient because of the absence of visual cues and linguistic expression. Despite the disadvantages of CMC, the evaluation of others is less stereotyped and more valid when visual observation is removed from communication (Straus, Miles, & Levesque, 2001). Also, asynchronous communication in VTs may be more effective in some aspects since communication can take place over an extended period of time. The delay between response and feedback can provide members with the opportunity to think about the problems and reflect more efficiently before responding (Lin et al., 2008).

Interestingly, in a study that examined group history, no differences were found in communication effectiveness or information sharing for groups that had a prior history of working together (Leenders et al., 2003; Warkentin & Beranek, 1999). Finally, for creativity, both very low and very high levels of interaction among CMC group members were found to be detrimental (Leenders et al., 2003).

Several studies have demonstrated that participation levels become more equalized in VTs than in FTF teams (Siegel et al., 1986; Zigurs, Poole, & DeSanctis, 1988). The most commonly cited reason for this is the reduction in status differences resulting from diminished social cues (Hollingshead, 1996). Hence, electronic communication is expected to be a means of establishing equality among group members and lowering distinctions among members (Dubrovsky et al., 1991). Last, it has been noted that since the communication tools used for virtual interaction allow for records to be retained (Suchan & Hayzak, 2001), VTs have a means for monitoring team activities that are not available to FTF teams Such archives were found to allow VT members to review team interactions and outputs and to use the most creative ones as templates in future situations (Nemiro, 2002). Additionally, in a computer simulated flight task, the electronic medium enhanced the ability of team leaders to differentiate the quality of member contributions (Hedlund et al., 1998). Similarly, social comparisons enabled by technology have been found to reduce the effects of social loafing in electronic brainstorming groups (Shepherd, Briggs, Reinig, Yen & Nunamaker, 1996).

Interpersonal processes

To date, the majority of VT research on interpersonal processes has focused on conflict, uninhibited behavior such as swearing and name-calling, informality of communication among group members, interpersonal trust, and group cohesiveness (Martins et al., 2004).

Researchers have long stated that *conflict* is an important process that allows teams to make better decisions because more alternatives are generated and considered prior to a decision being reached (Jehn & Mannix, 2001). Conflict is an awareness on the part of the parties involved of discrepancies, incompatible wishes, or irreconcilable desires (Boulding, 1963). In comparing FTF to VT, some researchers have found that conflict is more likely to occur in virtual contexts (Nijstad & De Dreu, 2002). However, the extent and effects of conflict in VTs has been can diminish the adverse impact that geographic distribution can have on psychological intimacy (Walther, 1994).

The concept of *trust* in VTs has been widely researched (Olson & Olson, 2012; Salas et al., 2008; Warkentin & Beranek, 1999; Wilson, Straus, & McEvily, 2006). Mutual trust is an emergent affective state critical to team effectiveness (Salas, Sims et al., 2005). As an individual attitude, trust is a belief or expectation that another individual will behave in a manner that is indicative of good intentions (Spector & Jones, 2004). Therefore, it follows that mutual trust is a “shared belief that team members will perform their roles and protect the interests of their teammates” (Salas, Sims et al., 2005, p. 561). Many dimensions of trust have been identified including cognitive trust, calculative trust and institutional trust (Peters & Karren, 2009). In a virtual environment, the determinants of trust that have been examined include time (Walther, 1995; Walther & Burgoon, 1992), communication intensity, and the ability to cope with technical and task uncertainty (Ratcheva & Vyakarnam, 2001). Moreover, it has been argued that trust in VTs needs to develop quickly as teams may only interact for a short period of time or may be working on a task that is of great importance and urgency (Kanawattanachai & Yoo, 2002).

Researchers have found that trust in VTs is derived initially from perceptions of ability and integrity as well as members’ propensity to trust (Kanawattanachai & Yoo, 2002; Olson & Olson, 2012). However, as the team’s task progresses, trust appears to be less related to assessments of ability. Furthermore, a study by Piccoli and Ives (2004) found that the use of behavioral controls, such as having members file weekly reports and assigning specific tasks, were associated with a decline in trust among VT members. Additionally, several attributes of team communication (social, predictable, and enthusiastic) have been found to facilitate the formation of trust within VTs (Jarvenpaa & Leidner, 1999). Interestingly, while high and low performing VTs may start with the same levels of trust, the high performers appear to be better able to develop and maintain high levels of trust throughout their project (Kanawattanachai & Yoo, 2002). Finally, the effects of trusting relationships within VTs appear to be similar to those evidenced in traditional teams (Holton, 2001). Specifically, trust in VTs has been shown to be positively associated with job satisfaction (Jehn & Mannix, 2001) and improved working relationships (Gloor, 2007).

Group cohesiveness is as import as trust. It refers to members' attraction to the group and to its task (Kozlowski &Bell, 2003). In a study of student teams from multiple universities, Warkentin, Sayeed and Hightower (1997) highlighted that FTF groups reported higher levels of cohesiveness than did VTs. Within VTs, cohesiveness has been associated with greater satisfaction; highly cohesive groups, regardless of communication media, were able to exchange information more effectively (Kuo & Yu, 2009).

Also, *task cohesiveness* was found to positively impact team effectiveness (performance quality) for dispersed student teams working to generate case solutions(González, Burke, Santuzzi, & Bradley, 2003). In contrast, Aiello and Kolb (1995) found that cohesiveness did not result in a higher rate of work in VTs working on a simple task.).

A *shared group identity* has been suggested as critical to the effective functioning of teams due to its impact on cooperation, commitment to decisions, and levels of trust (Kramer & Brewer, 1986). Identification may be of even greater significance within VTs particularly when the teams anticipate working together in the future (Walther, 1997). Spears, Lea and Lee (1990) found that even when team members worked in isolation, team identity could be strong if members saw themselves as a significant part of the team rather than as individuals working on a part of the team project. In two 7-week sessions using students, some authors (Fiol & O'Connor, 2005) found that group identity was initially lower for CMC groups than for FTF groups. However, this difference diminished over time and was non-significant by the end of the study. Prior research focusing on team empowerment has demonstrated a positive relationship with performance (Kirkman & Rosen, 1999). In a study of 35 VTs in a field setting, Kirkman et al. (2004) found that team empowerment was significantly and positively related to process improvement and customer satisfaction. Additionally, this study found that the extent of virtualness, assessed as the number of FTF meetings, moderated the relationship between empowerment and performance, such that empowerment was of greater significance for process improvement in teams that rarely met FTF.

2.3 The I-P-O Model: Outcomes

Much of the literature on VT has been devoted to examining the effects of virtual interaction on team affective outcomes (such as member satisfaction), and on performance outcomes (such as effectiveness, speed of decisions, and decision quality). Further, researchers have examined various contingency factors that may influence the effects of virtual interaction on team outcomes (e.g., Baker, 2002; Maznevski & Chudoba, 2000; Straus & McGrath, 1994).

Affective outcomes

Graetz, Boyle, Kimble, Thompson and Garloch (1998) observed that teams using electronic media reported higher levels of frustration as they had to exhibit significantly more effort due to the nature of CMC. For member satisfaction, the effects of virtual interaction appear to be dependent on the nature of the task and on team composition (e.g., Cappel & Windsor, 2000). In general, lower levels of satisfaction characterize VTs (Jessup & Tansik, 1991; Straus, 1996).

However, for decision-making tasks, members of CMC groups have reported being more satisfied with the group process, in part, because more alternatives were considered and more voting rounds took place (Valacich & Schwenk, 1995). Similarly, members of electronic brainstorming groups have been found to be more satisfied than their FTF counterparts (Gallupe et al., 1992).

Performance outcomes

When considering VT performance, researchers have consistently found that virtual interaction increases the amount of time required to accomplish tasks (e.g., Cappel & Windsor, 2000; Daly, 1993; Graetz et al., 1998; Hollingshead, 1996; Straus, 1996; Weisband, 1992). For example, Graetz et al. (1998) found that electronic chat groups took significantly longer to reach a decision and arrived at less accurate decisions than did teams working in FTF or teleconferencing contexts. Also, the asynchronicity of the communication media in VTs may result in members working on other tasks at the same time as they are participating in teamwork, and thus, the focus of their attention may not be solely on the team's task (Malhotra, Majchrzak, Carman &

Lott, 2001).

Yet, there is no evidence that VTs display less effort than FTF teams (Siegel et al., 1986). The findings for the effects of virtualness on the quality of a team's decisions have been mixed. Several researchers have found no difference in performance quality between virtual and FTF teams (e.g., Cappel & Windsor, 2000; Straus & McGrath, 1994). Hiltz et al. (1986) found that although FTF groups demonstrated higher levels of agreement than did CMC groups, there were no differences between the two types of groups in the quality of decisions.

Using corporate managers performing the desert survival task in a training session, Potter and Balthazard (2002) found that the objective performance and process outcomes of VTs were very similar to those of their FTF counterparts. In some instances, researchers have indeed found that FTF teams outperform VTs (e.g., Andres, 2002; McDonough et al., 2001; Straus & McGrath, 1994). It has also been noticed that VTs produce better work (Jarvenpaa et al., 1988), make more effective decisions (Schmidt, Montoya-Weiss & Massey, 2001), generate more unique and high quality ideas (Valacich, George, Nunamaker & Vogel, 1994), and report their solutions as being more original (Connolly, Jessup & Valacich, 1990).

3. Technologies supporting Virtual Team Effectiveness

The use of computerized collaborative tools to support group decisions and effectiveness has gone through several stages of evolution. In the 1980's and 1990's, a popular research stream was to adopt a Group Decision Support Systems (GDSS) and Computer Supported Cooperative Work (CSCW) to enhance team productivity. They are computing and communication technology based systems that assist groups of participants engaged in a common task, supporting communication, coordination, and collaboration through facilities such as information, discussion forums, and messaging (Ellis, Gibbs, & Rein, 1991; Lukosch & Schümmer, 2006). The scope of research coverage is quite broad, ranging from group editing, workflow, group scheduling and software design (e.g., Coleman and Khanna 1995; Schmidt and Bannon 1992; Cohn et al. 2009).

However, the line of research that has studied these tools has primarily been oriented toward FTF discussions in a meeting room. Moreover, research in these two areas has investigated many important issues in using IT to support group works, but they also encountered certain difficulties and were not very successful in investigating group decision making. For example, for GSS, a major limitation is that most research targeted at the FTF setting and the major performance improvement is found in the process improvement and satisfaction but not in the decision quality (Kreijns, Kirschner, & Jochems, 2002) while CSCW is basically technical oriented with a focus on system design. Moreover, instead of focusing on group decision-making, CSCW and groupware technologies focus on cooperative work in distributed environments.

A recent group of such technologies uses Web 2.0-based social software for such purposes. These tools aim at solving some of the problems cited earlier and, in a broader perspective, to improve the effectiveness and efficiency of the group decision-making process (Gloor, 2007), as well as to promote a new form of collaboration called collaboration 2.0. It refers to the deployment of Web 2.0-based social software tools and services, such as wikis, blogs, forums, RSS feeds, opinion polls, community chats and social networking, to facilitate enterprise collaboration. In fact, collaboration 2.0 includes large number of computerized tools, infrastructures, and service environments and it is frequently referred to as social software. The special capabilities of collaboration 2.0 tools and procedures can result in considerable flexibility in operation and cost reduction in some companies (Kreijns et al., 2002; Workman et al., 2003). They also (a) easily contribute small informal knowledge chunks; (b) support simple many to many interactions; (c) help to overcome space and time dispersion; (d) support the integration of both existing and new contributions, (f) promoting rapid alignment (Gaggioli, Riva, Milani, & Mazzoni, 2013). For example, assembling these basic concepts with the potential of the world wide web in its most recent version (web 2.0), enterprise 2.0 was born in the business context. It implies the emerging use of social software platforms within companies to facilitate the achievement of business objectives (McAfee, 2009). Thus, Enterprise 2.0 allows to work on reputation, (by both monitoring the internal reality of the organization, and identifying the dynamics implemented by external stakeholders and audiences), collaboration (by developing internal communities), communication (by stimulating the development of interactive exchanges), and connectedness (by enriching the relational and logical transmission of information). Other interesting phenomena linked to virtual integration are crowdsourcing and Collaborative Innovation Networks (COINs). The former represents an online, distributed problem-solving and production model that indicates the procurement of a set of tasks to a particularly broad and undefined group of individuals, called to collaborate through Web 2.0 tools (Estelles-Arolas & Gonzalez-Ladron-de-Guevara, 2012). The latter, indicates a "cyber-team of self-motivated people with a collective vision, enabled by the Web to collaborate in achieving a common goal by sharing ideas, information and works" (Gloor, 2007).

Web 2.0-based social software tools and services can support team performance at all the three levels discussed above:

- *Planning Phase:* the major role of the intelligence stage is to identify the problem and collect relevant information. While for many teams the problem (opportunity) is known and the mission then is to provide a solution, in other cases only the symptoms are known and the team needs to identify and define the problem. This phase involves mainly finding, sharing and analyzing information. Once a problem is identified, the team needs to determine if it is important (or urgent) enough. A most straightforward application for collaboration tools is to conduct searches and to help sharing information among participating group members. Applications in this category focus on efficient gathering of information and its dissemination in order to trigger new collaborations or foster existing ones. Corporations have been using RSS feeds, group chats, blogs' discussion forums, micro-blogs (mostly Twitter), and wikis for dissemination of briefs, queries, and finding best practices as an effective supplement or even as replacement of information dissemination via email.
- *Action Phase:* once a problem has been identified, the team needs to solve it. To do so, potential alternative courses of action need to be generated innovatively. One way to do it is to employ brainstorming. Social software can support the collection of experts opinions and suggestions (e.g.; via the answer function of Linkedln, by using Twitter or blogs to solicit help, or by using discussion forums, by using polling in social networks and by conducing live chats (e.g., IM). We note here briefly the use of large number of possible contributions, in what is referred to as the wisdom of the crowd, or the use of collective intelligence. Collective intelligence occurs when a large group of people work independently on a single project. Such projects typically take place on the Internet using collaboration 2.0 tools such as wikis, polling opinions, and forums. The wisdom of the crowd refers to the consolidation of the collective opinion of a group of individuals, and it is used in the corporate world for idea generation and problem solving (Surowiecki, 2004, 2005).

- *Interpersonal Phase:* making choices by groups usually requires some analysis, deliberation, discussion, voting and negotiation. Groups may also need to conduct some analysis of the alternative courses of action. A recent development is the integration of social networking and business intelligence (BI), which appears under the name of "collaborative decision making" or "CDM" (see Schlegel et al. 2009). CDM may dramatically improve the quality of decision making by directly linking the information contained in BI systems with collaborative input gleaned through the use of social software. This is especially true for non-routine, complex decisions that require iterative human interactions. Also, tying BI to decisions and outcomes that can be measured enables organizations to better demonstrate the business value of BI. Organizations already use collaborative social software to keep informed about where colleagues are and what they are doing and even thinking, and to mobilize them for urgent meetings to solve problems.

Conclusion

Within this chapter we noticed how the rapid development of Information and Communication Technologies (ICTs) and changes in the actual scenario have led to salient changes in the manner in which groups work, solve problems and communicate (Olson & Olson, 2003). People collaborate in virtual and dispersed teams with alternative non-hierarchical forms of leadership (Pearce, Conger, & Locke, 2008) so that nowadays, with rare exceptions, all organizational teams are virtual to some extent (Martins, Gilson, & Maynard, 2004). Virtual Teams (VT), or geographically distributed groups who rely primarily on computer-mediated technologies to communicate, are becoming critical for the long-term competitiveness of organizations (Driskell, Radtke, & Salas, 2003; Schiller & Mandviwalla, 2007).

Yet, the term "VT" is used to cover a wide range of activities and forms of technology-supported working (Hertel, Geister, & Konradt, 2005; Martins et al., 2004). All of the major research in this area contends that VTs must use some type of CMC. Gassmann and Von Zedtwitz (2003) defined VTs as groups of people and sub-teams who work across links strengthened by information, communication, and transport technologies. Similarly, Hertel et al. (2005) and Piccoli, Powell, & Ives (2004) suggest that VTs are distributed work teams whose members are geographically, organizationally and/or time dispersed, who coordinate their work predominantly with electronic information and communication technologies (e-mail, video-conferencing, telephone, etc.). Martins et al. (2004) argued that virtual are teams whose members use technology to varying degrees in working across locational, temporal, and relational boundaries to accomplish an interdependent task.

However, being equipped with even the most advanced technologies is not adequate to make a VT effective, since the internal group dynamics and external support mechanisms must also be present for a team to succeed in the virtual world (Ale Ebrahim, Ahmed, & Taha, 2009). With regards to team effectiveness we considered three basic criteria (Lurey & Raisinghani, 2001): (a) team's productivity level; (b) a team's ability to learn and improve its functioning thus sustaining itself over time can be evaluated; (c) the extent to which a team is able to provide satisfaction to its individual members along any number of intrinsic measures is the third dimension. All the three criteria fit the inputs-processes-outcomes (I-P-O) model (McGrath, 1964), the dominant framework used in the study of teams to explain how they can achieve their effectiveness. Within this model. inputs represent starting conditions of a group, such as group size, KSAs, task dimensional factors, technology and team composition. Processes represent dynamic interactions among group members as they work on a group's task and especially team decision-making dynamics. Outcomes represent affective and performance consequences of a group's functioning (Martins et al., 2004).

Finally, we analyzed which are the technologies that can be use to support the VTs and their dynamism within the I-P-O model. In the following chapter we will focus on how SG may be crucial in both studying and empowering human interaction and performance in VTs.

3. Mind the Game™: the design of a collaborative multiplayer Serious Game to promote team working

Computer game design is a well researched field where topics like engaging storyline, appropriate graphics and sounds, and game balance are often discussed (Blakesley, 2010; Jegers, 2007; Kafai, 2006; Marsh, 2011). However, in the area of SGs, game design has to address specific challenges as SGs not only have to fulfil the same requirements as other games, but they also have to promote training and empowerment (Wendel et al., 2013c). By using the latest simulation and visualization technologies, SGs are in fact able to contextualize the player's experience in stimulating and realistic environments that foster practical learning experiences blended with ludic and engaging affordances. Moreover, the design and development of SGs games, and especially, multiplayer SGs, can be a complex activity involving many participants from a variety of disciplines (Taylor, Gresty, & Baskett, 2006).

The aim of the present chapter is to focus on SGs that act as team building environments by promoting team interaction and performance. Therefore, we will firstly introduce concrete examples of SGs that have been designed to promote team dynamics, focusing on different areas, like military, emergency and business. Secondly, we will discuss SG design practices, considering different guidelines or frameworks for designing multiplayer SGs (Sung & Hwang, 2013). In particular, we will analyse the model developed by Johnson and Johnson (2002) who identified five factors that are able to promote collaboration and collaborative learning (Barron, 2000) in a multiplayer environment: *positive interdependence, individual accountability, promotive interaction, social skills and group processing*.

Eventually, we will introduce *Mind the* Game™, a multiplayer SG designed and developed to enhance team working and ingroup dynamics. Both the structure and the narrative affordances of the artefact will be deepened, considering game design practices. A sport-based narrative framework has been particularly useful to create a socio-technical environment based on distributed knowledge systems and complementary tasks. Integrated with the multiplayer affordance of the game, these traits trigger cooperation and competitiveness. They also stimulate a proactive co-construction of knowledge that can empower not only individual skills, but also the group as a whole. The game is presented according to the three development stages (Design, Implementation, and Evaluation) proposed by Starks (2014) and the indications given by Johnson and Johnson (2002).

1. Serious Games and Team Working

1.1 Playing Games to enhance collaboration and team working

In the last twenty years numerous SGs have been designed to promote team performance and collaboration in different fields. The military sector has led the way in the use of SGs for training team dynamics, first through an analysis of the opportunities related to the use of entertainment games like *Counter Strike* and *Call of Duty* (Mayer, van Dierendonck, van Ruijven, & Wenzler, 2013; Michael & Chen, 2006), followed by the development of tailored SGs like *America's Army* (Bergeron, 2006). Within this field, military operational team training is increasingly conducted in flexible simulation training solution for scenario training and mission rehearsal, like *Virtual Battle Space (VBS)*. SGs environments like VBS are used to set up specific scenarios for military training and assessment involving the army, air forces, navy, marine, special forces, humanitarian intervention and emergency relief teams (Andrews, 2007; Van Der Zee, Holkenborg, & Robinson, 2012).

Similarly, also the training of first aid teams and emergency managers has been deeply supported by SGs solutions and applications (Harz, Stern, & Sparks, 2008).

The same has happened in the medical field where many authors have acknowledged the role SGs have in the training of medical teams (Graafland, Schraagen, & Schijven, 2012; Mann et al., 2002; Michael & Chen, 2006; Peng, Lee, & Heeter, 2010).

Other good examples of SGs specifically designed for team training can be found in the field of organizational management and education (Bozanta, Kutlu, Nowlan, & Shirmohammadi, 2012; Hakkinen, Bluemink, Juntunen, & Laakkonen, 2012). For instance, *Infiniteams* is a multi-player, team-based and online game that is played with a team in order to reveal leadership potential of participants (Allen, Seeney, Boyle, & Hancock, 2009). Empirical results shows that transactional and transformational leadership behaviors are correlated with multiplayer online game experience (Zagal, 2006).

Another important issue within business organization is team building. Several SGs have been designed to address this challenge. *Everest V2,* was developed by the Harvard Business School to promote leadership and team working, and *Woodment* was presented as an educational web-based collaborative multiplayer SG, used by Wendel et al. (2010) to explore team dynamics within business field. *Woodment* players are challenged to manage a multinational company, encounter with unexpected events and try to solve conflicts, communicate with others via chat option. It has been shown that the game environment is useful for collaborative learning (Wendel, Gutjahr, Göbel, & Steinmetz, 2013b), enabling a collaborative gameplay and fostering collaborative behaviors. Similarly, *TeamUp* developed by The Barn in collaboration with the Delft University of Technology and Accenture (Mayer et al., 2013), was used by Mayer and his colleagues (2013) who noticed that 'team cohesion' and 'psychological safety' correlated significantly with in-game performance indicators. Within the study, teams with an unequal individual game performance spoke the most, while teams with an equally low or equally high individual performance spend significantly less time speaking.

To very the potential of immersive virtual games as team building environments Ellis, Luther, Bessiere, & Kellogg (2008) developed three games: C*rossing the Ravine, Tower of Babble and Castle Builder*. They observed that these games provided an alternate means for encouraging team development due to their affordances for facile communication, emotional engagement, and social interaction among participants.

Another game to support team building processes is *eScape* (Bluemink, Hämäläinen, Manninen, & Järvelä, 2010), an adventure game which is played by four people where participants try to solve a set of problems and escape from ancient prison. The game was used in an empirical study by Bluemink et al. (2010)

who collected data from a design experiment in which six randomly divided groups of four university students played a voice-enhanced game lasting about 1h. It was found that individual students, especially those with prior knowledge of gaming or prior social ties, can have a major impact on the social interaction and the outcome of collaboration. Therefore, authors concluded that *eScape* allowed students to engage in true and constructive collaborative activity, as well as that in the future multiplayer games could be used, to promote group cohesion and development.

In another study, Hamalainen used the game *Mustakarhu* (Hamalainen, 2008). The script of the game was designed to encourage students to make decisions together. The game includes three different types of puzzles; some can be solved individually, but others require effort and commitment from the whole team for successful completion. Hence, different modes of collaboration and cooperation are required. During the game students are expected to design the rooms, calculate the areas and costs of the materials, answer a quiz about materials, and finally write a report about the design process (*ibidem*). In the study a total of 20 participants played the game and participants expressed that the game environment is more attractive and helpful than traditional class environment. The game process also brought up a new form of interaction, as the students were able to use visual communication, as well. Moreover, the findings indicated that this game environment also offered a setting for different modes of interactions and encouraged teams to collaboration. Yet, collaboration was dependent on the learners' willingness to work together, so that in one team whose members preferred working alone, collaboration took place only when absolutely necessary.

1.2 Making Games to enhance collaboration and team working

Not only playing SGs, but also making them can encourage collaboration and team working. The pedagogic idea of learning by making games assumes that the construction of games helps learners to reformulate their understandings of the subject and express their personal ideas and feelings about both the subject of the game and the games constructed (Bermingham et al., 2013; Kafai, 2006). For example, designing games can lead to an enhanced sense of classroom community, which encourages students to ask and questions and provide help for others (Baytak & Land, 2010) as well as to share tips and alternative ways of doing things in the game - making environment (Robertson & Nicholson, 2007). Hwang, Wu, and Chen (2012) further reported that promoting interactions among students during the gaming process is helpful to students in improving their learning performance.

Game-making can also support the development of 21st century competencies like creative problem solving, collaboration, ICT literacy, systems thinking, and positively affect engagement (Bermingham et al., 2013; Eow, Ali, Mahmud, & Baki, 2010; Robertson & Nicholson, 2007; Van Der Zee et al., 2012).

2. Multiplayer Serious Game Design: from theory to practice

Computer game design is a well researched field where topics like engaging storyline, appropriate graphics and sounds, and game balance are often discussed (Blakesley, 2010; Jegers, 2007; Kafai, 2006; Marsh, 2011). Moreover, the design and development of modern games can be a complex activity involving many participants from a variety of disciplines (Taylor et al., 2006). According to Zagal, Nussbaum, & Rosas (2000), two things basically define a game concept and have to be taken into account when designing games:

- **Rules and Goals:** all games have rules of some form or another. Rules define what can or can't be done in a game. They lay down the framework, or model, within which the game shall take place. Rules regulate the development of the game and determine the different interactions that can take place within it. Games also need objectives that the players shall pursue, and these are the goals of the game.
- **Props and Tools:** the framework laid down by a set of rules is applied and assisted by the use of props and tools. These are the elements with which the game is to be played. Normally, the rules make these elements necessary in order to play the game, at different levels. A prop is an element that is used purely for decorative purposes, while a tool has a certain degree of functionality. That is, a tool is used by the players while a prop is merely looked at.

Both rules and goals and props and tools have to be defined by considering players and their characteristics (Zagal, 2006). These are key elements for SG design as well. Therefore, in the following paragraph, we will discuss how the principles of game design can be specifically deployed in field of SGs.

2.1 Serious Game Design guidelines

In the area of SGs, game design has to address other challenges as SGs not only have to fulfil the same requirements as other games, but they also have to promote training and empowerment (Wendel, Gutjahr, Göbel, & Steinmetz, 2013c).

Numerous models have been proposed. Taylor, Gresty, & Baskett (2006) and Kiili (2005) proposed a gaming model for SGs based on the flow theory of Csikszentmihalyi (Csikszentmihalyi, 2000; Nakamura & Csikszentmihalyi, 2002). The model stresses the importance of providing the player with immediate feedback, clear goals and challenges that are matched to his/her skill level, linking these elements to the *Person-Artifact-Task* (PAT) model that conceptualizes the major components of a person working on a computer-related activity (Finneran & Zhang, 2003). All three components, have to be considered when designing SGs.

From the perspective of game design, to make sure that the SG is able to provide fun to its players, is important to include entertainment game mechanisms, as role playing, collecting points, tile matching. Other mechanisms include also clear but challenging goals, rules, fantasy, progressive levels of difficulty, and feedback (Fullerton 2014; Baranowski, 2013; Deterding et al., 2011).

As noted in the first chapter, the aim of a SG is to provide players with challenges related to the main task so that flow experience is possible. Games are in fact "flow activities" (Csikszentmihalyi, 1991; 2000) as they are intrinsically able to provide enjoyable experiences (McGonigal, 2010), creating rules that require the learning of skills, defining goals, giving feedback, making control possible, and fostering a sense of curiosity and discovery. However, when both the task and the use of the artifact are complex, then the artifact and the task may detract from the user's attention (Kiili, Lainema, de Freitas, & Arnab, 2014). Bad usability decreases the likelihood of experiencing task based flow because the player has to sacrifice attention and other cognitive resources to inappropriate activity (Jegers, 2007). Because the information processing capacity of working memory is limited (Nakamura & Csikszentmihalyi, 2002), all possible resources should be available for relevant information processing rather than for the usage of the artifacts. In an ideal situation artifacts are transparent and allow the player to focus on the higher order tasks. Specifically, In order to develop a SG able to induce in players high level of immersion, it is important to look at game design elements, including for example (see also Fullerton, 2014; Baranowski, 2013; Sweetser & Wyeth, 2005):

- **Challenge:** As noted by Gee (Gee, 2003), who claims that the game experience should be "pleasantly frustrating", challenges have to match players' skills/level and to support their improvement throughout the game. During specific stages of the game, "Fish tanks" (stripped down versions of the real game, where gameplay mechanisms are simplified) and "Sand boxes" (versions of the game where there is less likelihood for things to go wrong) can support this dynamism;
- **Clear goals:** Games should provide players with specific, measurable, achievable, responsible and time-bounded goals;
- **Storyline:** The targeted content needs to be intrinsically coupled with the fantasy context (or story) of the game in order to improve motivation, emotional attachment (Malone and Lepper 1987), and cognitive load (Sweller 1994). The storyline needs to be developed according to the specific skills to train in the target to player types audience (Bartle, 2003);
- **Feedback:** Players have to be supported by feedback on the progress they are making, on their action, and the ongoing situations represented in the virtual environment;
- **Control:** It is fundamental for players to experience a sense of control over what they are doing, as well as over the game interface, and input devices; players should feel a sense of control through endogenous feedback, in order to increase their motivation and engagement in the game (Paras, 2005).

2.2 Multiplayer Serious Game Design guidelines

Further, researchers have attempted to propose guidelines or frameworks for designing multiplayer SGs (Sung & Hwang, 2013). For example, Zagal (2006) proposed a set of guiding principles for multiplayer SG design, analysing a collaborative board game and identifying important lessons learned and pitfalls when creating collaborative games. These are presented as follow:

Lessons
1. To highlight problems of competitiveness, a collaborative game should introduce a tension between perceived individual utility and team utility.
2. To further highlight problems of competitiveness, individual players should be allowed to make decisions and take actions without the consent of the team.
3. Players must be able to trace payoffs back to their decisions
4. To encourage team members to make selfless decisions, a collaborative game should be- stow different abilities or responsibilities upon the players
Pitfalls
1. To avoid the game degenerating into one player making the decisions for the team, collaborative games have to provide a sufficient rationale for collaboration
2. For a game to be engaging, players need to care about the outcome and that outcome should have a satisfying result.
3. For a collaborative game to be enjoyable multiple times, the experience needs to be differ

Tab.2 Lessons & Pitfalls (Zagal, 2006)

Similarly, Wendel, Gutjahr, Göbel, & Steinmetz (2013a), developed a multiplayer SG design proposal based on the following elements:

- **Common Goal/Success:** the goal of the game should be designed in a way such that success means success for all players;
- **Heterogeneous resources:** each player should have one unique tool or ability enabling him/her to perform unique tasks in the game which other players cannot perform, e.g. only the player with the axe can fell palms in order to get wood for building the hut, the raft or for fire;
- **Refillable personal resources:** in order to create a certain tension, there should be certain re- fillable resources (e.g. a health or hunger value) which slowly deplete automatically or when players act dangerously. Furthermore, they should be influenceable in a way such that players can help each other (e.g. food could be gathered by one player and then be given to another player to prevent him/her from starving);
- **Collectable and tradable resources:** there should be resources in the game world necessary for the players to win the game. These resources should be tradable between players in order to create space for decisions to negotiate or collaborate (e.g. giving a resource to another player for the common good of the team or trading resources between players);
- **Collaborative tasks:** if all tasks could be solved by one player, there would be no need to collaborate. So there should be tasks which are solvable only if players act

together. Those tasks may include the heterogeneous resources described above to create a need for certain players to participate in team tasks. This may cause a need for discussion among players when the group depends on one individual;

- **Communication:** it has been shown that communication is vital for collaborative learning. So the game should provide a way for players to communicate (e.g. chat system, voice communication). While voice communication might be easier for most players, a text-based chat system might be easier to evaluate. Also a third party tool for communication like Skype, TeamSpeak or Mumble could be used;
- **In-game help system:** the game should provide help to the players when they are stuck. The easiest way is a popup when players fail a task or it takes them too long to solve it. Furthermore, the help system should be triggerable by the players. A more sophisticated but also more immersive way is to include help in the game itself, e.g. by having in-game characters (NPCs) providing help when needed;
- **Scoreboard:** a scoreboard should show both individual efforts and team efforts at the end of the game. This may help players judge the overall success (e.g. by comparison with other teams or previous attempts) and each player's contribution to the team performance. The individual score may function as a motivator for selfish actions which helps to make collaboration not self- evident
- **Trading system:** players should be able to trade items among each other. This creates space for decisions for or against collaboration.

To integrate these models within a common framework, Johnson and Johnson (2002) proposed a model based on five factors that are able to promote collaboration and collaborative learning (Barron, 2000) in a multiplayer environment:

- **Positive interdependence:** knowing to be linked with other players in a way so that one cannot succeed unless they do;
- **Individual accountability**: individual assessment of each student's performance and giving back the results to both the group and the individual;
- **Promotive interaction**: promoting each other's success by e.g. helping, encouraging and praising;
- **Social skills**: interpersonal and small group skills are vital for the success of a cooperative effort.
- **Group processing:** group members discussing their progress and working relationships.

3. Mind the Game™: a multiplayer serious game to promote team work and collaboration

Mind the Game™ is a a multiplayer decision-making SG developed for a target of adult individuals to create a socio-technical environment (Fisher, Giaccardi, Eden, Sugimoto, & Ye, 2005) where the interconnection between humans and technology encourages the emergence of collaboration and team working.

Embedding the potential of serious gaming, *Mind the Game™* aims to expand the range of resources that groups can access in daily contexts, allowing a greater awareness of the skills possessed both individually and as a whole, and implementing an experiential learning process that supports shared optimal experiences. Hence, the game can be considered as a useful tool to promote collaboration and team working among individuals, both for virtual and FTF teams.

As a new medium aimed at facilitating change (Riva, Castelnuovo, & Mantovani, 2006), the SG generates a virtual environment where groups can express their potential, dealing with a reality that constantly redefines the balance between challenges and skills. This was studied to create a virtuous circularity that promotes collective peak experiences and high levels of perceived effectiveness, both in an individual and collective sense (Argenton, Pallavicini, & Mantovani, 2016; Argenton, Triberti, Serino, Muzio, & Riva, 2014).

Our development stages of the game were separated into the three iterative phases - Design, Implementation, and Evaluation (*see figure 2*) – proposed by Starks (2014). Each phase had micro iterations in the similar manner as a spiral model (Gongsook et al., 2014). Further, the game was designed, following the indications given by Johnson and Johnson (2002).

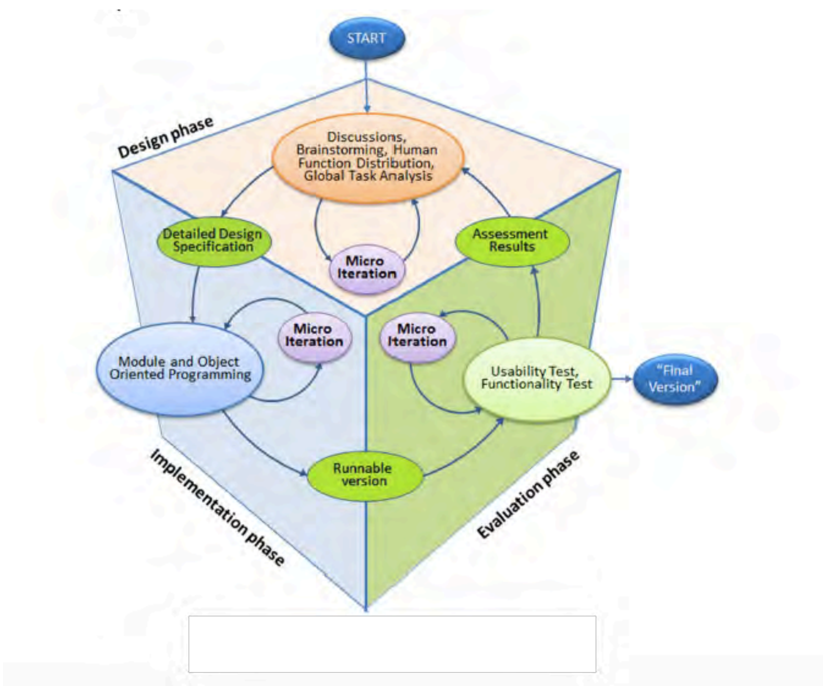


Fig.2 Design, Implementation, and Evaluation (Gongsook et al., 2014)

3.1 The Design Phase

An overview

The game has been designed following the indications given by Johnson and Johnson (2002) (*Tab.3*). In the following sections, we will deepen each characteristics.

The five factors Model (Johnson & Johnson, 2002)	
Key Factors	**Mind the Game**
Positive interdependence: knowing to be linked with other players in a way so that one cannot succeed unless they do.	Users will not be called to playing the game as pilots, but as the team members of an athlete that has to win the World Cup. Therefore, they are linked by a common goal: helping the athlete to achieve her dream, by making the best decisions within the game. The game is designed in a way such that success means success for all players.
Individual accountability: individual assessment of each student's performance and giving back the results to both the group and the individual	Each single player is also motivated by personal goals, different from those of the other participants. Both individual and team scores are assessed during the game. A scoreboard show both individual efforts and team efforts at the end of the game. This may help players judge the overall success and each player's contribution to the team performance. The individual score may function as a

	motivator for selfish actions which helps to make collaboration not self- evident.
Promotive interaction: promoting each other's success by e.g. helping, encouraging and praising	Each task is designed according to a *complementary logic* (Steiner, 1972), in an attempt to involve each player. Specifically, players are called upon to deal with distributed decision-making environments in which real success can not depend on free-riding efforts, but on the emergence of group phenomena, such as social facilitation, social labouring, and team thinking. Therefore, each player has one unique tool or knowledge enabling him/her to perform unique tasks in the game which other players cannot perform.
Social skills: interpersonal and small group skills are vital for the success of a cooperative effort	Collaboration and interdependency between participants are created by distributing different knowledge and resources to each player and triggering resource dependency among players (Oksanen, 2014; Price et al., 2003).
Group processing: group members discussing their progress and working relationships.	Both the storytelling and the task structure take into account the three main phases of group decision making, described in the previous chapter (Marks, Mathieu, & Zaccaro, 2001): • *Planning or transition processes*: they encompass mission analysis, interpretation and evaluation of the team's mission, goal setting, strategy formulation, and other processes related to focusing the group's efforts; • *Action processes:*.these are dynamics that occur during the performance of a group's task, such as communication, participation, coordination, tracking and monitoring of the group's progress; • *Interpersonal processes:* they refer to relationships among group members and include conflict, motivation and confidence building, trust, cohesion, affect, management and social integration.

Tab.3 From theory to practice: applying The five factors Model (Johnson & Johnson, 2002)

Game concept: sport as a narrative tool

The narrative framework - especially in technological solutions based on a textual environment - is a core element for SG design. Narratives have to be clear, straightforward, easy to understand and memorable to capture the interest of the player (Bateman, 2007; McQuiggan, et al., 2008). Therefore, the choice of plots and settings will be decisive to bring the group out of the comfort zone, nurturing the onset of spontaneous behaviors, as well as promoting the emergence of collective behaviours, social presence and ingroup dynamics in multiplayer settings. Moreover, the underlying potential of narratives can be amplified through the use of peculiar scenarios that have nothing to do with day by day experiences (Lindley, 2005). In this way, it is possible to modulate the impact of prior knowledge of player and to support common cognitive processes and knowledge sharing practices.

As a metaphor of life, sport is a powerful and effective training tool, capable of supporting learning and experiential transpositions. In particular, sport witnesses how beyond individual and team excellence there are challenges that do not end against the opponent, but in their relationship with the self.

According to the aforementioned considerations, a little-known sport was chosen: gliding. This is a discipline based on soaring flight, where, in the absence of the driving force of an engine, the pilot is required to take advantage of upward motions and movements of air masses (Brigliadori & Brigliadori, 2011). In fact, thanks to the overheating of the soil and the atmospheric layers close to it, the air creates connective vertical motions, called thermals, that support the flight. The development of the narrative plot structure on such a discipline can be particularly effective both because of an implicit and an explicit reason.

On the one hand, soaring flight embraces a deep archaic desire: the tension to the sky. Sky has represented a point of reference for a humanity that has begun to mature the dream of approaching it. Thus, before becoming the concrete possibility, outlined by the studies of Leonardo or by the efforts made by Wright and Montgolfier brothers, flight is synonym of purity and freedom, fantasy, hope, and imagination. It is the symbol of a challenge marked by a courageous and meaningful searching of the limit. On the other hand, as a sport, gliding implies competition and collaboration. The first concept is well reflected by the Grand Prix, a race in which pilots directly compete one another. The goal is to go throughout a task - a plot delimited by specific turning points that are placed so as to form a polygon – in the shortest time. Generally, the Grand Prix is structured among several days, implying different tasks from time to time. The choice of an individual sport to promote group creativity and of team working may instead appear paradoxical. But it is not: individual excellence is the tip of the iceberg beneath which team effort and coordination always make the difference. The collaborative dimension of gliding is present because, despite the solo flight of the pilot, his/her staff can support each step of the race from the ground. In fact, parameters to be taken into consideration are extremely numerous and they require the intervention of professionals specifically trained. In particular, according to the model described by Brigliadori and Brigliadori (2011), five elements are fundamental:

- **Technical:** managing an efficient flight and exploiting the energy available in the atmosphere in the best possible way, require specific skills: decision-making, problem-solving, control, and experience. Moreover, the maintenance of security and risk management are the foundation of successful flights.
- **Strategic:** the ability to take advantage of circumstances involves a process of decision-making able to take into account meteorological aspects, competitors, geography. The race is played on the ability to make the most from the opportunities that are revealed during the task.
- **Psychological:** control of emotions, stress management, relaxation, high levels of concentration, resilience and self-efficacy are just some of the psychological components that may be decisive during a competition.
- **Athletic:** pilots must take great care in athletic training, monitoring nutrition and fatigue management.
- **Meteorological:** climate is a component whose analysis should be careful and meticulous in order to avoid unnecessary risks and make winning choices.
- **Organizational**: the athlete, together with the staff, is expected to prepare the race in every detail, monitoring equipment and logistics practices.

The sense of in-group belonging is first increased by the narrative framework, that immerses players in a collaborative environment. In this way, it is possible to encourage the emergence of a we-intention. Therefore, users will not be called to playing the game as pilots, but as the team members of an athlete that has to win the World Cup. Each player will in fact be assigned one of the following roles: team manager, strategist, technical expert, meteorologist or doctor.

Characters Design

The arrangement by which each character appears to the player is the same and tends to follow the systemic model proposed by Bowman (2010). It is marked by the definition of name, age, nationality, as well as the role played within the team and the tasks he/she has to preside. The player can then discover his/her background. This is realized on three levels, indicating aspects of the past, present and future. At the same time, the player can also view the individual goals of the character. Finally, there is a brief personality description. Further, during the game each player receives specific information according to his/her role that are not seen by his/her teammates.

Task Design

The nature of the task, especially in multiplayer SGs is fundamental to foster collaboration and team working (Bellotti, Kapralos, Lee, Moreno-Ger, & Berta, 2013). In particular, according to Steiner's model (1972), it is possible to distinguish:

- **Additive** tasks, referred to situations in which the final result is determined by the sum of individual contributions;
- **Compensatory** tasks, where the result is determined as an average of the contributions made by individual subjects;
- **Conjunctive** tasks, where the success of the group depends on the success of each member;
- **Disjunctive** tasks, where each member can promote a solution of their own, knowing that the success of the group depends on a single correct alternative;
- **Complementary** tasks, that requires the sharing of knowledge, processes and methods so that the whole could exceed the sum of its single parts.

In line with this model, most of the tasks of Mind the Game are designed according to a *complementary logic*, in an attempt to involve each player. Specifically, players are called upon to deal with distributed decision-making environments in which real success can not depend on free-riding efforts, but on the emergence of group phenomena, such as social facilitation, social labouring, and team thinking. Clearly, the effectiveness of the group will be marked by its specific characteristics, as well as on its communicative, emotional and hierarchical structure. Collaboration and interdependency between participants are created by distributing different knowledge and resources to each player and triggering resource dependency among players (Oksanen, 2014; Price, Rogers, Stanton, & Smith, 2003).

Therefore, the tasks players have to solve are the following:

1. **Object Challenge**: players needs to identify from a list of 15 objects the five most important tools that their pilot has to bring with her on-board.
2. **Medicine Challenge**: according to the information they receive, players have to select to best medicine for the athlete. The task is complicated by the fact that players have different and partly contradictory information.
3. **Map Challenge**: after a GPS breakdown, the pilot is not able to identify her position on the map. Players have to chronologically reorder the information they received and to solve subgroups puzzles to point on the map the right position of the glider.
4. **Strategy challenge**: the final part of the race is approaching. Players have to decide whether going for a risky or a conservative strategy.
5. **Weather challenge**: the team has just 10 minutes to understand the meteorological condition of the race and to support the athlete with the best option.

Moreover, each task has been defined to match a specific stage of the team process described in chapter 2 (Marks, Mathieu, & Zaccaro, 2009) as well as to stress specific skills within the group (Tab 3).

Task	***Team Process Focus***	***Task Typology***	***Key Elements***
1. Object Challenge	Planning	Disjunctive	• Scan the environment for cues that have the potential to affect the success of the mission; • Search for consensus within the group; • Cohesion and teamwork; • Creativity of individual members and the group as a whole.
2. Medicine Challenge	Interpersonal	Complementary	• Balancing individual and team goals • Monitoring the balance between individual and group interests • Managing conflict
3. Map Challenge	Interpersonal & Action	Complementary	• Communication • Task cohesiveness

			• Monitoring the balance between individual and group interests • Managing conflict and trust
4. Strategy challenge	Action	Complementary	• Coordination, mutual monitoring, back-up behavior, systems monitoring • Team communication and participation • Monitoring the balance between individual and group interests • Managing conflict and trust
5. **Weather challenge**	Action	Complementary	• Coordination, mutual monitoring, back-up behavior, systems monitoring • Time management • Managing conflict and trust

Tab.4. Tasks: main features

Each task is time bounded and players have to select an option before the time ends, otherwise the system automatically considers the task not completed. To successfully complete the simulation, at least four answers have to be given correctly.

Scoring

We design the game so that each single player will be motivated by personal goals, different from those of the other participants (*Fig.3*)

Fig.3. Individual goals

The team's score is indeed defined as a result of the following parameters:

1. **Score obtained in the race by the athlete**: hen completing a task, each group was given 1, 5 or 10 points according to the quality of the given answer. If players were not able to obtain more than 7 points in two subsequent challenges before task 4, the SG stopped and subjects were not allowed to continue (failure). Moreover, for those who complete the game, single scores are summed at the end of the game and coded as follow:
   - Total Score= 50: excellent performance
   - $45 \leq$ Total Score <49: good performance
   - $41 \leq$ Total Score <44: medium performance
   - Total Score < 40: poor performance

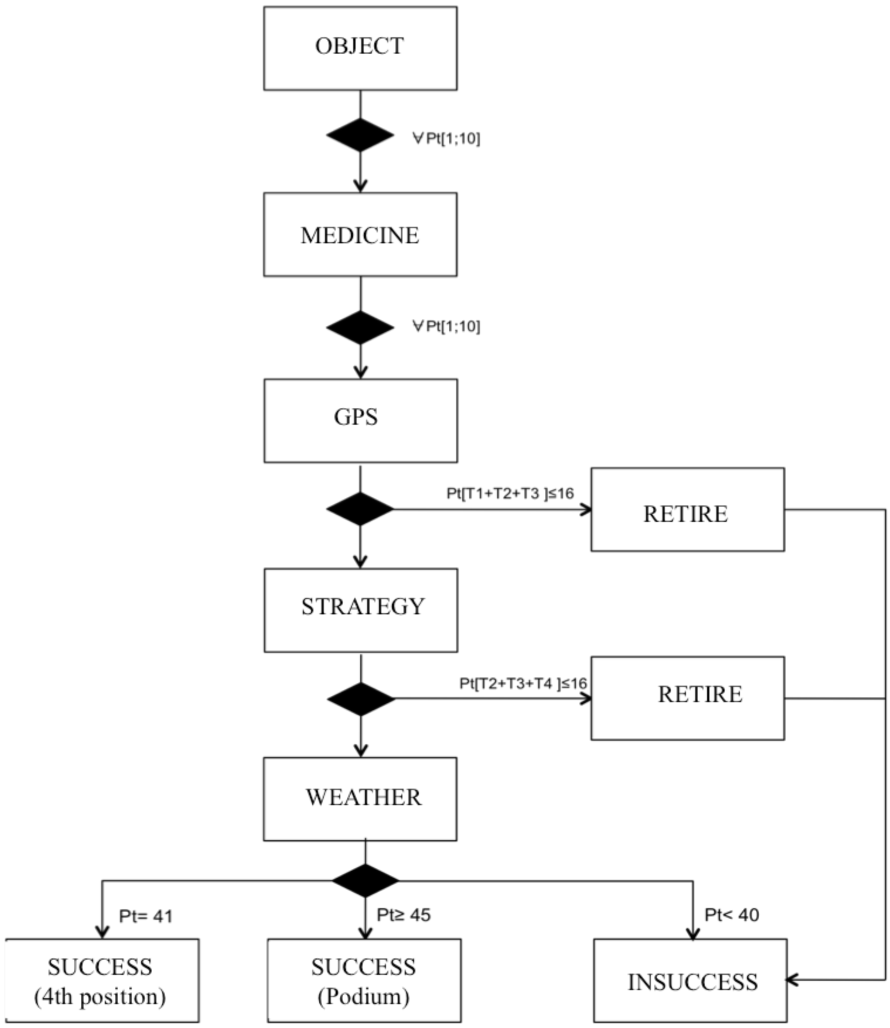


Fig.4. Game Path and Scores

2. **Time Management**: the time (min) needed to complete each one of the five tasks and the game as a whole was considered.

3.2 The Implementation Phase

The interface, developed with Html5, is primarily textual, enriched multimodally by clips images, and animated graphics that make the game more interactive (5). The game, studied for small groups of 5 people, provides the facilitator/the researcher with the ability to monitor the progress of the game. It is now embedded in a specific website (www.mindtheame.it) that consists of a welcome page, a tutorial, and the in-game section.

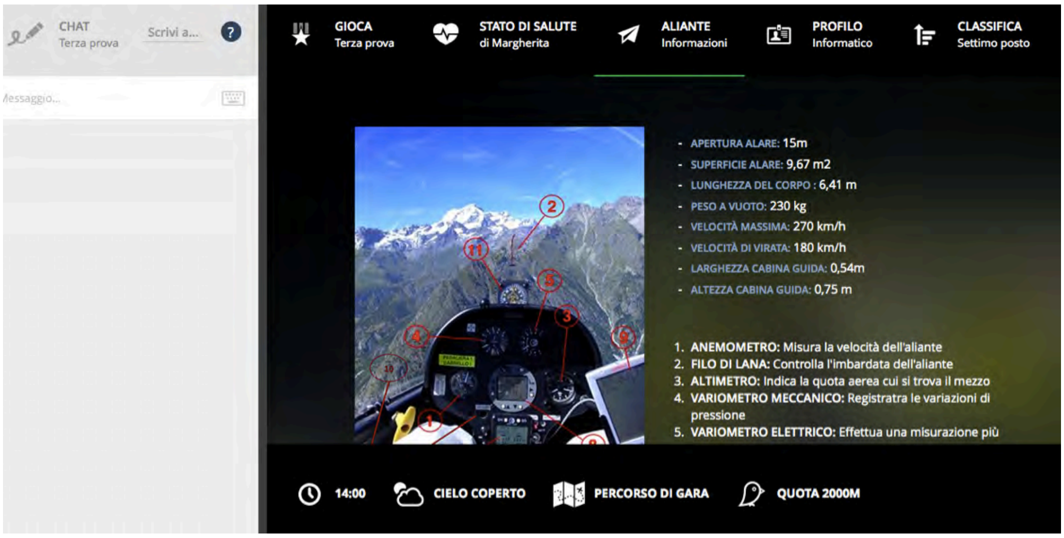


Fig.5. The primarily textual interface of Mind the Game ™ is enriched multimodally by clips, images, and animated graphics.

As it can be observed from Fig.5, the interface is divided in 5 main pages:

- **Play the game:** within this page users can find both the information related to the specific challenge they have to cope with and the personal information. These are information that are presented according to the role of each player and that differ from player to player.
- **Health Status:** this page allows users to monitor the health status of the athlete.
- **Glider:** in this section users may find all the information about the glider and its characteristics.
- **Profile:** players can always monitor their personal profile and goals both as individuals and as a team.
- **Ranking:** here players can analyse how the other pilots are performing.

Before entering the Game: the letter

With the support of a suggestive graphic environment and with an emotional clip, players are introduced to a letter written directly by "Sky Volaleggera", the main character of the game. After introducing herself, the pilot said to be in Australia where she will compete in the last gliding race of the season. Here she can realize her dream:

winning for the first time the World Competition. By showing the characteristics of the race, the pilot explains that the task is going to be very technical and complicated, stressing that every detail can make an important difference.

Players begin to realize their role in the simulation: they will not be called to be an athlete or an opponent of the athlete, but a member of her team. Each player will in fact be assigned one of the following roles: team manager, strategist, technical expert, meteorologist or doctor.

The tutorial

Before entering the game, player can have a quick look at a tutorial. The tutorial highlights how the team is made up by five players and how, next to a shared goal (leading the athlete to win the World Competition), each character will be motivated by personal goals, different from those of the other participants.

Tasks

The exploratory task

The exploratory task was designed with the goal of bringing the five players to familiarize with the information contained in the different folder. Challenged by Sky Volaleggera, users are asked to identify the overall weight of the glider after it has been weighted with a water load equal to 270 kg. To answer, players have to explore the interface and track the weight of the glider when it's empty. Since it is an exploratory task, the answer does not affect the progress of the race.

The object Challenge

Team Process focus: Planning

Type of task: Disjunctive

Key Elements:

- Scan the environment for cues that have the potential to affect the success of the mission;
- Search for consensus within the group;
- Cohesion and teamwork;

- Creativity of individual members and the group as a whole.

The first challenge has been developed with a focus on a typical decision-making task (Hirokawa, 1990; Pridmore & Phillips-Wren, 2012). Participants are presented 15 objects, accompanied by a picture and a brief description. Therefore, players will visualize a Swiss army knife, a pair of sunglasses, a parachute, a cigarette pack, a flashlight, an i-pod, a medical kit, a sunscreen, a water bottle, a life jacket, a geographical map and a rain jacket. Players needs to identify the five most important tools that their pilot has to bring with her on-board. Each player can select one specific object.

The five items were identified through interviews with experts glider pilots, as well as by a deep analysis of the literature (Rosén & Hedenström, 2002; Sukumar & Selig, 2013). A fully correct answer is determined by the choice of the following media:

- **Sunglasses**. Since the effectiveness of the decision-making depends the ability of the pilot to view at his/her best the situation, sunglasses represent an essential tool.
- **Water bottle**. The level of hydration is a basic requirement, especially in the face of the race from long duration.
- **Parachute.** Despite it's rarely used, pilots always bring it with them.
- **Medical Kit**. It is a resource required to manage emergencies more mild to those that risk the life of the pilot.
- **Swiss Army Knife**. It 'an essential tool for its flexibility and multi-functionality that sets it apart.

The medicine Challenge

Team Process focus: Interpersonal
Type of task: Complementary
Key Elements:

- Balancing individual and team goals
- Monitoring the balance between individual and group interests
- Managing conflict

Players are challenged to identify between three alternatives the drug that can improve the physical condition of Sky. Unlike the previous challenges, this has two features that make it particularly interesting. Firstly, it is primarily characterized by a fragmentation of information between different members, which can reach a correct answer collaborating, communicating and matching the data provided. Further, the information are not only fragmented, but also complex, requiring a careful approach. Secondly, this task tries to arise a conflict within the group: among the personal objectives given to the doctor there is the idea of pursuing a sponsorship pharmaceutical, proposing a particular drug, regardless of the benefits that characterize it.

The coach, however, is aware of the past of the doctor and warned about his poor ethical concerns.

The ability to reach the correct answer is then determined by an effective integration of the different information, and the willingness of all players to follow the interest of the athlete and team, instead of pursuing personal interests.

Variabili	Psicomag	Soterixina	Nosolin	Generali	Livello di allerta
PARAMETRI FISICI					
GLC= 40	Efficace	Rischio	Efficace	Soglia 40-70	Preoccupa
IDR = 50	Efficace	Efficace	Rischio/6h	Soglia 40-70	
BC = 50	Efficace	Efficace	Rischio/6h	Soglia 40-70	
CR = 60	Rischio	Efficace	Efficace	Soglia 40-70	Normale abbassamento
CONDIZIONE ATLETICA					
SAL= 60	+5% /2h	Inf(Rischio)	+5% /2h	Soglia =50	Preoccupa
ENG = 60	Rischio	- 5% /2h	Efficace	Soglia =50	Normale abbassamento
RES= 80	Inf (buona)	Inf(buona)	Rischio dopo8h	Soglia =50	Normale abbassamento
CONDIZIONE MENTALE					
EMZ= 55	Inf(Ok)	Inf (ok)	Inf(rischio)	Soglia =50	Non preoccupa
CONC= 70	Inf (buona)	Inf (rischio)	Inf(buona)	Soglia =50	Preoccupa
ATT = 80	Buona	Buona	Buona	Soglia =50	

Fig.6. Information Overview

The GPS Challenge

Team Process focus: Interpersonal & Action

Type of task: Complementary

Key Elements:

- Communication
- Task cohesiveness

- Monitoring the balance between individual and group interests
- Managing conflict and trust

This task is especially long-standing, requiring high levels of concentration in both the understanding of the problem and in its solution. Due to a sudden blackout electronic, Sky is forced to fly for 20 minutes without the support of her GPS. While waiting for the signal to resume, the athlete has collected a variety of information that, at different times, has sent to her team. Players have to identify the current position of the athlete and indicate the new coordinates to be included in the satellite system. The particularity of this task is to stimulate a work not only on textual data, but also on visual information: some players have in fact been sent to the images and photographs taken from above by the athlete.

Fig.6. The role of visual information when solving the task

Another interesting aspect is the integration of SGs as the practical possibilities of Google Maps, whose link is presented to each player. The solution can be achieved by chronologically ordering the information.

The strategy Challenge

Team Process focus: Action

Type of task: Complementary

Key Elements:

- Coordination, mutual monitoring, back-up behavior, systems monitoring
- Team communication and participation
- Monitoring the balance between individual and group interests
- Managing conflict and trust

Sky's main opponent, Kersnikova, has been forced to change the settings of her glider, showing an outstanding performance. Therefore, the team of Sky has three possibilities. It can imitate the German athlete, and ask Sky to make a manual change on her glider: in this case, however, Sky has to lower her speed. All this may take about 60 seconds.

Rather than asking Sky to make a manual intervention on the glider, the team can activate " FLY", a control system designed by the technical expert himself. The device should allow Sky to modify her speed, but has been tested only in the laboratory and has never been used in a situation of real flight.

Finally, players are also given the option to keep going, maintaining the actual settings.

Even in this challenge the objectives of individual players may conflict with those of the team. The technical expert will receive a bonus if he uses the device he invents. In the personal information, however, it is indicated that the choice might be risky as the device has never been tested in similar situations. The resilience and effectiveness of collective players are also challenged by such a huge amount of data:

Joyce	Thaisa	Hakett	Acquaderni	Isbert	Rosch	Kersnikova
Tempi registrati ad intervalli di 5km						
0:01:54:154 0:01:56:156 0:01:51:151 0:01:49:149	0:01:52:152 0:01:52:152 0:01:54:154 0:01:50:150	0:01:52:162 0:01:55:155 0:01:51:151 0:01:57:157	0:01:54:154 0:01:51:151 0:01:57:157 0:01:54:154	0:01:51:151 0:01:54:154 0:01:54:154 0:01:51:151	0:01:51:151 0:01:52:152 0:01:54:154 0:01:54:154	0:01:49:149 0:01:48:148 0:01:48:148 0:01:49:149
Velocità media registrata ad intervalli di 5Km						
158 Km/h 155 Km/h 162 Km/h 165 Km/h	161 Km/h 161 Km/h 158 Km/h 163 Km/h	160 Km/h 156 Km/h 162 Km/h 154 Km/h	158 Km/h 162 Km/h 154 Km/h 158 Km/h	162 Km/h 158 Km/h 158 Km/h 162 Km/h	162 km/h 161 km/h 158 Km/h 158Km/h	165 Km/h 167 Km/h 167 Km/h 165 Km/h
Efficienza (distanza percorsa per quota persa)						
44	44	43	44	45	43	46

Fig.7. Information Overview

Since speed, timing and efficiency of Sky are similar to those of the first three athletes, the choice of stopping the athlete to modify the glider is not tactically justified. The best option is therefore to leave the athlete following her current trend.

The weather challenge

Team Process focus: Action
Type of task: Complementary
Key Elements:

- Coordination, mutual monitoring, back-up behavior, systems monitoring
- Time management
- Managing conflict and trust

The final rush is coming. Sky is aware that the most important moment of the race is yet to come. She has to make the right decision by understanding how weather conditions will be in the final part of the race. In this task, players can answer by monitoring a video specially designed and developed to represent different weather factors that may affect the provision of a time.

Among his personal information, the weatherman knows that, despite storm forecasting can not be considered as an exact science, there are some parameters that can significantly reduce the percentage error. If at least three of the following parameters are identified, the possibility of a storm becomes very high. A first significant factor, is represented by the presence of an abnormal wind speed and therefore higher than 20 km / h. A

Another important indicator is the *K Index*, an estimate of the real possibility of cloud formation in thunderstorms. A K value less than 15 ° suggests a risk of precipitation almost absent. On the contrary, in the case in which the parameter is above this threshold, the possibility of formation storm grows proportionally to the value assumed. The Lifted Index measures the atmospheric stability instead. A value greater than 2 ° indicates the absence the chance of precipitation. Besides -6 °, storms are especially strong and can predict vortex phenomena. For values between -2 ° and -4 °, the probability of formations storm is higher than 50%. The cape Index finally expresses the total energy flotation of an air mass. Measured Joul / Kg, this index identifies the absence of rain for values less than 1000 J / Kg.

The possibility of identifying the correct response is determined primarily by an effective division of tasks. Only the weatherman has in fact provided the information necessary to identify a disturbance actually thunderstorm or less. Also in this case, some are redundant or irrelevant information in order to achieve the goal: we must select the correct ones and identify them appropriately within the video. A second element which is decisive regards instead the ability of comparison and reflection within the group. The information of the coach are in fact apparently contrast with the quarterback. While the former is aware of the fact that, where the winds diverge - as in fact are -, the time should be avoided, the second, in line with its profile, is instead pushed to dare and take the risk.

Conclusion

In the area of SGs, game design has to address specific challenges as SGs not only have to fulfil the same requirements as other games, but they also have to promote training and empowerment (Wendel et al., 2013c). Within this chapter we presented concrete examples to discuss the potential of SGs as complex team building environments, focusing on different sectors, like military, emergency and business. To address this opportunity, researchers have attempted to propose guidelines or frameworks for designing multiplayer SGs (Sung & Hwang, 2013). Among them, we focused on the model proposed by Johnson and Johnson (2002) who identified five factors that are able to promote collaboration and collaborative learning (Barron, 2000) in a multiplayer SG: *positive interdependence, individual accountability, promotive interaction, social skills, and group processing.*

Starting from them, we presented the design and development of *Mind the* Game™, a multiplayer decision-making SG developed for a target of adult individuals to create a socio-technical environment (Fisher et al., 2005) where the interconnection between humans and technology encourages the emergence of collaboration and team working. Embedding the potential of serious gaming, *Mind the Game*™ aims to expand the range of resources that groups can access in daily contexts, allowing a greater awareness of the skills possessed both individually and as a whole, and implementing an experiential learning process that supports shared optimal experiences. Hence, the game can be considered as a useful tool to promote collaboration and team working among individuals, both for virtual and FTF teams.

As a new medium aimed at facilitating change (Riva et al., 2006), the SG generates a virtual environment where groups can express their potential, dealing with a reality that constantly redefines the balance between challenges and skills. This was studied to create a virtuous circularity that promotes collective experiences and high levels of perceived effectiveness, both in an individual and collective sense (Argenton et al., 2016).

The game, studied for small groups of 5 people, provides the facilitator/the researcher with the ability to monitor the progress of the game. The interface, developed with Html5, is primarily textual, enriched multimodally by clips images, and animated graphics that make the game more interactive.

Further, the narrative framework - especially in technological solutions based on a textual environment - is a core element for SG design. The underlying potential of narratives can be amplified through the use of peculiar scenarios that have nothing to do with day by day experiences (Lindley, 2005). In this way, it is possible to modulate the impact of prior knowledge of player and to support common cognitive processes and knowledge sharing practices. As a metaphor of life, sport is a powerful and effective training tool, capable of supporting learning and experiential transpositions. In particular, sport witnesses how beyond individual and team excellence there are challenges that do not end against the opponent, but in their relationship with the self.

According to the aforementioned considerations, we chose a little-known sport that could be used to promote networked flow: gliding. This is a discipline based on soaring flight, where, in the absence of the driving force of an engine, the pilot is required to take advantage of upward motions and movements of air masses (Rosén & Hedenström, 2002). The choice of an individual sport to promote group creativity and of team working may instead appear paradoxical. But it is not: individual excellence is the tip of the iceberg beneath which team effort and coordination always make the difference. The collaborative dimension of gliding is present because, despite the solo flight of the pilot, his/her staff can support each step of the race from the ground. Players will not be called to be an athlete or an opponent of the athlete, but a member of her team. Each player will in fact be assigned one of the following roles: team manager, strategist, technical expert, meteorologist or doctor.

Therefore, in line with the proposal of Steiner (1972), each task is designed according to a *complementary logic*, in an attempt to involve each player. Specifically, players are called upon to deal with distributed decision-making environments in which real success can not depend on free-riding efforts, but on the emergence of group phenomena, such as social facilitation, social labouring, and team thinking. Clearly, the effectiveness of the group will be marked by its specific characteristics, as well as on its communicative, emotional and hierarchical structure.

In the following chapters we will present two empirical studies designed to evaluate and understand the potential of Mind the Game to create team building opportunities. Despite the impressive growth of SGs applications, only a few of them have been tested and scientifically validated (Mayer et al., 2013).

4. Multiplayer Serious Games and User Experience: a Comparison Between Paper-Based and Digital Gaming Experience

Since their infancy in the late 1990s, serious game have found important applications in different areas, such as education, industry, military and medicine, acquiring a prominent role in the actual knowledge society (Bergeron, 2006; Ritterfeld, Cody, & Vorderer, 2009). By fostering continuous learning experiences blended with ludic and engaging affordances, serious games have in fact been able to shape new opportunities for individual and collective learning and training, showing a discrete effectiveness (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Girard, Ecalle, & Magnan, 2013; Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013).

In particular, serious games have provided successful answers to two specific challenges of education and training in the 21st century (Bekebrede, Warmelink, & Mayer, 2011; Prensky, 2003): (a) the presence of a new generation of learners and trainees grown up in a fully digitalized society and (b) the need for a more engaging and motivating way of imparting skills, knowledge, or attitude that can be used in the real world (Bergeron, 2006).

It is clear that playing digital games leads to a variety of positive outcomes and impacts but it is also acknowledged that the literature on games is fragmented and lacking coherence (Connolly et al., 2012). For example, a key challenge within the SGs literature is to develop a workable classification of outcomes and impacts of playing games with respect to engagement, learning and other individual and collective skills. According to the meta-analysis developed by Girard et al. (2013), the most frequently occurring outcomes reported were affective and motivational and knowledge acquisition/content understanding, followed by perceptual and cognitive skills, behaviour change, and social/soft skills outcomes. Moreover, as digital technologies continue to play an increasingly important role to foster both human learning and training processes, scholars have attempted to explain how user's perception of different media are formed and how media themselves influence performance outcomes (Erdogan, 2009; Schilit, Golovchinsky, & Price, 1998). To address this challenge, authors have referred to the media-dependent perspective, claiming that the mechanical characteristics of media are the primary factors that may influence learning, task performance and communication (Daft & Lengel, 1984; a. R. Dennis & Valacich, 1999; Yoo & Alavi, 2001).Yet, there is not much work reported concerning the evaluation of digital (serious) games when compared with traditional paper-based games or board games. Moreover, multiplayer and collective game experiences are rarely taken into account. Similarly, within the media-dependent perspectives, social and contextual factors are in fact rarely considered (Yoo & Alavi, 2001).

A second trend of research have been focused on a more general social construction perspective of technology (Fulk, 1993; Guzzo, Yost, Campbell, & Shea, 1993; Klein & Kleinman, 2002; Kreijns, Kirschner, & Jochems, 2002). Here, researchers have evaluated how social factors influence user’s perception of media, arguing that factors like cohesion among groups, group climate and organizational culture deeply influence the way in which media are used and selected (Agrell & Gustafson, 1994; Chin, Salisbury, Pearson, & Stollak, 1999; Kanawattanachai & Yoo, 2002). However, they have rarely considered the role of different media conditions. Therefore, while these two categories focus and address different aspects of communication media choice and use, a grater understanding can be gained by considering these findings together (Carlson & Zmud, 1999; Chidambaram, 1996; Yoo & Alavi, 2001).

Accordingly, the aim of the present paper is to contribute to digital and serious games literature, synthesising these two perspectives, evaluating the potential of digital game technologies compared to paper-based applications not only on individuals, but also among groups. This allowed our research to focus both on subjective game experience and group dynamics, like team cohesion and team potency. Specifically, the present study has been developed with the aim of analysing a situation of zero-history groups interacting in a face-to-face (FTF) setting, where players deal with a multiplayer SG presented in a digital or a paper-based form. The research has two main goals: (i) studying the impact different media have on game experience, group dynamics and performance; (ii) evaluating the relationship between social presence, game experience and group dynamics.

Further, the studies that take into consideration the role of paper and digital applications within collaborative activities mainly used a qualitative and sociological perspective (Bowers, 1994; Harper & Sellen, 1995; Luff, Heath, & Greatbatch, 1992). The aim of the present study is to use an empirical approach.

In the next sections we will describe related relevant work and present our experiment, as well as its main results. Finally we discuss the obtained results and suggest some directions for future work.

1. Media-Dependent Perspective

1.1 Paper vs Computer: which medium is better?

Although the debate concerning the equivalence of computer- and paper-based applications has a long history dating back to the 80s, it has continued to interest scholars and researchers since recent years (Cakir & Simsek, 2010; Dillon, 1992; Haas, 1989; Noyes & Garland, 2008).

On the one hand, it has been evident that a simple dichotomy of paper versus digital technologies is not sufficient as a framework for understanding the cognitive ecology of real-world activities based on paper and digital artefacts (Sellen & Harper, 2003) and that experimental studies have faced several limitations. Most of these are related to whether a task in paper form remains the same when transferred to a computer or vice versa (Noyes & Garland, 2008).

Yet, on the other hand, Clark's (1983, 1994, 2007) argument that media are mere vehicles that deliver instructions but do not influence individual achievement and that media comparison studies are useless from a scientific point of view, has been replaced by more articulated and flexible positions (Becker, 2010; Kozma, 1994). Koumi (1994), in particular, emphasised the importance of a media comparison approach only (1) when there is a clear notion of what it means to make a comparison, (2) when there is a literature-supported perspective of how technologies can be compared, and (3) when there is awareness that comparing two technologies means also to compare two different contexts of use. When these conditions are satisfied, media comparison studies can provide important information to developers, educators or trainers, helping them to chose the solution that fits their needs and goals at the best.

A former substantial subset of research compared paper and digital tools, considering their impact on individual performance variables, like reading speed, reading accuracy, comprehension and production (Dillon, 1992; Gould et al., 1987; Gould, Conti, & Hovanyecz, 1983; Haas, 1989; Muter, Latrémouille, Treurniet, & Beam, 1982). In the same years also more qualitative analyses have been carried out to understand the effects of converting from paper to electronic media in the fields of business, medicine, literature, and education (Hogan & Wagner, 1997; Kincaid, Dupont, & Kaye, 1985; Kulik, Kulik, & Bangert-Drowns, 1985). Conclusions and results were controversial, but mainly indicated that a better individual performance was associated to the use of paper (Dillon, 1992; Noyes & Garland, 2008). Some researchers have explained this difference according to a cognitive interference caused by specific monitor characteristics, like refresh rates, fluctuating luminance, and contrast levels (Garland & Noyes, 2004; Ziefle, 1998).

However, both methodological issues and the rapid changes of digital industries, made it necessary to deepen the topic from a broader perspective. In their review, Noyes & Garland (2008) argued that the post-1992 media comparison studies have discussed the differences between paper and digital applications by considering non-standardized, open-ended tasks (i.e., composition), non-standardized, closed tasks (i.e., multi-choice questions) and standardized tasks (i.e., assessment and standardized test). For example, in a study realized by Maleck et al. (2001) 225 medicine students who attended a radiology course were randomly assigned to one of four learning conditions. Group A was trained using computer-based cases with interactive elements; group B used computer-based cases without interactive elements; group C used paper-based cases with interactive elements; and group D served as a control group. On a multiple-choice question test (a non standardised, closed task), groups A, B, and C showed significant improvements on a pre-test post-test evaluation. On an image interpretation test (a standardized, open-ended tasks), group A showed the most improvement, followed by group B, and group C, while no significant improvements were observed for the control group. Yet, no significant differences in learning outcomes were found between the two interactive groups (computer based and paper based). These studies undermined interesting differences related not only to performance outcomes (that still remain controversial), but to the psychological processes involved in the use of the two different media. For example, Garland & Noyes (2004) identified no differences in a comprehension task, but observed a significantly higher cognitive workload in the computer-based condition, meaning that subjects needed to put more effort into the computer task.

Despite several studies on paper and digital comparison, only a few took into consideration the role of paper and digital applications within collaborative activities. Further, they mainly used a qualitative and sociological perspective (Bowers, 1994;

Harper & Sellen, 1995; Luff et al., 1992). A good example is the research made by Luff and colleagues (1995) who examined the use of paper and screen-based documentation in three different settings: an architectural practice, a medical centre, and an underground control room. Similarly, Harper & Sellen (1995) used an ethnographic approach to understand the use of paper within the London Air Traffic Control Centre, a police constabulary in the U.K., and the International Monetary Fund. These studies have led scholars to argue the importance of paper for its "ecological flexibility"(Luff et al., 1992). Paper can in fact be moved around, handed over, distributed within the local environment, and used as a focus of discussion and coordination. At the same time, it allows users to monitor the history of the ways in which it has been tailored.

In concrete, paper has five main affordances (Dillon, 1992; Haas, 1996; Schilit et al., 1998; Sellen & Harper, 2003): (a) it is *tangible*, (b) both *easy to annotate*, and (c) *to navigate*, (d) and it can provide *large, inexpensive, high-resolution display surfaces* (e) marked by a *fixed division of the document into a fixed spatial layout*. The fact that paper is tangible, flexible, easy to mark, and that it displays fixed rather than dynamic information makes it a very important tool in day-by day contexts. Yet, paper is a static medium that cannot be re-layout, searched or indexed automatically (Guimbretière, 2003).

As compared to paper-based solutions, digital applications are unique (Flew, 2008) in terms of (a) *variability* since information can be easily memorized, modified, or shared among users, (b) *automaticity* as they can execute specific operations in an automatic way that is not visible to the user, (c) *multimediality* as they can combine different technical, symbolical or communicational systems in one and the same object (Galliani, 1992). Most of all, new media are marked by (d) *interactivity*: they have an high potential ability to let the user to manipulate and affect media experience directly, and to communicate with others through the medium itself (Jensen, 1998). Finally, digital technologies are also (e) *ubiquitous* (Dourish, 2004). The development of both web-based and clouding technologies has allowed contents to be separated from technology. This means that the same content can be manipulated from different media.

The interconnection of these affordances has resulted in the emergence of virtual space - the cyberspace – that has supported a new form of (f) *connectivity,* based on virtual networks and communities (Haythornthwaite, 2002). Yet, digital technologies have their drawbacks too. For example, they can be subjected to freezing and crashing, and they can generate cybersickness (Mousavi, Jen, & Musa, 2013) or anxiety (Powell, 2013)

1.2 Digital game vs paper or board games: which is better?

The digital affordances described above support the effectiveness of computer-based games and serious games for both learning and training (Girard et al., 2013; Papastergiou, 2009; Prensky, 2003; Wouters et al., 2013). Empirical evidence has been identified concerning all the learning and behavioural outcomes including knowledge acquisition, perceptual and cognitive, behavioural, affective, motivational, physiological and social outcomes (for a comprehensive review, see Connolly et al., 2012). Rich virtual worlds make games powerful contexts for individual and collective development (Wouters et al., 2013). Users can concretely act within virtual scenarios adequately re-created to mirror specific experiential, situated, multimodal routinized formats and experience complex concepts without losing the connection between abstract ideas and the authentic problems (Admiraal, Huizenga, Akkerman, & Dam, 2011; Anolli, Mantovani, Confalonieri, Ascolese, & Peveri, 2010).

Yet, the presence of the digital medium is not enough to explain the success of serious games. There are in fact numerous papers that deepened the effects of non-digital games on individual learning and training in different areas too. For example, Mayer, Carton, de Jong, Leijten, & Dammers (2004) matched scenario and games techniques to develop an engaging non digital game that helped students to understand the complexity of development planning in urban settings. Vahed (2008) described a game to promote literacy and improve the ability to retain with understanding the content area of Tooth Morphology for first year learners studying Dental Technology. Similarly, Amaro et al. (2006) presented a study on a board game developed to encourage healthy eating behaviours in children. He observed that children playing the game showed a significant increase in nutrition knowledge and in weekly vegetable intake with respect to the control.

Serious games are first of all games and games have themselves an inner potential for both learning and training. As complex and fruitful narrative learning environment, games are in fact bridging curiosity with the desire of novelty within a protected environment where individuals can experience the complexity of their self, and developing mastery and control (Akkerman, Admiraal, & Huizenga, 2009; Anolli et al., 2010; Juul, 2001). In other words, they are able to recreate a "magic circle" (Huizinga, 1950), that enforces individual agency, self-confidence and self-esteem (Bruner, 1964), by sustaining a process of acknowledgement of personal ability to perform well, solve problems, and manage with difficulties. Most of all, games are marked by challenging goals based on a set of agreed rules and constraints (Garris-Reif & Franz, 1995) and they constantly provide feedback, either as a score or as changes in the game scenarios, that help players to monitor their progress (Gee, 2003).

Further, the fact that games are intrinsically able to provide enjoyable experiences, creating rules that require the learning of skills, defining goals, giving feedback, and fostering a sense of curiosity and discovery, makes them 'flow activities' (Csikszentmihalyi, 1991) or 'networked flow activities' (Gaggioli, Riva, Milani, & Mazzoni, 2013). Flow is a state of deep absorption in an activity that is intrinsically enjoyable and perceived as worth doing for its own sake. Individuals function at their fullest capacity, and the experience itself becomes its own reward (Nakamura & Csikszentmihalyi, 2002). However, games are not focused only on individuals, but also on groups and they are able to create opportunities for social interaction by supporting competition, collaboration, and sharing among players, even outside the context of the game (Reeves & Read, 2009). These are the bases for networked flow experiences, optimal, peak creative states experienced by the group as a whole (Gaggioli et al., 2013).

1.3 Game experience

One of the most important aspects to analyse when considering serious and computer games from a scientific point of view is game experience (Poels, De Kort, & Ijsselsteijn, 2007; Sweetser & Wyeth, 2005; Takatalo, Nyman, & Laaksonen, 2008). Attempts to clearly define the construct are indeed scarce and the wide variety of games genres and the complex, subjective and dynamic nature of the idea of experience (Takatalo et al., 2008) makes it hard to find a common definition.

As indicated by Oksanen (20014), one of the most comprehensive model of the multi-dimensional and multi-layered nature of game experience is the one developed by Poels et al. (2008) during the EU funded "Fun of Gaming" (FUGA) project that resulted in the Game Experience Questionnaire (GEQ). The questionnaire was the natural output of years of research on the feelings and experiences people have in three conditions: (a) during the game, (b) at the end of the game and (c) when they play the game with other players (De Kort, Ijsselsteijn, & Poels, 2007; Poels et al., 2007; Poels, De Kort, & Ijsselsteijn, 2008a; Poels, de Kort, & IJsselsteijn, 2008b). According to the authors, the following are the core elements of game experience.

Immersion

The concept of game experience has been frequently related to *immersion* (Ermi & Mäyrä, 2005; Jennett et al., 2008), conceived as the subjective perception of "being there" in a virtual environment that includes the suppression of all surroundings. Ermi & Mäyrä (2005) differentiated between *sensory immersion* (the extent to which the interface features of a game have a perceptual impact on the user), *challenge-based immersion* (the extent to which the cognitive and motor aspects of the game are needed to meet game challenges), and *imaginative immersion* (the extent to which the game is able to create a world that stimulates users' fantasy and imagination). In the model proposed by Poels et al. (2008) immersion is considered both on a sensory and imaginative level. While the former has been conceptualized according to the proposal of Ermi & Mäyrä (2005), the latter has been referred to the sense of presence experienced in a digital environment. Presence has been used as a global experiential quality metric to evaluate, develop, and optimize virtual environments and media systems (Baños et al., 2004; Bystrom, Barfield, & Hendrix, 1999; IJsselsteijn, 2000; Mantovani & Castelnuovo, 2003; Riva, Davide, & Ijsselsteijn, 2003). Despite many researchers have tried to find a consensual and unique definition of presence, nowadays this psychological state is viewed as a complex concept composed by many factors that have to be considered, from technological issues to psychological ones, as well as from individual, social and cultural perspectives (Riva, 2007). Presence is generally defined as "a perceptual illusion of non-mediation" (Lombard & Ditton, 1997) or "the suspension of disbelief " of being located in a world other than the physical one (Sanchez-Vives & Slater, 2005). Moreover, there have been numerous attempts to distinguish presence from immersion. Slater (1999) defined immersion as an objective characterization of the technology, while the sense of presence was defined as subjective experience and only quantifiable by the user experiencing it. According, to this definition, presence is not a direct function of immersion alone (Baños et al., 2004).

Of course, the affordances and characteristics of a particular medium play an important role in the experience of presence. For example, the capacity of the technology to produce an environment of sensorial richness, with information for all the senses (i.e.,visual, haptic, auditory, olfactory) has been associated to high levels of presence (Bystrom et al., 1999). Technology-related elements associated with presence are also pictorial realism (Lee & Kim, 2008; Welch, 1999), system response time (Durlach & Mavor, 1994) and field of vision (Riva, 2007).
Yet, these elements are not enough: plot, stories and narratives, goal setting strategies, the presence of others, cultural and ecological validity are fundamental too (Mantovani & Castelnuovo, 2003).

Flow

The theory of *flow* (Csikszentmihalyi, 1991) has been extensively used to describe the main features of game experience (De Grove, Van Looy, Courtois, & De Marez, 2010; Nacke & Lindley, 2009; Nacke & Lindley, 2008). To promote a high quality game experience, serious games should promote flow experiences, stimulating a mental focus on in-game dynamics, by providing a set of engaging, differentiated and worth-attending stimuli that limit the influence of external variables. Along with other aspects, flow can result in hyper-learning processes that consist of the mental ability to totally focus on the task by using effective strategies aligned with personal traits (Nakamura & Csikszentmihalyi, 2002). An interesting model is the one proposed by Sweetser & Wyeth (2005). To assess flow in games they took into consideration concentration, challenge, players skills, control, clear goals, feedback, immersion and social interaction. In the model of Poels et al. (2008), flow is defined in terms of concentration, absorption and detachment.

Challenge

As noted by Gee (Gee, 2003), who claims that the game experience should be "pleasantly frustrating", challenges have to match players' skills/level and to support their improvement throughout the game. During specific stages of the game, "Fish tanks" (stripped down versions of the real game, where gameplay mechanisms are simplified) and "Sand boxes" (versions of the game where there is less likelihood for things to go wrong) can support this dynamism;

Competence

According to Poels et al. (2008) games have also to support player skills and competence throughout game usability, and specific support systems and rewards. This would result in feelings of pride, euphoria and accomplishment. The balance between challenges and competences or skills is fundamental to generate the emergence of flow experiences (Csikszentmihalyi, 1991).

Tension

Tension is often mentioned as an important in-game experience (Fu, Su, & Yu, 2009; Poels et al., 2007). Participants report that this experience is often related to game challenges and difficulties. It is marked by feelings of anxiety, frustration, thrill, pressure that are related to negative affects (Poels, De Kort, et al., 2008).

Positive and negative affect

Games can elicit several emotional states (Anolli et al., 2010). Many representations of players' affective states have been used in previous studies like anxiety, frustration, engagement, distress scales, and the valence-arousal space (Anderson & Ford, 1986; Freeman, 2004). In the model of Poels et al. (2008) both positive (fun, amusement, pleasure, relaxation) and negative emotions (frustration, disappointment, irritation, anger) were considered.

Interestingly, media characteristics have a strong impact on emotions. For example, when comparing the effects of a different number of audio channels on presence and emotions, Västfjäll (2003) found that a stereo and six-channel reproduction resulted in significantly stronger changes in emotional reactions than the mono condition. In another study, Riva et al. (2007) argued the possible use of Virtual Reality as an extraordinary tool to induce specific emotions in the user. The interrelation between sensory immersion and positive emotion has also been recognized as fundamental for the emergence of an high sense of presence (Baños et al., 2004).

Social Presence

Since it is also essential to pay attention to the meaning of the social dimension of gaming (Ducheneaut, Moore, & Nickell, 2007), the GEQ takes into consideration social presence too. After focus group investigation of presence experiences of gamers, several authors have started to assume that the social dimension of gaming may even overwhelm traditional ideas of visual and audial richness being the most important attributes to focus on in establishing spatial or social presence (Brom et al., 2014; De Kort et al., 2007).Short and colleagues (1976) introduce the term "social presence" to indicate the degree of salience of the other person in a mediated environment and the consequent salience of their interpersonal interaction. On this point, Riva and colleagues (2003) argued that an individual is present within a group if he/she is able to put his/her own intentions (presence) into practice and to understand the intentions of the other group members (social presence). According to McGrath (1990), a continuum ranging from e-mail, teleconferencing, computer-desktop and face-to-face meetings can be made in regards to social presence. The lowest levels of social presence are associated to e-mail, while the highest are related to face-to-face meetings as a result of the richness of information (Kydd & Ferry, 1994) they are able to convey.

In the model of De Kort, Ijsselsteijn, & Poels (2007) the concept of social presence is operationalized in terms of a *psychological involvement*, fostered by positively (empathy) and negatively (negative feelings) toned emotions towards co-players, and *behavioural involvement*, that indicates the degree to which players feel their actions to be dependent on their co-players behaviours.

Some studies have addressed the relationship between social presence and immersion finding controversial results (Cairns, Cox, Day, Martin, & Perryman, 2013; Oksanen, 2014; Sweetser & Wyeth, 2005; Yoo & Alavi, 2001). On the one hand, there are those who claim that the presence of others, even mediated via online play, would require players to think about the other players and so draw their attention away from the thinking about the game, determining low level of immersion (Sweetser & Wyeth, 2005). Other studies have indeed highlighted the opposite. For example, Cairns et al. (2013) run three experiments that showed that players were more immersed when playing against another person than playing against a computer and that there was not significant different in the levels of immersion whether the other person was present in the room or not. Similarly, Oksanen (2014) found that the sociability of the environment strengthen the emergence of social presence and that it can also contribute to the formation of positive game experiences.

Moreover, social presence has a specific role, particularly in collaborative games, to open communication, critical thinking, group cohesion, supportive interaction and negotiation (Kreijns, Kirschner, & Jochems, 2003; Kreijns et al., 2002). High levels of social presence are predictors of learning (Gunawardena, 1995) and they are correlated to high levels of enjoyment (Gajadhar, de Kort, & IJsselsteijn, 2008), social interaction (Tu & McIsaac, 2002) and group cohesion (Yoo & Alavi, 2001).

2. Social construction perspective

Within the social construction perspective, research focus has been moved to evaluate how social factors influence user's perception of media, arguing that factors like cohesion among groups, group climate and organizational culture deeply influence the way in which media are used and selected (Agrell & Gustafson, 1994; Chin et al., 1999; Kanawattanachai & Yoo, 2002) (Fulk, 1993; Guzzo et al., 1993; Klein & Kleinman, 2002; Kreijns et al., 2002). The opportunity of monitoring in-game group dynamics can provide interesting elements to narrow the gap in the understanding of both multiplayer serious game experiences and the relationship between the social dimension of gaming and core game experiences. Within this perspective, the literature has deeply considered group efficacy (see chapter 1) in terms of group cohesion, team potency and group climate.

The former has been defined by Bollen & Hoyle (1990) as "an individual sense of belonging to a particular group and his or her feelings of morale associated with membership in the group". While team potency has been conceptualized by Guzzo et al. (1993) as the belief in a group about its general effectiveness across multiple tasks, group climate describes not only the degree to which the group represents a sense of acceptance, support, and belongingness, but also the group process along conflict and avoidance (MacKenzie, 1981).

Therefore, these factors are often described as a psychological forces that binds people together (González, Burke, Santuzzi, & Bradley, 2003) and they are some of the main outcomes of the group development process (McGrath, Arrow, & Berdahl, 2000). For example, group cohesion is taken as a n index of the level of group development , directly relate d t o within-group cooperation and to both the quality and quantity of group interaction (Chang & Bordia, 2001; Curşeu, 2006; Evans & Dion, 2012; Greer, 2012). Evans and Dion' s (2012) meta-analysis on the relationship between group cohesion and group performance found a significant positive relationship between the two variables, indicating that cohesive groups , on average, tend to be more productive than non-cohesive groups. Interestingly, Yoo & Alavi (2001) found that influence of group cohesion over social presence was additive, rather than substitutive, to that of media condition. 135 college students working a decision-making task showed that media condition (audio conferencing vs. desktop video-conferencing) has significantly smaller influences on social presence and task participation than group cohesion. However, this effect has been noticed only among the members of established groups: in situation of zero-history groups, members have no prior situation for forming group cohesion and they have to start developing (*ibidem*).

Shea and Guzzo (1993) proposed that also potency leads to high levels of team effectiveness. Research has shown that teams high in potency perform better than teams low in potency (Duffy & Shaw, 2000; Guzzo et al., 1993). Campion et al. (1996) found significant positive associations between potency and productivity, employee satisfaction, and managerial ratings of performance. In general, the higher the potency, the more positive were the collective outcomes (Gully, Incalcaterra, Joshi, & Beauien, 2002; Hu & Liden, 2011).

3. Research Goals and Hypotheses

The present study has been developed with the aim of analysing a situation of zero-history groups interacting in a FTF setting, where players deal with a multiplayer SG presented in a digital or a paper-based form. In particular, the research has two main goals: (i) studying the impact different media have on game experience, group dynamics and performance; (ii) evaluating the relationship between social presence, game experience and group dynamics.

With regard to the first goal, we mainly referred to the media-dependent perspective and, in particular, to the media richness theory that argues that a medium's richness is determined by certain, invariant, mechanical characteristics of the medium such as the degree of personalization, speed of feedback, language variety (Dennis & Valacich, 1999). Rich media are better suited to ambiguous tasks that requires resolution of different views and opinions among people (Yoo & Alavi, 2001) since they promote higher level of immersion (Workman, Kahnweiler, & Bommer, 2003) and positive feelings among users (Mennecke, Valacich, & Wheeler, 2000; Vickery, Droge, Stank, Goldsby, & Markland, 2004). In particular, within digital games users can concretely act within virtual scenarios adequately re-created to mirror specific experiential, situated, multimodal routinized formats and experience complex concepts without losing the connection between abstract ideas and the authentic problems (Admiraal et al., 2011; Anolli et al., 2010). Therefore, we argue that:

- ***H1**: People who played the digital version of the game will experience higher level of immersion than players who experience the paper-based version of game.*

- ***H2:** People who played the digital version of the game will experience higher level of positive affects and lower negative feelings than players who experience the paper-based version of game.*

With regard to the second goal, authors argued, social presence has a specific role in collaborative games, to open communication, critical thinking, group cohesion, supportive interaction and negotiation (Kreijns et al., 2003, 2002). High levels of social presence are predictors of learning (Gunawardena, 1995) and they are correlated to high levels of enjoyment (Gajadhar et al., 2008), and group cohesion (Yoo & Alavi, 2001). Therefore, such an experience should result in the gamer developing positive attitudes for the game and higher level of immersion. Moreover, some studies have highlighted that cohesive groups show more positive, personal and favourable communication interactions (Chin et al., 1999; Levine & Moreland, 1994) and that group cohesion will increase social presence and task participation (Kanawattanachai & Yoo, 2002). Drawing on specific empirical findings (Carlson & Zmud, 1999; Chidambaram, 1996; Yoo & Alavi, 2001), will assume that:

***H3 :** There will be a positive relationship between social presence and group processes.*

Authors have argued that gameplay experience is a distinct construct from presence and social presence (Örtqvist & Liljedahl, 2010). Multiplayer gameplay experiences relate to the gamers' development of attitudes toward the game (Wendel, Gutjahr, Göbel, & Steinmetz, 2013), whereas social presence is rather related to the degree of salience of the other person in a mediated environment and the consequent salience of their interpersonal interaction (Gunawardena, 1995).. Further, social presence is an essential part of game experience in multiplayer games (Oksanen, 2013). Results of previous research showed that the sociability of the game and a sense of social presence are strongly connected to the various dimensions of the core game experience, including engagement, in the forms of flow and immersion (Cairns et al., 2013; Hämäläinen, 2011; Oksanen, 2013). These results indicate that the sociability of the game and sense of social presence are potential factors in the emergence of positive and engaging game experiences, at least in the context of collaborative games. As such, we assume that:

H4: *There will be a positive relationship between social presence and game experience, especially in terms of immersion and positive affects.*

4. Method

Participants

A total of 95 Italian students who attended a postgraduate specialization in sport medicine played *Mind the Game,* a serious game developed by our research group (Argenton, Triberti, Serino, Muzio, & Riva, 2014). Of the participants, 72.6% (n= 69) were male and 27.4% (n=26) were female. Students ranged in age from 20 to 64. The mean age was 27.80 years (SD= 7.396).

Participants were recruited at the University of Pisa, Italy. Individuals did not receive money or university credit for participating in the study. Individuals gave their written consent before the study began.

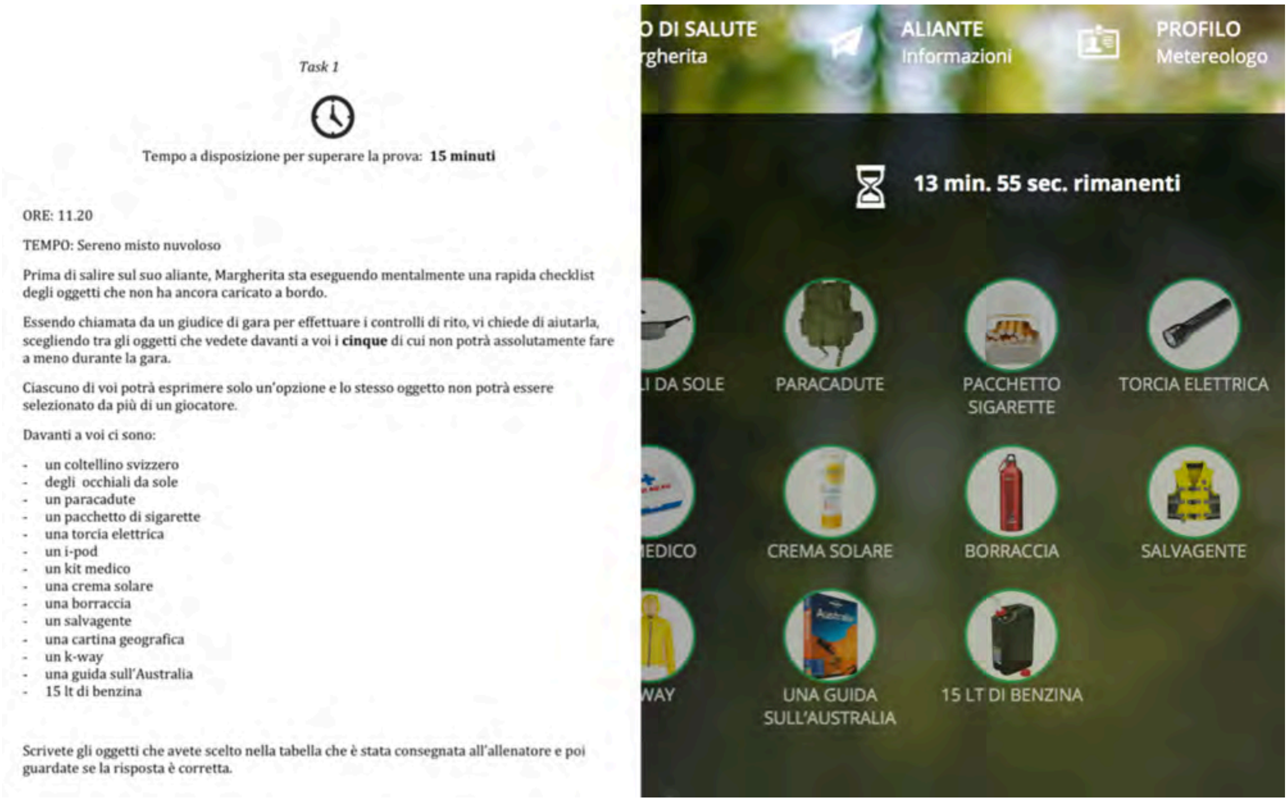
Except for the effort to balance gender, participants were randomly divided into 19 zero-history groups that consisted of 5 people. Groups were balanced such that there was at least one female per team. While 10 groups played the digital game (condition 1), 9 groups experienced the game through paper-based materials (condition 2).

Materials

Mind the Game (MtG) was used as a serious game for the present study. This is a multiplayer decision-making serious game developed to create a socio-technical environment (Fisher, Giaccardi, Eden, Sugimoto, & Ye, 2005) where the interconnection between humans and technology encourages the emergence of collaboration and team working (for a more precise description of the game, see chapter 3 and Argenton et al., 2014).

In order to test the game in the second condition, a paper-based version of MtG was prepared and developed as a board game. In this case, players were given a specific game equipment comprising:

- A board made up of a set of 5 compartments (related to the 5 challenges) on which players could monitor the position of the athlete during the competition.
- A number of sets of cards bearing the 5 questions to which players must reply, and answers to these questions, each set bearing a mark (A, B, C).
- A folder containing task-related information and private information. As it can be seen by Fig. 2, paper-based materials were mostly presented in a black and white, simple and flat way. Images were used only when strictly necessary.
- A count-down timer automatically set for each task.
- A set of instruction to play the game.



Task 1

Tempo a disposizione per superare la prova: **15 minuti**

ORE: 11.20

TEMPO: Sereno misto nuvoloso

Prima di salire sul suo aliante, Margherita sta eseguendo mentalmente una rapida checklist degli oggetti che non ha ancora caricato a bordo.

Essendo chiamata da un giudice di gara per effettuare i controlli di rito, vi chiede di aiutarla, scegliendo tra gli oggetti che vedete davanti a voi i **cinque** di cui non potrà assolutamente fare a meno durante la gara.

Ciascuno di voi potrà esprimere solo un'opzione e lo stesso oggetto non potrà essere selezionato da più di un giocatore.

Davanti a voi ci sono:

- un coltellino svizzero
- degli occhiali da sole
- un paracadute
- un pacchetto di sigarette
- una torcia elettrica
- un i-pod
- un kit medico
- una crema solare
- una borraccia
- un salvagente
- una cartina geografica
- un k-way
- una guida sull'Australia
- 15 lt di benzina

Scrivete gli oggetti che avete scelto nella tabella che è stata consegnata all'allenatore e poi guardate se la risposta è corretta.

Fig. 9. Differences between the game in condition 1 (digital version of the game) and 2 (paper-based version of the game).

Procedure

All participants attended a single testing session at the University of Pisa. The empirical study was conducted as an ice-breaking activity during the first day of a postgraduate specialization course in sport medicine. Two of the authors of the present article were asked to run a class that stressed the importance of team working and collaboration in sport medicine. Upon the participants' arrival, the procedure was explained to them and their informed consent was obtained. Participants were exposed randomly to either condition 1 or 2 following a pre-established randomization schema obtained from **http://www.randomizer.org/**.

Each group was physically isolated from the others and allowed to perform the game in a quiet and isolated room. Players of each group were seated around a squared table and could freely speak with each other, without showing their teammates the private information received during the game.

In the first condition, each player was given a laptop to play the serious game. Laptops (Lenovo G50-30; Intel® N3540 2,16/2,4 Ghz, 2ML L2) had a standard QWERTY keyboard, a monitor of 15.6'' and a working internet connection. Participants were asked to sit in front the laptop at a distance of one meter. In the second condition, players were given all the materials listed in the previous section of the chapter.

None of the students had played the game before. An average game session lasted 41.51 minutes (SD= 9.041). Subsequently, participants were asked to complete the psychometric questionnaires that will be presented in the following section of the chapter.

Measures

On the one hand, to assess users' subjective gaming experience we used the *Game Experience Questionnaire* (GEQ) developed by Poels, De Kort, & Ijsselsteijn (2007, 2008).

On the other hand, to evaluate group processes we used the *Team Potency Scale* (Guzzo et al., 1993), the *Perceived Cohesion Scale* (PCS) ((Bollen & Hoyle, 1990; Chin et al., 1999), the *Group Climate Questionnaire* (GCQ) (Costantini et al., 2002) and the *Group Performance Evaluation Questionnaire* (GPEQ) (Comunian, 2004). Group performance measures were considered too. A full list of the variables considered in the study is presented in Tab.1.

Game Experience

- **Game Experience Questionnaire (GEQ).** The GEQ is a self report questionnaire developed during the "Fun of Gaming" (FUGA) project funded by the European Commission under the 6th Framework Programme on the basis of focus group research (Poels, De Kort, et al., 2008). The questionnaire aims at covering a range of digital game experiences and, thus, enabled an empirical exploration of the game experience within digital games in a quantitative and comprehensive way (Oksanen, 2014).

  The questionnaire is marked by a modular structure. It consists of (a) The core questionnaire, (b) The Social Presence Module, and (c) The Post-game module. Part (a) is the core part of the GEQ. It assesses game experience on seven components: *Immersion, Flow, Competence, Positive and Negative Affect, Tension, and Challenge*. This results in a 33-items module where players are asked to indicate how they felt during the game on a 5-point Likert scale (0 = not at all, 2 = moderately, 4= extremely). The questionnaire contains items such as " I felt content", " I was good at it", "I felt bored".

Part (b), the Social Presence Module, investigates *psychological* (empathy and negative feelings*) and behavioural involvement* of the player with other social entities, be they virtual (i.e., in-game characters), mediated (e.g., others playing online), or co-located. It consists of 17 items based on a 5-point Likert scale (0 = not at all, 2 = moderately, 4= extremely). "I empathized with the other(s)", "When the other(s) was(were) happy, I was happy", "What I did affected what the other(s) did" are some of the items the questionnaire is made of. Each individual's score was computed by averaging across the item developed for each dimension.

Part (c), the Post-game Module, assesses how *players felt* after they had stopped playing trough 17 items based on a 5-point Likert scale (0 = not at all, 2 = moderately, 4= extremely). The module consists of four components: *positive experience, negative experience, tiredness, returning to reality.* The following are examples of statements included in this module: " I felt revived", " I felt weary", "I felt powerful". Each individual's score was computed by averaging across the item developed for each dimension.

Previous studies have shown that the GEQ is sufficiently accurate to report gameplay experience (Nacke & Lindley, 2009; Norman, 2013; Poels, De Kort, et al., 2008). Moreover, although the GEQ (Poels et al., 2008) has been validated and mainly used in the area of entertainment games, it has also been applied to single and multi-player serious games (De Grove et al., 2010; Oksanen, 2014).

However, since we referred to an Italian-speaking population, we had to translate the GEQ into Italian. The Italian version of the questionnaire was created using a back translation procedure. A bilingual expert translated the GEQ items into Italian in a way that maximized their linguistic and conceptual correspondence with their original counterparts. Thus, a second bilingual person retranslated it into English. A research committee, that included the authors of this article, compared the wording of the Italian and English forms of the questionnaire and created the version of the GEQ on the basis of consensual agreement.

Group Processes

- **Team Potency Scale.** By using this self-reporting questionnaire it was possible to assess "group potency", defined by Guzzo et al. (1993) as the belief in a group about its general effectiveness across multiple tasks. This eight-item scale contains items such as "My group expects to be known as a high-performing team", "My group believes it can be very productive". Group members individually completed the eight items using a 10-point scale (1 = to no extent , 3 = to a limited extent , 5 = to some extent , 7 = to a considerable extent , and 10 = to a great extent). Each individual's score was computed by averaging across the eight items. The scale was translated into Italian using the same back-translation procedure described for the GEQ.

- **Perceived Cohesion Scale (PCS):** This six-item scale addresses the concept of cohesion as "an individual sense of belonging to a particular group and his or her feelings of morale associated with membership in the group" (Bollen & Hoyle, 1990). Specifically, the scale is based on the two core dimensions of cohesion: *a sense of belonging*, reflected by items like "I feel that I belong to this group", and *feelings of morale*, defined by items like "I'm content to be part of this group". Responses were recorded on a 7-point, Likert-type scale (1= strongly disagree, 3= slightly disagree, 5= slightly agree, 7= strongly agree). The original version of the scale was developed and tested from a sociological perspective by Bollen & Hyle (1990) who used relatively large reference groups for their validation purposes. However, the scale was also adapted and validated with small groups by Chin, Salisbury, Pearson, & Stollak (1999). We used the latter version of the scale, translating it into Italian according the back-translation procedure described for the GEQ and the Team Potency Scale.

- **Group Climate Questionnaire (GCQ).** Firstly developed at the University of British Columbia (MacKenzie, 1981), the GCQ has been mainly used to measure emotional climate during group psychotherapy sessions, but it could be perfectly applied to our research goals. Moreover, the questionnaire was translated into Italian and then validated by Costantini et al. (2002) who identified two main subscales: *positive climate* ("Team members felt that what happened was important and experienced a sense of cohesion") and *conflict* ("Team members didn't trust each others") . Each scale consists of 12 items, assessed on a 7-point Likert scale (0= not at all, 3= moderately, 6= extremely).

Questionnaire	Variable	Descriptors/definition
GEQ Core Module	Competence	Pride, euphoria, accomplishment
	Sensory and Imaginative Immersion	Absorbed in the story, empathy, identification
	Flow	Concentration, absorption, detachment
	Tension/Annoyance	Annoyance, irritation, frustration
	Challenge	Pressure, difficulties, task challenges
	Negative affect	Disappointment, irritation, anger
	Positive affect	Contentment, fun, happiness
GEQ Social Presence Module	Psychological Involvement – Empathy	Enjoyment with others
	Psychological Involvement – Negative Feelings	Jealousy, malicious delight, revengefulness
	Behavioural Involvement	Being connected with others
GEQ Post-game Module	Positive Experience	Accomplishment, satisfaction
	Negative experience	Regret, guilt, disappointment
	Tiredness	Weariness, exhaustion
	Returning to Reality	Jetlag, lost track of time
Team Potency	Team potency	A belief in a group about its general effectiveness across multiple tasks
PCS	Sense of belonging	Individual's sense of belonging to a particular group
	Feelings of morale	Individual's feelings of morale associated with membership in the group
GCQ	Involvement	Individual perception of group involvement
	Conflict	Individual perception of ingroup conflicts
GPEQ	Group Goals	Goal sharing
	Group Resources	Resource allocation

Tab.5**.** *Full variables list*

- **Group Performance Evaluation Questionnaire (GPEQ)**. Developed and validated in Italian (Comunian, 2004), this questionnaire consists of 16 items that are focused on two main dimensions: *group goals* and *group resources*, both assessed on a 6-point Likert scale (1 = totally agree , 6 = totally disagree). The questionnaire is characterized by questions that aim to measure team member satisfaction according to the definition of common goals (“ We were not able to share our individual goals”) and the actual use of available team resources (“The group didn’t use all the available resources”). Each individual’s score was computed by averaging across the item developed for each dimension.

Group Performance

- **Score.** When completing a task, each group was given 1, 5 or 10 points according to the quality of the given answer. If players were not able to obtain more than 7 points in two subsequent challenges before task 4, the serious game stopped and subjects were not allowed to continue (failure). We coded as 1 a situation were the simulation was not completed and as 2 a situation were players could experience the complete game. Moreover, for those who completed the simulation, single scores were summed at the end of the game and coded as follow.
  - Total Score= 50: excellent performance
  - 45 ≤ Total Score <49: good performance
  - 41 ≤ Total Score <44: medium performance
  - Total Score < 40: poor performance

- **Time.** In order to unobtrusively observe team performance we considered the time (min) needed to complete each one of the five tasks and the game as a whole. The total time was computed for the groups who completed the full game only.

5. Results

Overview

Prior to the deepening of hypotheses, guidelines for screening missing data and outliers were followed. There were only few missing values and no substitutions were required. Further, outliers were searched in the data set. Since none of the observations appeared to be extreme, all the data were kept for analysis. Data normality was also checked using Skewness, Kurtosis, and Kolmogorov–Smirnov normality. The results of this examination led us to assume data normality.

After this verification, reliability statistics (Cronbach's α) for each dimension of the questionnaires were considered (Tab.6). Then, to very H1 an independent sample *t* test was used. Since team performance data were calculated on a group level, a non-parametric test (Kolmogorov–Smirnov) was chosen for them. A chi-square test was applied to identify significant differences on the number of groups who completed the simulation and on the quality of the performance. All data were analysed using SPSS version 21.

Questionnaire	**Variable**	***Digital Condition***		***Paper Condition***		**Cronbach's α**
		M	**SD**	**M**	**SD**	
GEQ Core Module	Competence	2.13	.677	2.13	.677	.86
	Sensory and Imaginative Immersion	1.27	.49	1.27	.49	.68
	Flow	2.32	.84	2.32	.84	.79
	Tension/Annoyance	.69	.86	.69	.86	.72
	Challenge	1.71	.76	1.70	.76	.66
	Negative affect	.79	.63	.79	.63	.44
	Positive affect	2.63	.67	2.63	.66	.84
GEQ Social Presence Module	Psychological Involvement – Empathy	2.52	.55	2.52	.55334	.80
	Psychological Involvement – Negative Feelings	1.04	.75	1.04	.75	.70
	Behavioural Involvement	1.98	.61	1.98	.61	.78
GEQ Post-game Module	Positive Experience	1.44	.74	1.44	.73	.83
	Negative experience	.85	.71	.85	.71	.64

	Tiredness	.70	.82	.70	.82	.78
	Returning to Reality	.87	.76	.86	.76	.57
Team Potency	Team potency	4.26	1.34	4.25	1.34	.96
PCS	Sense of belonging	4.76	1.75	4.76	1.75	.93
	Feelings of morale	4.76	1.67	4.76	1.67	.89
GCQ	Involvement	4.13	1.03	4.13	1.03	.80
	Conflict	2.86	.77	2.86	.77	.43
GPEQ	Group Goals	3.79	.81	3.79	.80	.63
	Group Resources	4.27	.99	4.27	.99	.78

Tab 6. Descriptive Statistics and Reliability for the Dimensions of the GEQ (Scales Range From 0 to 4: 0= *Not at All*, 4 = *Extremely), Team potency Scale* (Scale Range From 1 to 10: 1 = *to no extent*, 10 = *to a great extent*), PCS (Scales Range From 1 to 7: 1= *strongly disagree*, 7= *strongly agree*), Group Climate Questionnaire (Scales Range From 0 to 6: 0= *Not at All*, 6 = *Extremely)* and the Optimal Group Performance Evaluation Questionnaire (Scales Range From 1 to 6: 1 = *Totally agree* , 6 = *Totally disagree*).

Reliability

Game experience

The reliability of the GEQ appeared to be generally good (.70 > α > .86), even if the internal consistency of specific subscales was just acceptable (*Sensory and imaginative immersion:* α = . 684, *Challenge:* α = .69, *Positive affect:* α = .67, *Negative experience:* α = .64). According to the indication given by Nunnally & Bernstein (1994), only two subscales were considered as weak and not acceptable: *Returning to reality* (α =.57) and *Negative affect* (α=.44).

Group Processes

The reliability of both the Team Potency Scale (α=.96) and the PCS subscales (*Sense of belonging:* α =.93, *Feelings of morale*: α =.89) was excellent. Results were acceptable for the Group Climate Questionnaire and for the Optimal Group Performance Evaluation Questionnaire (.63 > α > .80), except for the *Conflict* subscale (α =.43). This value was considered as unacceptable and the scale was not taken into consideration for further analysis, as it happened for the *Returning to reality* (α =.57) and *Negative affect* (α=.43) scales of the GEQ.

Team Performance

In the digital condition, 90% of the groups completed MtG, but 66.6% had a poor performance. Only 11,1% of the groups showed an excellent performance and 22.22% obtained a good score.

44.4% of groups who played the paper-based version of the game was not able to complete MtG. Among those who completed the simulation, 60% showed a poor performance, 20% obtained both a good and an excellent performance.

The average time groups needed in both conditions to complete each task are shown in Table 3.

Variable	***Digital Condition***			***Paper Condition***		
	N	**M**	**SD**	***N***	**M**	**SD**
TIME T1	10	5.55	2.29	9	6.18	1.90
TIME T2	10	7.98	2.44	9	7.29	2.49
TIME T3	10	14.73	3.78	9	13.44	4.85
TIME T4	10	6.39	2.60	9	6.63	2.39
TIME T5	9	10.46	1.40	5	9.14	2.02
TIME TOTAL	9	45.57	4.89	5	42.69	9.98

Tab 3. Time: descriptive statistics

Comparison between paper and digital game experience

In order to identify the differences between the computer-based (condition 1) and the paper-based condition (condition 2), data were analyzed using an independent-samples t-test. The test was found to be statistically significant for seven variables.

***H1**: People who played the digital version of the game will experience higher level of immersion than players who experience the paper-based version of game.*

When considering the Core Module of the GEQ, a significant difference on *Sensory and Imaginative Immersion* ($t(93)=2.87$, $p= 0.005$) was registered. The effect size for this analysis ($d = .59$) was found to be medium, as indicated by the Cohen's (1988) convention. This result indicates that people who played the paper-based version of the game had a significantly lower feeling of immersion (M= 1.27, SD = 0.49) than subjects who experienced the computer-based version (M= 1.96, SD= 0.59).

A second significant difference was found on the *Tension* subscale ($t(71.41) = -2.17$, p = 0.03) with an acceptable effect size (d=. 45). Thus, subjects exposed to the paper condition (M= 0.70, SD = 0.8674) experienced higher annoyance, irritation and frustration than people who played the digital version of the game (M= 0.53, SD = 0.69).

H2: *People who played the digital version of the game will experience higher level of positive affects and lower negative feelings than players who experience the paper-based version of game.*

Another significant difference was observed on the Core Module of the GEQ and it's related to the *Positive Affect* scale ($t(93)= -1.85$, p=0.017). The effect size for this analysis (d= .500) was found to be medium. The result of this analysis suggests that digital gamers felt an higher sense of contentment, satisfaction and happiness during the game (M= 2.96, SD = 0.65) than those who had to play with the paper-based version of *Mind the Game* (M= 2.63, SD= 0.67).
Only one significant difference was observed in the Social Presence Module of the GEQ and it was highlighted on the *Negative Feelings* scale ($t(93)= -1.85$, p=0.017) with a medium size effect (d=.586). This suggests that subjects who experienced the digital condition (M=0.69, SD =0.38) reported lower negative feelings when thinking about their group experience than players of the second condition (M= 1.0433, SD= 0.7540). Similarly, a significant effect was registered on the *Negative Experience* scale of the Post Game Module of the GEQ ($t(68) = -2.4$, p = 0.007). This result indicates that those who played the paper-based version of the game (M= 1.0, SD= .045) described the experience as more negative than the people who were exposed to the digital condition (M= 0,85, SD= .071).

Interrelation between group processes, game experience and social presence

Bivariate correlations were completed both for the digital and the paper-based condition. Results are shown in Tab. 6 and Tab 7.

H3. There will be a positive relationship between social presence and group processes

In the first condition (the digital game experience), *team potency* strongly correlated with *competence* ($r(50)=.51$, $p<.01$), *flow* ($r(50)=.33$, $p<.01$), *positive affect* ($r(50)=.39$, $p<.01$), *empathy* ($r(50)=.33$, $p<.01$), and *positive experience* ($r(50)=.57$, $p<.01$). It also appeared to be negatively correlated with *negative feelings* ($r(50)=-.28$, $p<.01$). Moreover, the *sense of belonging* was significantly related to *positive affect* ($r(50)=.36$, $p<.05$) and *empathy* ($r(50)=.36$, $p<.01$).

The same correlations were found for the *feelings of morale* that was strongly linked to both *positive affect* ($r(50)=.39$, $p<.01$) and *empathy* ($r(50)=.45$, $p<.01$). Further, the level of tension experienced during the game negatively correlated with the perception of *group goals* ($r(50)=-.37$, $p<.01$), *group resources* ($r(50)=-.29$, $p<.05$), and *group involvement* ($r(50)=-.29$, $p<.01$) that was linked to *positive experience* ($r(50)=.29$, $p<.01$).

Similar correlations were found in the paper-based condition too. For example, as it happened in the previous condition, *team potency* correlated with *competence* ($r(45)=.44$, $p<.01$), *positive affect* ($r(45)=.30$, $p<.05$), *empathy* ($r(45)=.47$, $p<.01$), and *positive experience* ($r(45)=.42$, $p<.01$) and it was negatively linked to *negative feelings* ($r(45)=-.40$, $p<.01$). However, in this condition a significant correlation was not found with *flow*, but with *behavioural involvement* ($r(45)=-.36$, $p<.05$).

As in the first condition, the *sense of belonging* was linked to *positive affect* ($r(45)=.39$, $p<.05$) and *empathy* ($r(45)=.32$, $p<.05$) but also to *behavioural involvement* ($r(45)=.43$, $p<.05$), *positive experience* ($r(45)=.31$, $p<.05$) and negatively to *tension* ($r(45)=-.31$, $p<.05$).

The same correlations were found for the *feelings of morale scale* that was strongly related to *positive affect* ($r(45)=.40$, $p<.01$), *empathy* ($r(45)=.37$, $p<.05$), *behavioural involvement* ($r(45)=.46$, $p<.01$), *positive experience* ($r(45)=.33$, $p<.05$) and negatively to *tension* ($r(45)=-.36$, $p<.05$).

Group goals negatively correlated with *tension* ($r(45)=-.362$, $p<.05$) and *negative experience* ($r(45)=-.303$, $p<.05$), but positively with *positive affect* ($r(45)=.54$ $p<.01$), and *empathy* ($r(45)=.55$, $p<.01$). *Empathy* ($r(45)=.382$ $p<.05$) and *positive affect* ($r(45)=.35$ $p<.05$) showed a correlation also with *group resources,* along with *competence* ($r(45)=.30$ $p<.01$). Finally, results showed a correlation between *involvement* and *positive affect* ($r(45)=.38$ $p<.05$) as well as *empathy* ($r(45)=.35$ $p<.05$).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Competence (1)	1	,70**	,56**	-,139	,213	,687**	,555**	,230	,472**	,611**	,018	-,046	,026	-,023	,069	,175	,515**	,083
Sensory and Imaginative Immersion (2)	,704**	1	,733**	,015	,414**	,778**	,622**	,063	,461**	,581**	,199	-,081	,045	-,061	,100	,178	,247	,083
Flow (3)	,565**	,733**	1	,061	,449**	,617**	,624**	,078	,563**	,540**	,263	,076	,243	,124	,065	,130	,330**	,141
Tension/ Annoyance (4)	-,139	,015	,061	1	,401**	-,059	-,068	,217	,075	-,186	,586**	,324*	-,371**	-,290*	-,076	-,065	-,132	-,292*
Challenge (5)	,213	,414**	,449**	,401**	1	,348*	,351*	,006	,299*	,059	,464**	,112	,100	-,032	,116	,083	,050	-,109
Positive affect (6)	,687**	,778**	,617**	-,059	,348*	1	,768**	,156	,367**	,597**	,201	-,171	,138	-,016	,314*	,391**	,397**	,145
Psychological Involvement – Empathy (7)	,555**	,622**	,624**	-,068	,351*	,768**	1	,365**	,501**	,582**	,261	,004	,284*	,128	,366**	,451**	,537**	,205
Psychological Involvement – Negative Feelings (8)	,230	,063	,078	,217	,006	,156	,365**	1	,225	,199	,203	,380**	-,007	,077	,001	,123	,285*	,227
Behavioural Involvement (9)	,472**	,461**	,563**	,075	,299*	,367**	,501**	,225	1	,302*	,119	,007	-,007	-,030	,069	,169	,167	,208
Positive Experience (10)	,611**	,581**	,540**	-,186	,059	,597**	,582**	,199	,302*	1	,149	-,026	,258	,091	,106	,247	,579**	,296*
Negative experience (11)	,018	,199	,263	,586**	,464**	,201	,261	,203	,119	,149	1	,381**	,038	,068	,075	,115	,187	-,005
Tiredness (12)	-,046	-,081	,076	,324*	,112	-,171	,004	,380**	,007	-,026	,381**	1	,065	,035	,006	-,099	,289*	,034
GPEQ Goals (13)	,026	,045	,243	-,371**	,100	,138	,284*	-,007	-,007	,258	,038	,065	1	,767**	,309*	,248	,331*	,508**
GPEQ Resources (14)	-,023	-,061	,124	-,290**	-,032	-,016	,128	,077	-,030	,091	,068	,035	,767**	1	,328*	,307*	,219	,427**
PCS Belonging (15)	,069	,100	,065	-,076	,116	,314*	,366**	,001	,069	,106	,075	,006	,309*	,328**	1	,897**	,322*	,167
PCS Morale (16)	,175	,178	,130	-,065	,083	,391**	,451**	,123	,169	,247	,115	-,099	,248	,307*	,897**	1	,380**	,249
Team potency (17)	,515	,247	,330*	-,132	,050	,397**	,537**	,285*	,167	,579**	,187	,289*	,331*	,219	,322**	,380**	1	,043
GCQ Involvement (18)	,083	,083	,141	-,292**	-,109	,145	,205	,227	,208	,296*	-,005	,034	,508**	,427**	,167	,249	,043	1

Tab 6. Bivariate Correlation between the GEQ Core, GEQ Social Presence Module and GEQ Post Game Experience Module and Team Potency, PCS, GPEQ, GC scales for the Digital Game Experience.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Competence (1)	1	,542**	,094	,015	-,107	,323*	,513**	,360*	,246	,570**	,058	,015	,256	,299*	,123	,123	,441**	,141
Sensory and Imaginative Immersion (2)	,542**	1	,449**	,205	,348*	,409**	,388**	,333*	,158	,516**	,263	,018	,041	,171	-,004	,031	,069	,192
Flow (3)	,094	,449**	1	,170	,460**	,365*	,297*	-,039	-,010	,235	,022	-,141	,063	,009	-,019	-,054	-,200	,116
Tension/ Annoyance (4)	,015	,205	,170	1	,441**	-,324*	-,193	,486**	,000	,183	,653**	,531**	-,362*	-,252	-,309*	-,302*	-,019	-,167
Challenge (5)	-,107	,348*	,460**	,441**	1	,011	,061	,277	,061	,179	,516**	,434**	-,111	-,047	-,223	-,180	-,045	,045
Positive affect (6)	,323*	,409**	,365*	-,324*	,011	1	,627*	,038	,254	,386**	-,235	-,292	,540**	,349	,388**	,402**	,305*	,380*
Psychological Involvement – Empathy (7)	,513**	,388**	,297*	-,193	,061	,627**	1	,140	,424**	,510**	-,034	-,242	,546**	,382	,321*	,373*	,468**	,346*
Psychological Involvement – Negative Feelings (8)	,360*	,333**	-,039	,486**	,277	,038	,140	1	,491**	,506**	,718*	,535**	-,134	-,042	,234	,279	,402**	,228
Behavioural Involvement (9)	,246	,158	-,010	,000	,061	,254	,424**	,491**	1	,486**	,306*	,160	,087	-,100	,432**	,461**	,359*	,092
Positive Experience (10)	,570**	,516**	,235	,183	,179	,386**	,510**	,506**	,486**	1	,269	,216	,217	,235	,306	,332*	,416**	,262
Negative experience (11)	,058	,263	,022	,653**	,516**	-,235	-,034	,718**	,306*	,269	1	,753**	-,303*	-,127	-,026	,041	,173	,114
Tiredness (12)	,015	,018	-,141	,531**	,434**	-,292	-,242	,535**	,160	,216	,753**	1	-,268	-,254	-,189	-,065	,138	,053
GPEQ Goals (13)	,256	,041	,063	-,362*	-,111	,540**	,546**	-,134	,087	,217	-,303+	-,268	1	,695**	,418**	,423**	,583**	,437**
GPEQ Resources (14)	,299**	,71	,009	-,252	-,047	,349*	,382*	-,042	-,100	,235	-,127	-,254	,695**	1	,365*	,307*	,415**	,393**
PCS Belonging (15)	,123	-,004	-,019	-,309*	-,223	,388**	,321*	,234	,432**	,306*	-,026	-,189	,418**	,365*	1	,942**	,486**	,628**
PCS Morale (16)	,123	,031	-,054	-,302*	-,180	,402**	,373*	,279	,461**	,332*	,041	-,065	,423**	,307*	,942**	1	,571**	,678**
Team potency (17)	,441**	,069	-,200	-,019	-,045	,305*	,468**	,402**	,359*	,416**	,173	,138	,583**	,415**	,486**	,571**	1	,350*
GCQ Involvement (18)	,141	,192	,116	-,167	,045	,380*	,346*	,228	,092	,262	,114	,053	,437**	,393**	,628**	,678**	,350*	1

Tab.7 Bivariate Correlation between the GEQ Core, GEQ Social Presence Module and GEQ Post Game Experience Module and Team Potency, PCS, GPEQ, GC scales for the Paper-based Game Experience.
*p<.05 **p<.01

H4. There will be a positive relationship between social presence and game experience, especially in terms of immersion and positive affects.

Correlations between the dimensions of the core game experience and social presence revealed that these factors are strongly linked to each other.

In the digital condition significant correlations were found between *empathy* and the main elements of the core game experience like *competence* ($r(50)=.55$, $p<.01$), *immersion* ($r(50)=.62$, $p<.01$), *flow* ($r(50)=.62$, $p<.05$), *challenge* ($r(50)=.35$, $p<.05$) and *positive affects* ($r(50)=.76$, $p<.01$). *Empathy* also correlated with a post-game *positive experience* ($r(50)=.58$, $p<.01$).

Further, the *negative feelings* associated to the social dimension of the game correlated only with *tiredness* ($r(50)=.38$, $p<.01$); while *behavioural involvement* was linked to *competence* ($r(50)=.47$, $p<.01$), *immersion* ($r(50)=.46$, $p<.01$), *flow* ($r(50)=.56$, $p<.05$), *challenge* ($r(50)=.29$, $p<.05$), *positive affects* ($r(50)=.36$, $p<.01$) and to a post-game *positive experience* ($r(50)=.302$, $p<.05$).

Results in the paper-based condition showed a strong correlation between *empathy* and the main elements of the core game experience like *competence* ($r(45)=.51$, $p<.01$), *immersion* ($r(45)=.38$, $p<.01$), *flow* ($r(45)=.29$, $p<.05$), and *positive affect* ($r(45)=.62$, $p<.01$). *Empathy* also correlated with a post-game *positive experience* ($r(45)=.51$, $p<.01$). T-e second component of the Social Presence Module – *negative feelings* – correlated significantly with *competence* ($r(45)=.36$, $p<.05$), *immersion* ($r(45)=.33$, $p<.05$), *tension* ($r(45)=.48$, $p<.01$), and both with a post-game *positive* ($r(45)=.50$, $p<.01$) and *negative experience* ($r(45)=.71$, $p<.01$).

The third component – *behavioural involvement* – was significantly associated only to two post-game dimensions: *positive* ($r(45)=.48$, $p<.01$) and *negative experience* ($r(45)=.30$, $p<.01$).

Other results: *group processes*

When the attention was focused on the questionnaires we used to analyze group processes, two main differences emerged and they were both related to the PCS. Significant differences were in fact observed in the *Sense of Belonging* Scale ($t(92)= 1.90$ $p= 0.061$) and in the *Feelings of Morale Scale* ($t(92)= 2.18$ $p= 0.032$). Digital gamers reported higher scores in both scales (*Feelings of Morale*: M= 5.4867, SD =

1.53; *Sense of Belonging:* M= 5.41, SD=1.52) suggesting they experienced a stronger sense of belonging to their groups and feelings of morale associated with membership in the group itself than players who were exposed to the paper condition (*Feelings of Morale*: M= 4.765, SD = 1.68; *Sense of Belonging:* M= 4.76, SD=1.75).

Team Performance

A chi-square test was used to identify significant differences on the number of groups who completed the simulation and on the quality of the performance of groups who reached the end of the game. No relationship was found between the media condition and the conclusion of the simulation (X^2 (1, N = 19) = 2.89, p= .09). Similarly, no relationship was observed between the media condition and the quality of performance (X^2 (2, N = 14) = .21, p= .90).

As shown in Tab.8, results for the Kolmogorov-Smirnov test indicated that there was not a significant difference between the two conditions both on the time to complete each task and the time to complete the full game.

	TIME T1	TIME T2	TIME T3	TIME T4	TIME T5	TIME TOTAL
Kolmogorov-Smirnov (Z)	.65	.53	.55	.55	.87	.99
Sign.	.78	.94	.91	.91	.42	.27

Tab.8. Results for the Kolmogorov-Smirnov test

6. Discussion

The aim of the present study was to contribute to digital and serious games literature, evaluating the potential of digital game technologies compared to paper-based applications not only on individuals, but also among groups. To this end, the study was developed to analyse a situation of zero-history groups interacting in a FTF setting, where players dealt a multiplayer SG presented in a digital or a paper-based form.

Aligned with the results obtained by Yoo & Alavi (2001), our research supports the media dependent and the social construction perspective by focusing both on subjective game experience and group dynamics.

Firstly, people who played the digital version of the game experienced higher level of immersion than players who experience the paper-based version of game. In particular, people who played the paper-based version of the game had a significantly lower feeling of *sensory and imaginative* immersion than subjects who experienced the computer-based version. While *sensory immersion* refers to the extent to which the interface features of a game have a perceptual impact on the user, *imaginative immersion* underlies the extent to which the game is able to create a world that stimulates users' fantasy and imagination.

These findings are in line with the media-dependent perspective and with the media richness theory that argues that a medium's richness is determined by certain, invariant, mechanical characteristics of the medium such as the degree of personalization, speed of feedback, language variety (Dennis & Valacich, 1999). The affordances and characteristics of a rich medium play an important role on the experience of immersion (Workman et al., 2003). As compared to paper-based solutions, digital applications are unique (Flew, 2008) in terms of (a) *variability*, (b) *automaticity*, (c) *multimediality* and (d) *interactivity* (Jensen, 1998). For example, the capacity of the technology to produce an environment of sensorial richness, with information for all the senses has been associated to high levels of immersion (Bystrom et al., 1999). Technology-related elements associated with immersion are also pictorial realism (Lee & Kim, 2008; Welch, 1999), system response time (Durlach & Mavor, 1994) and field of vision (Riva, 2007). Compared to paper-based games, digital games are better suited to ambiguous tasks that requires resolution of different views and opinions among people. Further, especially within digital games users can concretely act within virtual scenarios adequately re-created to mirror specific experiential, situated, multimodal routinized formats and experience complex concepts without losing the connection between abstract ideas and the authentic problems (Admiraal et al., 2011; Anolli et al., 2010).

Secondly, people who played the digital version of the game experienced higher level of positive affects and lower negative feelings than players who experienced the paper-based version of game. Subjects exposed to the paper condition also experienced higher annoyance, irritation and frustration than people who played the digital version of the game. These results confirm that games can elicit several emotional states (Anolli et al., 2010) but also that digital technologies can empower the quality of emotional experiences (Botella et al., 2012; Serino, Cipresso, Gaggioli, & Riva, 2013; Wiederhold & Riva, 2012). Different devices have proven to be effective from this point of view. For example, the Butler Project, a technological e-health platform designed to deliver health care to the elderly (Botella et al., 2009) appeared to be effective in promoting positive emotions and decreasing negative feelings. Other studies explored the potentiality of emerging mobile devices to exploit the potential of positive emotions (Serino et al., 2013). For instance, Grassi, Gaggioli, & Riva (2009), showed that relaxing narratives supported by multimedia mobile phones were effective to enhance relaxation and reduce anxiety in a sample of commuters. Digital games can evoke higher levels of *sensorial pleasure* throughout graphics, usability, game aesthetic and strengthen the *pleasure for victory* (Mayer & Johnson, 2010; Wouters et al., 2013).

Thirdly, we observed a positive relationship between social presence and group processes, with particular regard to *team potency*, *sense of belonging* and *feelings of morale.* The same correlations were found in both the paper-based and the digital condition. According to the literature, social presence has a specific role in collaborative games, to open communication, critical thinking, group cohesion, supportive interaction and negotiation (Kreijns et al., 2003, 2002). High levels of social presence are predictors of learning (Gunawardena, 1995) and they are correlated to high levels of enjoyment (Gajadhar et al., 2008), and group cohesion (Yoo & Alavi, 2001).

Many authors have also argued that gameplay experience is a distinct construct from presence and social presence (Örtqvist & Liljedahl, 2010). Multiplayer gameplay experiences relate to the gamers' development of attitudes toward the game (Wendel et al., 2013), whereas social presence is rather related to the degree of salience of the other person in a mediated environment and the consequent salience of their interpersonal interaction (Gunawardena, 1995). While separate, we observed a strong and positive relationship between social presence and gameplay experience (Oksanen, 2013). Results of previous research showed that the sociability of the game and a sense of social presence are strongly connected to the various dimensions of the core game experience, including engagement, in the forms of flow and immersion (Cairns et al., 2013; Hämäläinen, 2011; Oksanen, 2013). These results indicate that the sociability of the game and sense of social presence are potential factors in the emergence of positive and engaging game experiences, at least in the context of collaborative games.

The latter two findings are really important as they highlight that not only media conditions, but also social factors influence the way that group members perceive and use technology (Yoo & Alavi, 2001).

This research had several limitations. First, the number of participants was limited, and the investigation focused only on one game. Therefore results cannot be generalized to all kind of collaborative games and to single-player SGs. Third, the methods used in this study are limited to the self-reporting tool for measuring subjective game experiences. As it has been pointed out that GEQ is recommended for use in combination with other methods (IJsselsteijn, De Kort, Poels, Jurgelionis, & Bellotti, 2007) and in qualitative research, looking at the players' experiences in playing games would strengthen our understanding of engagement in games (Boyle et al., 2012).

Fourth, the reliability of the scales *returning to reality* (α =.57) and *negative affect* (α=.44) of the GEQ and the *Conflict* subscale (α =.43) for Optimal Group Performance Evaluation Questionnaire was found to be weak. It might indicate errors in language translation. However, based on this study, the low reliability of these two dimensions cannot be explained. Similarly, the role of team processes was studied in a single session. Research could employ a longitudinal design to verify whether these results can be replicated. Further, we did not consider players' level of familiarity with ICTs.

This study has raised numerous new research topics to be investigated. To produce more generalizable knowledge about subjective game experiences, multiple research methods should be combined. Systematic research with multiple methods on game experience enables us to recognize game design patterns that lead to engaging and immersive gaming experiences, which may further have a positive effect on learning (Nacke et al., 2009). A future challenge from the collaborative learning point of view is to find ways to link game experiences to the processes of collaboration during gameplay. This may make it possible to identify game mechanics and structures of game tasks that promote collaborative activities and social interaction in a pleasant and engaging way.

5. Multiplayer Serious Games and Team Effectiveness: Communication patterns in Computer Mediated versus Face-to-Face group problem solving

The rapid development of Information and Communication Technologies (ICTs) has led to salient changes in the manner in which groups work, solve problems and communicate (Olson & Olson, 2003). Computer-Mediated Communication (CMC) systems are increasingly been used as an environment to support cooperative problem solving and decision-making (Van Der Meijden & Veenman, 2005) as well as to facilitate knowledge sharing among people who are not working in face to face (FTF) settings (Siegel, Dubrovsky, Kiesler, & McGuire, 1986). More often, people collaborate in virtual and dispersed teams with alternative non-hierarchical forms of leadership (Pearce, Conger, & Locke, 2008) so that nowadays, with rare exceptions, all organizational teams are virtual to some extent (Martins, Gilson, & Maynard, 2004). Thus, Virtual Teams (VTs), or geographically distributed groups who rely primarily on computer-mediated technologies to communicate, are becoming critical for the long-term competitiveness of organizations (Driskell, Radtke, & Salas, 2003; Schiller & Mandviwalla, 2007).

Further, the effectiveness of group functioning in terms of problem-solving and decision making is largely determined by how well the group's members communicate with each other. Because group members interact to influence one another, group communication processes or group dynamics are among the most important variables that influence the effectiveness and efficiency of any group decisions or problem solutions (Jonassen & Kwon, 2001). However, the frequent use of CMC systems has raised the question of whether the communication patterns, can be compared to the same patterns of under FTF circumstances (Van Der Meijden & Veenman, 2005). These questions have lead to a controversial debate where, on the one hand, some authors described CMC as an impersonal medium where emotions are very difficult to express (Rice & Love, 1987; Riordan & Kreuz, 2010), while, on the other, researchers have claimed that the differences between CMC and FTF are minimum and can dissolve over time (Tidwell & Walther, 2002; Walther, Anderson, & Park, 1994).

Among the different perspectives that have addressed the relationship between communication and group effectiveness, the functional theory (Li, 2007) emerged as a major paradigm in the group decision-making literature (Baltes et al., 2002).The core notion of this perspective is that several critical task requirements have to be performed for a group to achieve high-quality decision making, and the group relies on group interaction to satisfy these critical task requirements. Therefore, effective decision-making groups are characterized by interactions that are able to successfully satisfy their task requirements, whereas ineffective groups lack these characteristic interactions (Hirokawa, 1990; Tasa & Whyte, 2005).

As deeply discussed in the present thesis, Serious Games (SGs) have proven to be able to shape new opportunities for training and empowering human decision making and problem solving (Dabbish, Kraut, & Patton, 2012; Fitó-Bertran, Hernández-Lara, & Serradell-López, 2014). They have in fact supported the creation of socio-technical environments (Fisher et al., 2005), where both the interconnection between humans and technology and the merge between continuous learning experiences and ludic affordances encourages the emergence of communication and collaboration (Mayer, van Dierendonck, van Ruijven, & Wenzler, 2013).

However, despite the large body of literature on cooperative or collaborative behaviours, there is not much work reported comparing the effects of SGs played in FTF and CMC situations with a specific focus on collaborative problem-solving tasks. Therefore, in this study, we compared the communication patterns within zero-history groups that were collaboratively solving problems within a multiplayer SG via FTF and CMC.interactions.

In the next sections we will describe related relevant work and present our experiment, as well as its main results. Finally we discuss the obtained results and suggest some directions for future work.

1. Group problem-solving in CMC and FTF settings

According to the functional perspective, effective decision-making groups are characterized by interactions that are able to successfully satisfy their task requirements, whereas ineffective groups lack these characteristic interactions (Hirokawa, 1990; Tasa

& Whyte, 2005). In particular, five critical task functions have been identified (Orlitzky & Hirokawa, 2001; Wittenbaum et al., 2004):

1. to accurately understand the problem in its decision-making task, which includes the nature, the seriousness, and the possible causes of the problem, as well as the consequences when not solving the problem effectively;
2. to establish the criteria for an acceptable decision, which are the specific standards that a good decision should have;
3. to generate as many of the possible and realistic choices as it can from which a best decision can be made;
4. to assess the positive aspects of each alternative;
5. to discuss the negative aspects of each alternative.

Although most of the research on the functional perspective has been conducted FTF, CMC technologies are being used increasingly to support group decision making. Therefore, some authors have argued that the performance in CMC groups is superior to the performance of FTF groups due to the lack of a social presence in the CMC groups and thereby a less personal and socio-emotional form of interaction and a more task-oriented form of communication than in the FTF groups (Becker-Beck, Wintermantel, & Borg, 2005; Rhoads, 2010). In contrast, other authors have argued that the task discussions in CMC groups almost always take longer to complete than in FTF groups; that the absence of various nonverbal and social context cues to communication in the CMC situation may clearly hamper the efficiency of task performance; and that the absence of a social context and nonverbal cues to communication may even create a significant degree of anonymity and thereby a higher incidence of rude or offensive behavior in the CMC as opposed to FTF situations (Chang & Bordia, 2001; Tanis & Postmes, 2003).

Further, FTF and CMC groups differ largely in terms of discourse management strategies (Condon & Cech, 1996; Hedlund, Ilgen, & Hollenbeck, 1998). Usually tasks are cognitively structured into decision routines that reduce the amount of linguistic encoding necessary to convey discourse function, such as task clarification and turn management. Researchers found that FTF groups focus more on orientation and solution development, while CMC groups rely on discourse markers and short orienting phrases (Condon & Cech, 1996; Hedlund et al., 1998).

In terms of decision-making outcomes, past research has often found different and conflicting results when comparing FTF and CMC teams (Kerr & Tindale, 2004). In some studies, FTF groups make better decisions, while in others no differences were found. Generally, computer-mediated teams exhibit a lower frequency of communication than FTF teams, although they tend to exchange more task-oriented messages as a proportion of total communication (Tasa & Whyte, 2005). However, some empirical research suggests that CMC equalizes participation since members tend to be less inhibited in their interactions, and the effects of status differences are mitigated (McGrath, Arrow, & Berdahl, 2000).

Moreover, while much research has been conducted on group decision making under same time and place conditions, there has been a paucity of research on different-time/different-place teams supported by asynchronous technology (Schmidt, Montoya-Weiss, & Massey, 2001). In the limited number of studies that have examined decision making by dispersed teams, computer-mediated systems were found to be fairly effective. Dispersed, asynchronous teams generated more diverse perspectives, conducted more in-depth analyses, and produced higher quality decisions than FTF groups (Pridmore & Phillips-Wren, 2012; Schmidt et al., 2001).

2. The role of social presence and emotions in CMC and FTF settings

When investigating computer-mediated group decision-making, media dependent perspectives have been frequently employed to account for the effect of CMC on group decision making (Daft & Lengel, 1986; Daft, Lengel, & Trevino, 1987). Within this scenario, the media richness theory argues that a medium’s richness is determined by certain, invariant, mechanical characteristics of the medium such as the degree of personalization, speed of feedback, language variety (Dennis & Valacich, 1999). Rich media are better suited to ambiguous tasks that requires resolution of different views and opinions among people (Yoo & Alavi, 2001) since they promote higher level of immersion (Workman, Kahnweiler, & Bommer, 2003) and positive feelings among users (Mennecke, Valacich, & Wheeler, 2000; Vickery, Droge, Stank, Goldsby, & Markland, 2004). The social-information-processing theory takes a similar view to that of the media richness theory, but it adds one more variable (i.e., the social influence in organizations) to explain the perceived degree of information- carrying capacity of a communication channel. The notion of this theory is that the match between task ambiguity and the degree of media richness is still critical for managers to achieve communication effectiveness (Fulk, 1993).

Both theories emphasise the role of *social presence*, a term introduced by Short and colleagues (Short, Williams, & Christie, 1976) to indicate the degree of salience of the other person in a mediated environment and the consequent salience of their interpersonal interaction. On this point, Riva and colleagues (Riva et al., 2007) argued that an individual is present within a group if he/she is able to put his/her own intentions (presence) into practice and to understand the intentions of the other group members (social presence). Techniques to promote such a sense of being with another throughout a medium have a long history, going back to the first stone sculptures that evoked a sense of some other being in the mind of an ancestral observer. Biocca, Harms, and Burgoon (2003) state that social presence is the sense of being together with another. Social presence is about the social connections one makes to entities within a virtual environment, and the level of social presence one feels in a virtual environment depends upon the strength of these connections.

According to McGrath (1990), a continuum ranging from e-mail, teleconferencing, computer-desktop and FTF meetings can be made in regards to social presence. The lowest levels of social presence are associated to e-mail, while the highest are related to FTF meetings as a result of the richness of information (Kydd & Ferry, 1994) they are able to convey. Nowadays, social presence has been empowered by advanced ICT systems. Groupware, for example, are computing and communication technology based systems that assist groups of participants engaged in a common task, supporting communication, coordination, and collaboration through facilities such as information, discussion forums, and messaging (Lukosch & Schümmer, 2006).

According to social presence theory, online interaction, due to fewer nonverbal cues, demands less communicative complexity and creativity than FTF communication. A lack of social presence may lead to a high level of frustration, a critical attitude toward the instructor's effectiveness, and a lower level of affective learning (Lowry, Roberts, Romano, Cheney, & Hightower, 2006). Moreover, social presence has a specific role, particularly in collaborative games, to open communication, critical thinking, group cohesion, supportive interaction and negotiation (Kreijns, Kirschner, & Jochems, 2003, 2002). High levels of social presence are predictors of learning (Gunawardena, 1995) and they are correlated to high levels of enjoyment (Gajadhar, de

Kort, & IJsselsteijn, 2008), social interaction (Tu & McIsaac, 2002) and group cohesion (Yoo & Alavi, 2001).

As noted in the first study of the present thesis (chapter 4), social presence is also related to affects and emotions experienced by players. In recent years, researchers have also investigated the role of emotions in CMC and FTF environments (Derks, Fischer, & Bos, 2008). In FTF settings, people rely on a whole set of explicit and implicit mechanisms to adapt to their partners and the situation (Molinari, Chanel, Bétrancourt, Pun, & Bozelle, 2013). In CMC, contextual non-verbal cues, such as facial expressions, head or body movements, eye gazes, are missing or seriously limited. The awareness of others may therefore be impaired and this may lead to inefficient interactions (Riordan & Kreuz, 2010). Studies in which CMC has been compared with other communication channels show that CMC is not characterized by a lack of emotions, on the contrary, they suggest that positive emotions are expressed to the same extent as in FTF interactions, and that more intense negative emotions are even expressed more overtly in CMC (Derks et al., 2008). Moreover, authors highlighted no differences between FTF and CMC situations with respect to expression of positive emotions and even suggest that people express more freely their negative emotions in CMC (Derks et al., 2008). Even in asynchronous CMC systems (e.g., chat), emotions can be displayed by emoticons and acronyms (e.g. "lol) that are regularly used with a difference between men and women. The former rarely use emoticons during on-line conversation and feel less satisfied with CMC experiences than women (Hancock, Landrigan, & Silver, 2007). In the model proposed by Derks et al (2008), anonymity and reduced visibility have been identified as two contextual features of CMC that would be crucial in the comparison with FTF interactions. Most studies have shown that the anonymous nature of the interaction is the most important determinant of the relative ease and frequency with which both positive and negative emotions are expressed in CMC (Fulk, 1993; Tanis & Postmes, 2003). In many studies, however, an anonymous context implies both reduced visibility and a stranger as interaction partner, thus it is often impossible to disentangle the effects of each contextual feature (Derks et al., 2008). CMC is especially likely to reduce negative social appraisals both with regard to negative and positive emotion expressions (Young & Lo, 2012). Negative social appraisals indicate that people are aware of and pay attention to the potential negative consequences of their emotional reactions. As studies by Evers and colleagues (2005) and Fridlund (1991, 1994) have shown, the absence or presence of others in FTF interactions has an impact on the way in which we regulate our emotions.

The absence of visible others in more or less anonymous interactions in CMC is therefore assumed to lead to fewer negative appraisals and thus to more overt and explicit negative emotions expression (Derks et al., 2008). This may results in more anger expressions, especially in more anonymous settings, where individuals seem to feel less embarrassed or anxious to communicate their feelings. The relative absence of negative appraisals may also result in greater intimacy and closeness, because participants may be less concerned with the impression they make on others, or with vulnerability they might display. As a consequence, CMC may create a safer communication context than many FTF contexts, especially for the communication of negative emotions. These results are indeed controversial. For example, in a study made by Mallen et al. (2003) students who did not previously know each other were placed in pairs and randomly assigned to a conversation with a partner in either a FTF setting or an asynchronous CMC system. Emotional understanding, self-disclosure, closeness, and depth of processing were measured. The findings indicate that the FTF group felt more satisfied with the experience and experienced a higher degree of closeness and self-disclosure with their partner. There were no significant differences between groups in regard to the level of emotional understanding of their partner, although the FTF group reported higher levels of positive and negative affect. No significant differences were also found in depth of processing during the follow-up phone call. The implications for online counseling are discussed.

Satisfaction concerns the participants' perceptions of being able to achieve success and feelings about the outcomes achieved (Beranek & Martz, 2005). Several studies have explored student satisfaction under CMC versus FTF conditions. For example, Fjermestad and Hiltz (1999), Johnson, Aragon, Shaik, and Palma-Rivas (2002), Ocker and Yaverbaum (1999), and Kreijns, Kirschner, & Jochems (2002) found students to be more satisfied with a FTF collaboration process than with a CMC process. Several reasons for the relatively more negative perceptions of the students in the CMC conditions are then mentioned by the authors: asynchronous communication, coordination difficulties as the group members must, for example, agree on how frequently to communicate; relative anonymity of computer-mediated collaboration resulting in less effort on the task.

Xolocotzin Eligio and colleagues (2012) carried out experiments with the aim to investigate the relation between emotion understanding and performance in CMC. Results showed that collaborators had difficulties to accurately assess their partner's emotions in CMC situations. In order to overcome such difficulties, collaborators were instructed to share their self-reported emotions with their partner during specific moments of the task. Results highlighted an higher group performance and higher accuracy at estimating their partner's emotions in the emotion awareness condition. This suggests a positive impact of emotion awareness tools on collaborative processes and outcomes.

3. Research Goals and Hypotheses

The present study has been developed with the aim of analysing a situation of zero-history groups interacting in a FTF and CMC setting, where players deal with a multiplayer SG based on choosing and negotiating tasks (McGrath, 1984) .

In particular, the research has two main goals:

(i) evaluating the impact of different media conditions on communication processes and performance in small group problem solving settings;

(ii) studying how CMC and FTF situations affect emotions and social presence.

With regard to the first goal, research has confirmed differences in communication patterns between CMC and FTF groups while solving problems (Adejumo, Duimering, & Zhong, 2008; Jonassen & Kwon, 2001; Van Der Meijden & Veenman, 2005) and in terms of discourse management strategies (Condon & Cech, 1996; Hedlund et al., 1998). Usually tasks are cognitively structured into decision routines that reduces the amount of linguistic encoding necessary to convey discourse function, such as task clarification and turn management. Researchers found that FTF groups focus more on orientation and solution development, while CMC groups rely on discourse markers and short orienting phrases (Condon & Cech, 1996; Hedlund et al., 1998).

Therefore, we argue that:

- ***H1**: groups who will play the game in the FTF condition will focus more on orientation and solution development than players who experience the CMC condition.*

In terms of performance outcomes, past research has often found different and conflicting results when comparing FTF and CMC teams (Kerr & Tindale, 2004). CMC groups were less effective than FTF groups when they were performing tasks that required a great deal of communication. Many studies have applied McGrath's (1984) task complex to classify tasks into four types (i.e., generating, choosing, negotiating, and executing). The four types of tasks differ from each other in terms of the amount of communication required for completing the tasks, with the choosing and negotiating tasks demanding more time than the others. The majority of studies show that CMC groups were less effective than were FTF groups when performing the tasks of choosing or negotiating under the condition that CMC (Li, 2007). Further, authors have argued that the task discussions in CMC groups almost always take longer to complete than in FTF groups despite CMC teams exhibit a lower frequency of communication than FTF teams (Tasa & Whyte, 2005). Accordingly, we argue that:

- ***H2:** groups who will be challenged with choosing and negotiating tasks within the game in FTF conditions will:*
  - H2a. take shorter to complete the game than CMC groups;
  - H2b. exhibit an higher frequency of communication;
  - H2c. exhibit a better performance than CMC groups.

Further, we mainly referred to the media-dependent perspective and, in particular, to the media richness theory that argues that a medium's richness is determined by certain, invariant, mechanical characteristics of the medium such as the degree of personalization, speed of feedback, language variety (Dennis & Valacich, 1999). Rich media are better suited to ambiguous tasks that requires resolution of different views and opinions among people (Yoo & Alavi, 2001) since they promote higher level of social presence (Workman et al., 2003) and positive feelings among users (Mennecke, Valacich, & Wheeler, 2000; Vickery, Droge, Stank, Goldsby, & Markland, 2004). Therefore, we argue that:

- ***H3**: People who will play the game in the FTF condition will experience higher level of social presence than players who will play the game in CMC conditions.*
- ***H4**: People who will play the game in the FTF condition will experience higher level of positive emotions than players who will play the game in CMC conditions.*

4. Method

Participants

A total of 100 Italian students who attended a postgraduate specialization in Psychology played *Mind the Game,* a serious game developed by our research group (Argenton, Triberti, Serino, Muzio, & Riva, 2014). Of the participants, 64.6% (n= 64) were male and 34,3% (n=34) were female. Students ranged in age from 20 to 52. The mean age was 23.75 years (SD= 6.21). All participants were university students. They did not receive money or university credit for participating in the study. Except for the effort to balance gender, participants were randomly divided into 20 zero-history groups that consisted of 5 people. Groups were balanced such that there was at least one female per team.

Procedure

All participants attended a single testing session at the University of Milan-Bicocca. Participants were exposed randomly to either a FTF condition or a CMC condition following a pre-established randomization schema obtained from http://www.randomizer.org/.

After being divided in groups of 5 people, half of the participants played the game in FTF Condition while the other half experienced the game in a CMC condition through an audio conferencing system. Both the game and the tasks assigned to participants remained the same in the two conditions. None of the students had played the game before and an average game session lasted 41.06 minutes (SD= 8.041).

In the CMC condition, players of each group were seated around a squared table and could freely speak with each other, without showing their teammates the private information received during the game. In the second condition, players were physically isolated and allowed to perform the game in five quiet and isolated rooms with a five way conference call system and computer application sharing capabilities. In this situation players had never the opportunity to see and meet their virtual teammates.

A pre-test post-test design was used. Before starting the game, all participants were asked to fulfil a demographic survey, the VAS-A and the PANAS. At the end of the game, subjects had to complete the VAS-A, the PANAS, and the Social Presence Questionnaire (Tab.1).

Pre-Test	Post-Test
• Demographic Survey • Computer competency level and frequency of use • VAS-A • PANAS	• VAS-A • PANAS • Social Presence Questionnaire

Tab.9: The pre-test-post-test design

Materials

FTF interactions were carried out in a room set up for audio recording, equipped with a voice recorder connected to two unidirectional microphones. CMC interactions were also recorded by a voice recorder connected to the audio conference work station.

Each player was given a laptop to play the SG. Laptops (Lenovo G50-30; Intel® N3540 2,16/2,4 Ghz, 2ML L2) had a standard QWERTY keyboard, a monitor of 15.6’’ and a working internet connection. Participants were asked to sit in front the laptop at a distance of one meter.

Mind the Game (MtG) was used as a serious game for the present study. This is a multiplayer decision-making serious game developed to create a socio-technical environment (Fisher, Giaccardi, Eden, Sugimoto, & Ye, 2005) where the interconnection between humans and technology encourages the emergence of collaboration and group problem solving (for a more precise description of the game, see chapter 3).

Measures

1. *Grid Coding*

All the verbal transactions related to Task 1 – the *object challenge* - in the FTF and CMC conditions groups were transcribed from the audio replay of all sessions and segmented into individual communication acts.

- **Functional Category System (FCS)**

All written interactions were also segmented into individual communication acts according to the function they fulfilled in the group problem-solving processes using the Poole and Holmes (1995) Functional Category System (FCS).

- *Problem definition*: communication acts classified as problem definition category included any statement or question that enabled group understanding of the problem case itself. Problem definition acts could be either problem analysis or problem critique.
- *Orientation i*ncluded any comments related to the group process such as suggestion, planning, reflection, evaluation, and facilitation of group progress by group members (e.g., "Well all is going well. But what should they be doing and what shouldn't they? Any idea guys?").
- *Solution development* acts included statements, suggestions, and questions related directly to solutions
- *Non-task acts* included any off-task statements not related to solving problems such as personal comments (e.g., "Sorry guys. I read it wrong. ").
- *Simple agreement or disagreement acts* were those expressions of approval or objection related to other comments (e.g. "I agree with you B. I feel we should choose the map").

1. Problem Definition (PD).

1a. Problem analysis: Statements that define or state the causes behind a problem

lb. Problem critique: Statements that evaluate problem analysis statements (expressed by a positive (lb+) or negative (lb-) valence)

2. Orientation (OO)

2a. Orientation: Statements that attempt to orient or guide the group's process

2b. Process reflection: Statements that reflect on or evaluate the group's process or progress

3. Solution Development (SOLD)

3a. Solution analysis: Statements that concern criteria for decision-making or general parameters for solutions

3b. Solution suggestion: Suggestions of alternatives

3c. Solution elaboration: Statements that provide detail or elaborate on a previously stated alternative. They are neutral in character and provide ideas or further information about alternatives

3d. Solution evaluation: Statements that evaluate alternatives and give reasons, explicit or implicit, for the evaluations. They may be assigned a positive (3d+) or negative (3d-) valence

3e. Solution confirmation: Statements that state the decision in its final form or ask for final group confirmation of the decision. They may be assigned a positive (3e+) valence if they argue for confirmation. If the responses are negative, they are coded as (3e-)

4. Non-task (NT): Statements that do not have anything to do with the decision task. They include off-topic jokes and tangents

5. Simple agreement (SA)

6. Simple disagreement (SD)

7. Inaudible

Tab.10: FCS: categories

- **Personal Pronouns:** First-person plural pronouns (i.e., we, us, our, and ourselves) were counted and used as a measure of belonging (e.g., Rafaeli & Sudweeks, 1997; Sherblom, 1990). As suggested by Michinov & Michinov (2004), we calculated an index to be used in the statistical analysis. This sense of belonging index was equal to the number of first-person plural pronouns minus the number of first-person singular pronouns divided by the total number of statements (or "thought units"). Consequently, we used the following formula in calculating the sense of belonging index: SBI = [(We – I)/Total "Thought Units"].

2. Group task performance

In order to monitor group performance we decided to consider both the quality of the performance and its effectiveness in terms of time. Therefore we analysed:

- **Game Scores.** When completing a task, each group was given 1, 5 or 10 points according to the quality of the given answer. If players were not able to obtain more than 7 points in two subsequent challenges before task 4, the serious game stopped and subjects were not allowed to continue (failure). We coded as 1 a situation were the simulation was not completed and as 2 a situation were players could experience the complete game. Moreover, for those who completed the simulation, single scores were summed at the end of the game and coded as follow.

- Total Score= 50: excellent performance
- 45 ≤ Total Score <49: good performance
- 41 ≤ Total Score <44: medium performance
- Total Score < 40: poor performance

- **Time.** In order to unobtrusively observe team performance we considered the time (sec) needed to complete each one of the five tasks and the game as a whole. The total time was computed for the groups who completed the full game only.

3. *Emotion & Social Presence*

In order to evaluate the role of emotion and social presence, the following questionnaires were used:

- **PANAS.** The PANAS (Watson, Clark, & Tellegen, 1988) is a 20-item measure of two primary dimensions of mood: Positive Affect (PA, 10 items) and Negative Affect (NA, 10 items). Items are rated on a 1 (*very slightly or not at all*) to 5 (*extremely*) scale (total scores range from 10 to 50) . In the present study, respondents completed the PANAS items, indicating the extent to which they felt each feelings or emotion both before and after playing the game. This scale has been used in numerous researches that aimed at analysing hedonic well-being (Diener, 2000; Kahneman & Krueger, 2006)
- **Visual analogue scale for anxiety (VAS-A).** The VAS-A (Hornblow & Kidson, 1976) is a 100 mm vertical line with end points anchored as no anxiety at the bottom of the scale and anxiety as bad as it could possibly be at the top; scores range from 0 to 10. Among the numerous tools available for assessing anxiety, direct scaling procedures, such as the VAS, are popular because of their simplicity, versatility, relative insensitivity to bias effects, and the assumption

that the procedures yield numerical values that are valid, reliable, and on a ratio scale (Grassi, Gaggioli, & Riva, 2009; van Laerhoven, van der Zaag-Loonen, & Derkx, 2004).

- **Social Presence Scale (SP).** This seventeen, five-point bipolar scales (Gunawardena, 1995) solicited players reactions on a range of feelings toward the medium. The questionnaire was administered after the players completed the game. The question asked players to indicate their "current feelings" about their game experience. The 17 bipolar scales included: Stimulating-dull, personal-impersonal, sociable-unsociable, sensitive-insensitive, warm-cold, colorful-colorless, interesting-boring, appealing-not appealing, interactive-non-interactive, active-passive, reliable-unreliable, humanizing-dehumanizing, immediate-non-immediate, easy-difficult, efficient-inefficient, unthreatening-threatening, and helpful-hindering. Players were asked to respond to each of the five point scales according to their current feelings about the medium. For each scale, "5" indicated a negative reaction to the medium, for example, in the scale, stimulating- dull, "5" indicated "very dull," and "1" indicated a very positive reaction: "very stimulating." If they were undecided or neutral or thought that the medium was equally likely to be stimulating or dull, they indicated so by circling "3," the midpoint of the scale.

5. Data Analysis

The video and audio-recorded interactions were fully transcribed. Starting from interactions entirely transcribed, a sampling of the material to be analysed was carried out: we focused on the first task, the *object challenge.* Participants are presented 15 objects, accompanied by a picture and a brief description. Therefore, players will visualize a Swiss army knife, a pair of sunglasses, a parachute, a cigarette pack, a flashlight, an i-pod, a medical kit, a sunscreen, a water bottle, a life jacket, a geographical map and a rain jacket. Players need to identify the five most important tools that their pilot has to bring with her on-board. Each player can select one specific object. According to McGrath's taxonomy this is a typical disjunctive task based on choosing.

The classification of each communication act was based on consensus between two coders. Both coders, who were doctoral students in psychology, were trained for three hours on the FCS (Poole & Holmes, 1995) classification scheme before coding all of the communication acts. The inter-rater reliability between the two coders was .871. Decisions about messages with different codes were made in discussions between the coders and the researcher.

Then, raw frequencies were calculated for each category. These raw frequencies were subsequently weighted by the total number of sentences pronounced by the individual in the course of the interaction.

Prior to the deepening of hypotheses based on self-report measures, guidelines for screening missing data and outliers were followed. There were only few missing values and no substitutions were required. Further, outliers were searched in the data set. Since none of the observations appeared to be extreme, all the data were kept for analysis. Data normality was also checked using Skewness, Kurtosis, and Kolmogorov–Smirnov normality. The results of this examination led us to assume data normality. After this verification, reliability statistics (Cronbach's α) for each dimension of the self-report questionnaires were considered (Tab.11). The reliability of the all the scales appeared to be generally good (.70 > α > .89). Further, no differences were found between the two experimental conditions when taking into consideration computer competency level ($t(96)= -1.05$, $p= .295$) and frequency of use ($t(96)= .21$, $p= .838$). Similarly, no differences were highlighted in the average time spent playing video games ($t(96)= -1.55$ $p= .124$). All data were analysed using SPSS version 21.

An independent sample *t* test was performed to verify H1, H3, and H4. The level of significance was set at α = 0.05. A chi-square test was used to identify significant differences on the number of groups who completed the simulation and on the quality of the performance of groups who reached the end of the game.

Questionnaire	**Variable**	***FTF***		***CMC***		**Cronbach's α**
		M	**SD**	**M**	**SD**	
PANAS	Positive Affect (Pre)	3.18	0.75	3.38	0.65	.86
	Negative Affect (Pre)	1.40	0.47	1.68	0.68	.88
	Positive Affect (Post)	2.70	0.83	3.21	0.79	.79
	Negative Affect (Post)	1.40	0.47	1.67	0.67	.70
	VAS-A (Pre)	2.78	2.16	3.22	2.76	

VAS-A	VAS-A (Post)	1.92	2.21	2.29	2.16	
SP	Stimulating	1.98	0.91	1.69	0.89	
	Personal	2.44	0.94	2.53	1.10	
	Sociable	1.63	0.98	1.49	0.71	
	Sensitive	2.46	0.90	2.33	1.03	
	Warm	2.25	0.91	2.12	0.95	
	Colorful	2.44	1.09	2.02	0.83	
	Interesting	1.88	0.87	1.63	0.86	
	Appealing	2.04	0,92	1,88	0,99	.89
	Interactive	1.52	0.77	1.45	0.79	
	Reliable	2.42	0.87	2.45	0.96	
	Humanizing	2.08	0.68	2.20	0.91	
	Immediate	2.46	1.11	2.80	1.08	
	Easy	2.94	1.04	3.37	0.97	
	Efficient	2.19	0.82	2.45	0.87	
	Unthreatening	1.92	0.96	1.76	0.97	

Tab.11: Mean, standard deviation and reliability for each subscale

6. Results

Problem-solving

In order to investigate the effects of communication mode on the kind of messages produced, each communication act was classified according to the FCS (Poole & Holmes. 1995; see Table 1). The number of messages in each category constituted the dependent variables. The mean frequencies and standard deviations of individual messages in FTF and CMC are presented in Table 4.

FCS	***FTF***		***CMC***	
	M	**SD**	**M**	**SD**
1a. Problem analysis	5.30	4.92	2.80	2.15
1b. Problem critique	2.30	3.02	1.80	1.69
2a. Orientation	19.50	10.79	15.60	10.72

2b. Process reflection	3.30	2.21	1.00	1.16
3a. Solution analysis	2.70	2.79	0.30	0.68
3b. Solution suggestion	16.40	6.43	14.80	9.95
3c. Solution elaboration	11.40	7.47	7.10	7.53
3d+ Solution evaluation	2.90	2.51	2.40	2.68
3d- Solution evaluation	4.30	3.06	3.40	3.17
3e+ Solution confirmation	14.80	11.15	12.90	8.37
3e- Solution confirmation	3.90	3.90	3.00	2.75
4. Non-task	12.10	9.86	10.30	9.21
5. Simple agreement	9.20	6.36	9.20	8.52
6. Simple disagreement	1.70	0.95	1.00	1.25
7. Inaudible	8.30	6.96	4.40	5.15
I Person Pronouns Sing.	23.20	7.30	23.90	18.02
II Person Pronouns Sing.	10.00	8.19	6.60	6.72
I Person Pronouns Plur.	11.10	9.64	9.10	10.80
II Person Pronouns Plur.	1.80	2.66	2.00	1.76
SBI INDEX	-0.1449	0.1197	-0.1892	0.10931

Tab.12: FCS categories and SBI Index. Means and Standard Deviations

When considering the FCS Categories three significant differences were highlighted. The first one concerned problem orientation and, specifically, process reflection statements that are statements that reflect on the group's process or progress (*t*(18)= 2.91, p= 0.009). Groups exposed to the CMC condition (M= 3.30, SD = 2.21) used significantly less process reflection statements than people who played the game in the FTF condition (M= 1.00, SD = 1.16). The effect size for this analysis (d = .69) was found to be medium, as indicated by the Cohen's (1988) convention.

The second significant difference was registered on the solution development area and. specifically. on solution analysis statements (3a) (*t*(18)= 2.704, p= 0.017) with a good effect size (*d*=. 85). Hence, people who played the game in the FTF (M= 2.70, SD = 2.79) condition used more statements that concern criteria for decision-making or general parameters for solutions than groups who experienced the CMC condition (M= 0.30, SD = 0.68). Another significant difference was noted on *solution elaboration statements* (3c) (*t*(18)= 1.282, p= 0.025). Therefore, groups in FTF (M=

11.40, SD = 7.47) situations relied more on statements that provide detail or elaborate on a previously stated alternative than CMC players (M= 7.10, SD = 7.53).

The average number of messages exchanged in the object task (*t*(18)= 1.08, p= .015) by FTF groups (M= 118.10, SD = 54.79) exceeded the average number of messages exchanged in CMC conditions (M= 90.00, SD = 61.97). No significant differences were identified according to the time spent by groups to complete the task (*t*(18)= .31, p= 0.117). The average time spent to complete the task was 4.47 min for FTF groups and 4.32 for CMC groups.

Team Performance

In both the CMC and the FTF condition, only 60% of the groups completed MtG. While in FTF settings 83.3% had a poor performance, in CMC conditions only 33.3% of the groups got a final score lower than 40. Moreover, 10% of the groups showed an excellent performance within the CMC situation. In the same situation, 16.6% of the groups completed the game with a good and a medium performance. Among FTF groups, 16.6% showed a medium performance.

A chi-square test was used to identify significant differences on the number of groups who completed the simulation and on the quality of the performance of groups who reached the end of the game. No relationship was found between the media condition and the conclusion of the game (X^2 (1, N = 19) = 2.89, p= .09). Similarly, no relationship was observed between the media condition and the quality of performance (X^2 (2, N = 12) = .21, p= .90).

However, a significant difference was found between the two conditions in the time to complete the full game (*t*(11)= -1.99, p= .045). In CMC conditions, groups took significantly more time to complete the game (M = 2227,83 sec ; DS: 208,11), than those who played the game in a FTF setting (M = 1908,14 sec ; DS: 341,68).

Social Presence and Emotions

In order to identify the differences between the FTF and the CMC condition data were analysed using an independent-samples t-test. On the Social Presence Scale two significant differences were found. The first one was observed on the subscale *appealing-not appealing* (*t*(95)=-2.12, p= 0.036) and the second one on the subscale *easy-difficult* (*t*(96)=-2.10, p= 0.038). These results suggested that in a FTF setting players perceived MtG as more appealing (M= 2.04, SD = 1.09) and easy to play (M= 2.94, SD = 1.04) than those who had to play with *the game* in the CMC condition (*appealing*: M= 1.88, SD= 0.83; *easy*: M= 3.37, SD= 0.97).

When considering the PANAS *pre* a significant difference was found on the *Negative Affect Scale* (*t*(95)=-2.357, p= 0.021) with an acceptable effect size (*d*=. 45). Thus, subjects exposed to the CMC condition (M= 1.68, SD = 0.68) reported higher level of negative emotions before starting to play the game than people who were supposed to play the game in a FTF condition (M= 1.40, SD = 0.47).

A second significant difference was found on the PANAS post. It was registered on the *Positive Affect Scale* (*t*(95)=-3.045, p= 0.003). The effect size for this analysis (d = .69) was found to be medium, as indicated by the Cohen's (1988) convention. This result indicates that people who played the game in the CMC condition experienced significantly higher positive affects (M= 2.70, SD = 0.83) than subjects who experienced the FTF version of the game (M= 3.21, SD= 0.79).

No differences were found on the VAS scale both during the pre-test (*t*(96)=-0.897, p= 0.372) and the post-test (*t*(95)=2.34, p= 0.021).

7. Discussion

The present study has been developed with the aim of analysing a situation of zero-history groups interacting in a FTF and CMC setting, where players deal with a multiplayer SG based on choosing and negotiating tasks (McGrath, 1984) .

In particular, the research has two main goals:

(i) evaluating the impact of different media conditions on communication processes and performance in small group problem solving settings;

(ii) studying how CMC and FTF situations affect emotions and social presence.

Problem-solving

With regard to the first goal we noticed that groups who played the game in the FTF condition focused more on orientation and solution development than players who experience the CMC condition. Firstly, groups exposed to the CMC condition used significantly less *process reflection* statements than people who played the game in the FTF condition. Secondly, people who played the game in the FTF condition used more statements that concern criteria for decision-making or general parameters for solutions (solution analysis statements) than groups who experienced the CMC condition. Another significant difference was noted on *solution elaboration statements*. Therefore, groups in FTF situations relied more on statements that provide detail or elaborate on a previously stated alternative than CMC players. These results confirmed differences in communication patterns between CMC and FTF groups while solving problems (Adejumo et al., 2008; Jonassen & Kwon, 2001; Van Der Meijden & Veenman, 2005) and in terms of discourse management strategies (Condon & Cech, 1996; Hedlund et al., 1998). Researchers found that FTF groups focus more on orientation and solution development, while CMC groups rely on discourse markers and short orienting phrases (Condon & Cech, 1996; Hedlund et al., 1998). Usually tasks are cognitively structured into decision routines that reduces the amount of linguistic encoding necessary to convey discourse function, such as task clarification and turn management (Jonassen & Kwon, 2001). These findings are in line with the *functional theory* (Li, 2007). The core notion of this perspective is that several critical task requirements have to be performed for a group to achieve high-quality decision making, and the group relies on group interaction to satisfy these critical task requirements. Therefore, effective decision-making groups are characterized by interactions that are able to successfully satisfy their task requirements, whereas ineffective groups lack these characteristic interactions (Hirokawa, 1990; Tasa & Whyte, 2005).

Team Performance

However, results were controversial when considering team performance. On the one hand, groups who played the game in FTF conditions took shorter to complete the game than CMC groups and exhibited an higher frequency of communication. Authors have argued that the task discussions in CMC groups almost always take longer to complete than in FTF groups despite CMC teams exhibit a lower frequency of communication than FTF teams (Tasa & Whyte, 2005). Generally, less information is being exchanged in CMC than in FTF (Hollingshead, 1996; Straus & McGrath, 1994). The increased time necessary to form stable interpretations in CMC will slow down the communication process and, in most cases, the time to reach group decisions (Baltes et al., 2002). Several studies have found that impression and attitude formation are slower and less positive in initial interactions in CMC than in FTF communication (Walther, 1994, 1996).

On the other hand, no relationship was found between the two conditions and the successful conclusion of the game. Similarly, no relationship was observed between the two conditions and the quality of the answers given by each groups. Therefore, *H2c* was not confirmed.

Researchers have often found different and conflicting results when comparing FTF and CMC teams (Kerr & Tindale, 2004). CMC groups were less effective than FTF groups when they were performing tasks that required a great deal of communication. Many studies have applied McGrath's (1984) task complex to classify tasks into four types (i.e., generating, choosing, negotiating, and executing). The four types of tasks differ from each other in terms of the amount of communication required for completing the tasks, with the choosing and negotiating tasks demanding more time than the others. The majority of studies show that CMC groups were less effective than were FTF groups when performing the tasks of choosing or negotiating under the condition that CMC (Li, 2007). However, our results seemed to support researchers who have claimed that the differences between CMC and FTF are minimum (Tidwell & Walther, 2002; Walther, Anderson, & Park, 1994) and that decision making supported by computer-mediated systems can be effective as well for choosing and negotiating tasks (Pridmore & Phillips-Wren, 2012; Schmidt, Montoya-Weiss, & Massey, 2001). For instance, Adrianson and Hjelmquist (1991) found no difference in quality of decisions. Similarly, Daly (1993) also concluded that CMC and FTF groups were equally good at arriving at a correct solution. Different explanations have been proposed. Some researchers highlighted that, because it takes CMC groups longer to communicate, they improvise and compensate by indulging less in social-emotional conversation and more in task-oriented talk (Weisband , 1992). Others argued that this result can also be explained with regard to visual anonymity in the group process. It was shown, for example, that CMC groups in which the members were anonymous performed equally well as FTF groups (Baltes et al., 2002).A third explanation may be related to the fact that most of the CMC literature that has studied group performance has mainly focused on asynchronous systems (eg. Chat) and not on high social presence systems, like audio-conferencing (Fowler & Wackerbarth, 1980; Rhoads, 2010).

Social Presence and Emotions

According to McGrath (1990), a continuum ranging from e-mail, teleconferencing, computer-desktop and FTF meetings can be made in regards to social presence. The lowest levels of social presence are associated to e-mail, while the highest are related to FTF meetings as a result of the richness of information (Kydd & Ferry, 1994) they are able to convey. Our results confirmed this assumption. People who played the game in the FTF condition experienced higher levels of social presence than players who played the game in CMC conditions. In particular, in FTF settings players perceived MtG as more appealing and easy to play than those who had to play with *the game* in the CMC condition.

Interestingly, when considering emotions, a significant difference was found on *Negative Affects*. Thus, subjects exposed to the CMC condition reported higher level of negative emotions before starting to play the game than people who were supposed to play the game in a FTF condition. A second significant difference was found after the game and it was registered on *Positive Affects*. This result indicates that people who played the game in the CMC condition experienced significantly higher positive than subjects who experienced the FTF version of the game. These findings are confirmed by the literature that suggests that CMC systems have a strong impact on individual arousal (Joinson, 2001). However, while the former result may be explained by referring to the unconventionality of the task for students that are not used to work together in CMC settings, the latter confirmed not only that games can elicit several emotional states (Anolli et al., 2010), but also that digital technologies can empower the quality of emotional experiences (Botella et al., 2012; Serino et al., 2013; Wiederhold & Riva, 2012).

Conclusion

In summary, our study provides preliminary evidence that, despite having different problem-solving approaches in terms of time, frequency of interaction, problem orientation and solution development, CMC groups perform as effectively as FTF groups.

While these results could be very important for the advancement of knowledge in this research field, our study has some important limitations that could affect the findings or the generalizability of the results. Firstly, the number of participants was limited. This may have impacted analysis potency and reliability. Secondly, our samples relied only on students: different contexts and ages may be analysed, considering that the literature has highlighted age-related differences in decision-making practices (Light 2000) and that the familiarity with specific CMC systems, like audio-conferencing, may vary from setting to setting. Lastly, we considered zero-history groups. In further studies, we will investigate other kind of groups, like *task forces* (temporary groups of people formed to carry out a specific project, or to solve a problem that requires a multi-disciplinary approach) or *work teams* (stable groups of people that work together to achieve a common goal). Moreover, due to dynamic organizational changes characteristics of many training environments, gathering quantitative longitudinal data can also be interesting.

Further, the investigation focused only on one game. We have not yet compared Mind the Game with some of the other digital team games discussed in the thesis. Therefore results cannot be generalized to all kind of collaborative games and to single-player SGs. Research data about other serious games are still scarce, which implies that a lot of effort has still to be done in this direction. Further, the fact that the game has a manly textual interface and that interactivity is not very high also suggest that further research is needed.

From a methodological point of view, the empirical study of SGs is still lacking a strong methodological paradigm (IJsselsteijn, De Kort, Poels, Jurgelionis, & Bellotti, 2007). To produce more generalizable knowledge about game experiences and group processes, multiple research methods should be combined. Systematic research with multiple methods will enable researchers to recognize game design patterns that lead to engaging and immersive gaming experiences, which may further have a positive effect on individual and group performance (Nacke et al., 2009). The use of discourse analysis was one step ahead towards this goal. This will make it possible to identify game mechanics and structures of game tasks that promote collaborative activities and social interaction in a pleasant and engaging way. Further research has still to be done.

In conclusion, although this is a preliminary study, it provides important hints for future application of the use of multiplayer SGs in both FTF and CMC contexts. Our results seem to suggest that while CMC experiences may represent a promising solution to promote effective collaborative problem solving.

Conclusion

SGs are digital games used for purposes other than mere entertainment. By using the latest simulation and visualization technologies, SGs are able to contextualize the player's experience in stimulating and realistic environments (Bellotti et al., 2013) that foster practical learning experiences blended with ludic and engaging affordances.

It is clear that playing digital games leads to a variety of positive outcomes and impacts but it is also acknowledged that the literature on games is fragmented and lacking coherence (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). For example, a key challenge within the SGs literature is to develop a workable classification of outcomes and impacts of playing games with respect to engagement, learning and other individual and collective skills. According to the meta-analysis developed by Girard et al. (2013), the most frequently occurring outcomes reported were affective, motivational and knowledge acquisition, followed by perceptual and cognitive skills, behaviour change, and social/soft skills outcomes.

The present work addressed this complexity by focusing on the role of SGs as team building environments. Networking and team working are in fact becoming the foundations of human performance in educational, organizational and recreational settings (Barabási, 2003; Menold, 2009). Further, the rapid development of Information and Communication Technologies (ICTs) and changes in the actual scenario have led to salient changes in the manner in which groups work, solve problems and communicate (Olson & Olson, 2003). Virtual Teams (VT), or geographically distributed groups who rely primarily on computer-mediated technologies to communicate, are becoming critical for the long-term competitiveness of organizations (Driskell, Radtke, & Salas, 2003; Schiller & Mandviwalla, 2007).

All of the major research in this area contends that VTs must use some type of Computer Mediated Communication (CMC). Among the different technologies that can support these processes, Serious Games (SGs) are acquiring a prominent role: in the last twenty years, numerous SGs have been designed to promote team performance and collaboration in different fields, such as business, military, medicine and emergency.

However, despite the impressive growth of SGs applications, only a few of them have been designed, tested and scientifically considered from an empirical point of view, especially by analysing their impact on team processes (Mayer, van Dierendonck, van Ruijven, & Wenzler, 2013). This is a major challenge for future research and investigation.

Moreover, as digital technologies continue to play an increasingly important role to foster both human learning and training processes, scholars have attempted to explain how user's perception of different media are formed and how media themselves influence performance outcomes (Erdogan, 2009; Schilit, Golovchinsky, & Price, 1998). To address this challenge, authors have referred to the media-dependent perspective, claiming that the mechanical characteristics of media are the primary factors that may influence learning, task performance and communication (Daft & Lengel, 1984; a. R. Dennis & Valacich, 1999; Yoo & Alavi, 2001).Yet, there is not much work reported concerning the evaluation of the impact different communication settings and media conditions have on team processes and effectiveness. Moreover, multiplayer and collective game experiences are rarely taken into account.

Similarly, within the media-dependent perspectives, social and contextual factors are rarely considered (Yoo & Alavi, 2001). Therefore, a second trend of research has been focused on a more general social construction perspective of technology (Fulk, 1993; Guzzo, Yost, Campbell, & Shea, 1993; Klein & Kleinman, 2002; Kreijns, Kirschner, & Jochems, 2002). Here, researchers have evaluated how social factors influence user's perception of media, arguing that factors like cohesion among groups, group climate and organizational culture deeply influence the way in which media are used and selected (Agrell & Gustafson, 1994; Chin, Salisbury, Pearson, & Stollak, 1999; Kanawattanachai & Yoo, 2002). However, they have rarely considered the role of different media conditions. Therefore, while these two categories focus and address different aspects of communication media choice and use, a grater understanding can be gained by considering these findings together (Carlson & Zmud, 1999; Chidambaram, 1996; Yoo & Alavi, 2001).

Accordingly, the present work had two main goals. Firstly, it presented Mind the Game,™ a multiplayer decision-making SG developed for a target of adult individuals to create a socio-technical environment (Fisher, Giaccardi, Eden, Sugimoto, & Ye, 2005) where the interconnection between humans and technology encourages the emergence of collaboration and team working. The game was developed considering both game design frameworks and guidelines, as well as the social psychological literature, with a particular focus on the inputs, processes and outputs (I-P-O) that influence group performance.

The game was in fact designed according to the model proposed by Johnson and Johnson (2002) who identified five factors that are able to promote collaboration and collaborative learning (Barron, 2000) in a multiplayer SG: *positive interdependence, individual accountability, promotive interaction, social skills, and group processing.* A sport-based narrative framework was chosen, selecting a little-known sport: gliding. This is a discipline based on soaring flight, where, in the absence of the driving force of an engine, the pilot is required to take advantage of upward motions and movements of air masses (Rosén & Hedenström, 2002). The choice of an individual sport to promote group creativity and of team working may instead appear paradoxical. But it is not: individual excellence is the tip of the iceberg beneath which team effort and coordination always make the difference. The collaborative dimension of gliding is present because, despite the solo flight of the pilot, his/her staff can support each step of the race from the ground. Hence, players are not called upon to be an athlete or an opponent of the athlete, but a member of her team. Each player will in fact be assigned one of the following roles: team manager, strategist, technical expert, meteorologist or doctor. Moreover, each player is motivated by personal goals, different from those of the other participants.

Further, in line with the proposal of Steiner (1972), each task was designed according to a *complementary logic*, in an attempt to involve each player. Specifically, players are called upon to deal with distributed decision-making environments in which real success cannot depend on free-riding efforts, but on the emergence of group phenomena, such as social facilitation, social labouring, and team thinking. Therefore, collaboration and interdependency between participants are also created by distributing different knowledge and resources to each player and triggering resource dependency among players (Oksanen, 2014; Price, Rogers, Stanton, & Smith, 2003).

Both the storytelling and the task structure took into account the three main phases of group decision making, described in the first chapter (Marks, Mathieu, & Zaccaro, 2001)*: planning acting, managing Interpersonal dynamics.*.

A second key goal of the present thesis was to evaluate the potential of Mind the Game on group dynamics and game experience, considering different media condition. This allowed us to explore areas of the literature that have not been deeply investigated yet.

In a first empirical study, we discussed the differences between digital SG technologies and paper-based applications, with a specific focus on subjective game experience and group dynamics, like team cohesion and team potency. In a second study we continued our analysis, addressing another key issue for the SG literature. Despite the large body of research on cooperative or collaborative behaviours, there is not much work reported comparing the effects of SGs played in face to face (FTF) and CMC situations. Therefore, the study aimed at evaluating the impact of different media conditions on communication processes and performance in small group problem solving settings, studying how CMC and FTF situations affect emotions and social presence while playing the game.

Our researches supported the media dependent and the social construction perspective. In the first study, people who played the digital version of the game experienced higher level of immersion than players who experience the paper-based version of game. These findings are in line with the media-dependent perspective and with the media richness theory that argues that a medium's richness is determined by certain, invariant, mechanical characteristics of the medium such as the degree of personalization, speed of feedback, language variety (Dennis & Valacich, 1999).

Further, people who played the digital version of the game experienced higher level of positive affects and lower negative feelings than players who experienced the paper-based version of game. Subjects exposed to the paper condition also experienced higher annoyance, irritation and frustration than people who played the digital version of the game. These results confirmed that games can elicit several emotional states (Anolli, Mantovani, Confalonieri, Ascolese, & Peveri, 2010) but also that digital technologies can empower the quality of emotional experiences (Botella et al., 2012; Serino, Cipresso, Gaggioli, & Riva, 2013; Wiederhold & Riva, 2012). Digital games can evoke higher levels of *sensorial pleasure* throughout graphics, usability, game aesthetic and strengthen the *pleasure for victory* (Mayer & Johnson, 2010; Wouters et al., 2013).

Thirdly, we observed a positive relationship between social presence and group processes, with particular regard to *team potency*, *sense of belonging* and *feelings of morale.* According to the literature, social presence has a specific role in collaborative games, to open communication, critical thinking, group cohesion, supportive interaction and negotiation (Kreijns, Kirschner, & Jochems, 2003; Kreijns et al., 2002). Results of previous research showed that the sociability of the game and a sense of social presence are strongly connected to the various dimensions of the core game experience, including engagement, in the forms of flow and immersion (Cairns, Cox, Day, Martin, & Perryman, 2013; Hämäläinen, 2011; Oksanen, 2013). High levels of social presence are predictors of learning (Gunawardena, 1995) and they are correlated to high levels of enjoyment (Gajadhar, de Kort, & IJsselsteijn, 2008), and group cohesion (Yoo & Alavi, 2001)..These results indicate that the sociability of the game and sense of social presence are potential factors in the emergence of positive and engaging game experiences, at least in the context of collaborative games. The latter two findings are really important as they highlight that not only media conditions, but also social factors influence the way that group members perceive and use technology (Yoo & Alavi, 2001).

The second study analyzed the potential of SG technologies in FTF and CMC settings. The study compared a situation of zero-history groups interacting in a FTF or CMC setting, where players dealt with Mind the Game. We noticed that groups who played the game in the FTF condition focused more on orientation and solution development than players who experienced the CMC condition. Groups exposed to the CMC condition used significantly less *process reflection* statements than people who played the game in the FTF condition. Further, people who played the game in the FTF condition used more statements that concern criteria for decision-making or general parameters for solutions (*solution analysis statements*) than groups who experienced the CMC condition. Another significant difference was noted on *solution elaboration statements*. Therefore, groups in FTF situations relied more on statements that provide detail or elaborate on a previously stated alternative than CMC players.

These results confirmed differences in communication patterns between CMC and FTF groups while solving problems (Adejumo, Duimering, & Zhong, 2008; Jonassen & Kwon, 2001; Van Der Meijden & Veenman, 2005) in terms of discourse management strategies (Condon & Cech, 1996; Hedlund, Ilgen, & Hollenbeck, 1998). Researchers found that FTF groups focus more on orientation and solution development, while CMC groups rely on discourse markers and short orienting phrases (Condon & Cech, 1996; Hedlund et al., 1998). Usually tasks are cognitively structured into decision routines that reduces the amount of linguistic encoding necessary to convey discourse function, such as task clarification and turn management (Jonassen & Kwon, 2001).

Moreover, these findings are in line with the *functional theory* (Li, 2007). The core notion of this perspective is that several critical task requirements have to be performed for a group to achieve high-quality decision making, and the group relies on group interaction to satisfy these critical task requirements (Hirokawa, 1990; Tasa & Whyte, 2005). However, results were controversial when considering team performance.

On the one hand, groups who played the game in FTF conditions took shorter to complete the game than CMC groups and exhibited a higher frequency of communication. Authors have argued that the task discussions in CMC groups almost always take longer to complete than in FTF groups despite CMC teams exhibit a lower frequency of communication than FTF teams (Tasa & Whyte, 2005). Generally, less information is being exchanged in CMC than in FTF (Hollingshead, 1996; Straus & McGrath, 1994). The increased time necessary to form stable interpretations in CMC will slow down the communication process over all and, in most cases, the time to reach group decisions (Baltes et al., 2002). Several studies have found that impression and attitude formation are slower and less positive in initial interactions in CMC than in FTF communication (Walther, 1994, 1996).

On the other, no relationship was found between the two conditions and the successful conclusion of the game. Similarly, no relationship was observed between the two conditions and the quality of the answers given by each groups. Researchers have often found different and conflicting results when comparing FTF and CMC teams (Kerr & Tindale, 2004). Our results seemed to support researchers who have claimed that the differences between CMC and FTF are minimum (Tidwell & Walther, 2002; Walther, Anderson, & Park, 1994) and that decision making supported by computer-mediated systems can be as effective as it is in FTF setting (Pridmore & Phillips-Wren, 2012; Schmidt, Montoya-Weiss, & Massey, 2001). For instance, Adrianson and Hjelmquist (1991) found no difference in quality of decisions. Similarly, Daly (1993) also concluded that CMC and FTF groups were equally good at arriving at a correct solution. Different explanations have been proposed. Some researchers highlighted that, because it takes CMC groups longer to communicate, they improvise and compensate by indulging less in social-emotional conversation and more in task-oriented talk (Weisband , 1992). Others argued that this result can also be explained with regard to visual anonymity in the group process. It was shown, for example, that CMC groups in which the members were anonymous performed equally well as FTF groups (Baltes et al., 2002).A third explanation may be related to the fact that most of the CMC literature that has studied group performance has mainly focused on asynchronous systems (eg. Chat) and not on high social presence systems, like audio-conferencing (Fowler & Wackerbarth, 1980; Rhoads, 2010).

According to McGrath (1990), a continuum ranging from e-mail, teleconferencing, computer-desktop and FTF meetings can be made in regards to social presence. The lowest levels of social presence are associated to e-mail, while the highest are related to FTF meetings as a result of the richness of information (Kydd & Ferry, 1994) they are able to convey. Our results confirmed this assumption. People who played the game in the FTF condition experienced higher levels of social presence than players who played the game in CMC conditions. In particular, in FTF settings players perceived MtG as more appealing and easy to play than those who had to play with *the game* in the CMC condition.

Interestingly, when considering emotions, a significant difference was found on *Negative Affects*. Thus, subjects exposed to the CMC condition reported higher level of negative emotions before starting to play the game than people who were supposed to play the game in a FTF condition. A second significant difference was found after the game and it was registered on *Positive Affects*. This result indicates that people who played the game in the CMC condition experienced significantly higher positive than subjects who experienced the FTF version of the game. These findings are confirmed by the literature that suggests that CMC systems have a strong impact on individual arousal (Joinson, 2001). However, while the former result may be explained by referring to the unconventionality of the task for students that are not used to work together in CMC settings, the latter confirmed not only that games can elicit several emotional states (Anolli et al., 2010), but also that digital technologies can empower the quality of emotional experiences (Botella et al., 2012; Serino et al., 2013; Wiederhold & Riva, 2012).

Despite these interesting results, our studies had several limitations. Firstly, the number of participants was limited. This may have impacted analysis potency and reliability. Secondly, our samples relied only on students: different contexts and ages may be analysed, considering that the literature has highlighted age-related differences in decision-making practices (Light 2000) and that the familiarity with specific CMC systems, like audio-conferencing, may vary from setting to setting. Lastly, we considered zero-history groups. In further studies, we will investigate other kind of groups, like *task forces* (temporary groups of people formed to carry out a specific project, or to solve a problem that requires a multi-disciplinary approach) or *work teams* (stable groups of people that work together to achieve a common goal). Moreover, due to dynamic organizational changes characteristics of many training environments, gathering quantitative longitudinal data can also be interesting.

Further, the investigation focused only on one game. We have not yet compared Mind the Game with some of the other digital team games discussed in the thesis. Therefore results cannot be generalized to all kind of collaborative games and to single-player SGs. Research data about other serious games are still scarce, which implies that a lot of effort has still to be done in this direction. Further, the fact that the game has a manly textual interface and that interactivity is not very high also suggest that further research is needed.

From a methodological point of view, the empirical study of SGs is still lacking a strong methodological paradigm (IJsselsteijn, De Kort, Poels, Jurgelionis, & Bellotti, 2007). To produce more generalizable knowledge about game experiences and group processes, multiple research methods should be combined as we did in the second study. Systematic research with multiple methods will enable researchers to recognize game design patterns that lead to engaging and immersive gaming experiences, which may further have a positive effect on individual and group performance (Nacke et al., 2009). The use of discourse analysis was one step ahead towards this goal. This will make it possible to identify game mechanics and structures of game tasks that promote collaborative activities and social interaction in a pleasant and engaging way.

To conclude, the work described in this thesis is an on-going research on the design, development and evaluation of a multiplayer SGs that can foster team collaboration and effectiveness. Networking and team working are becoming the foundations of human performance in educational, organizational and recreational settings (Barabási, 2003; Menold, 2009). Here, new communities of practice are being established to promote an engagement economy (McGonigal, 2010) that will be able to foster innovation and success by sustaining collective well-being and group flourishing. SGs can greatly support this trend. Therefore, further work can focus on understanding how well SGs can be integrated in team training programs and how the concrete application of these results may improve multiplayer user-centred design models. This consists of understanding the barriers, gains and benefits, and then to investigate how to improve the benefits of and overcome the barriers towards the use of the SGs. Game mechanics are in fact a potential way to give rise to social interaction and to nurture collaboration among the players. Through appropriate game design and mechanics, it is possible to structure the players' skills and support collaborative processes, that facilitate group members to develop effective performances (Oksanen, 2013). Further, to improve the quality, relevancy, and usability of SGs, an integrated approach where game design practices are matched with the scientific literature need to be developed.

The present work confirms that Mind the Game can be an optimal device to be used to assess, train and conduct experimental research on individuals and groups. On the one hand, the game might be considered as a tool to both train and assess individual and social skills. Team and individual measures may be considered along with outcome and process measures. The game can, therefore, be used within training and empowerment programs that aims at facilitating team work and collaborative problem-solving. On the other, it can be used to maintain high levels of ecological validity and experimental control, giving the researcher the possibility to manipulate specific variables in everyday life environments. Hence, it will represent an helpful resource for future studies and research not only in the field of SGs, but also for those who want to investigate small group performance and behaviours.

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