Impact of Viewpoint on Social Presence and Collaborative Processes in a Collaborative Serious Game

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Abstract: Collaborative serious games have proven to be effective learning environments to enhance the development of learners' soft skills, such as collaboration, negotiation and cooperation. To be effective, such role paying games should provide genuine interactions. However, little is known on how design choices, such as the viewpoint (either first or third person perspective), impact collaborative processes and learners' perception of their partners. This paper reports an exploratory study on the impact of the viewpoint on the sense of social presence, and on collaborative processes that emerge from learners' interactions in a collaborative serious game dedicated to soft skills training. To address this issue, learners played in either first-person or third-person perspective during a session of two games. Our results show that the first-person view allowed for a higher sense of social presence and increased information sharing. This seems to be mainly due to the knowledge asymmetry caused by the affordances of the environment, in other words design choices. These results can be applied in the design of collaborative serious games that support social interactions and collaborative skills training.

1 INTRODUCTION

With the strong technological evolution, soft skills (non-technical skills) are becoming more and more important in education. In many fields they are highly valued by recruiters, Archer and Davison (2008) argue that most employers consider students' soft skills to be more important than their degree qualifications. The European Commission (2018) has highlighted the key competencies for learning: problem solving, decision making, cooperation, and communication. Various studies on serious games agree that they can be effective tools for the development of such skills, and other 21st century skills such as self-regulation, information skills, networked co-operation and problem solving strategies (Westera et al., 2008). Serious games can easily immerse learners into a specific scenario, using role-playing methods, which allows learners to experience a specific situation with others (humans or artificial agents), learning about social roles and interactions (Marocco et al., 2015). In this context, some studies underline the importance of considering the levels of immersion, presence, interactivity and fidelity for a game to be effective (De Freitas et al., 2010). Among others, social presence, "the feeling of being with others in a mediated environment" (Heeter, 1992), seems particularly interesting to develop for soft skills training. In fact, different studies have shown that social presence has an impact on many factors, for example allowing to increase participation and interaction (Zhao et al., 2014). Thus, in this paper we focus on two interrelated aspects of serious games for soft skills training: the social presence perceived by learners and the collaborative processes that emerge in such environment.

We conducted a study based on the hypothesis that the affordances of a virtual environment (in other words design choices), and more particularly the learner viewpoint, has an impact on both social presence and collaboration between players. The good choice of the viewpoint in the design of video games is primordial given its impact on many elements such as presence (spatial presence, self-presence) or embodiment perceived by players (Denisova and Cairns,

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2015). We conducted a study with 18 participants, who played a collaborative serious game in either a first or third-person perspective. Our study mainly shows that the first-person viewpoint increases social presence and information sharing. These results show the importance of this design choice for the development of serious games that support social interactions and collaborative skills training.

2 RELATED WORK

2.1 Soft Skills and Collaborative Processes

Traditionally, education has focused on the transmission of knowledge and hard skills (technical skills) training. However, due to the important technological evolution, Prensky (2004) showed that our way of socializing, searching for information, learning and analyzing has changed significantly. Trilling and Fadel (2009) show the importance of "21st century skills", also called soft skills, including collaboration and communication, which are among the most important skills for success in modern society (Romero et al., 2015).

Collaborative learning is an educational approach to teaching and learning, which involves groups of learners working together to solve a problem, complete a task, or create a product (Laal and Laal, 2012). There are several studies that highlight the usefulness and benefits of "cooperative teams". For example these teams achieve higher levels of thinking and retain information longer (Johnson and Johnson, 1987). In these collaborative activities, the coordination of individual actions within each group is important. Indeed, since the participants have a common goal, they will have to act while taking into account several constraints such as time or organization. For this, several processes will be used for collaboration such as awareness, regulation, information sharing and discussion (Tong, 2017). For Schmidt (2002), awareness refers to "reciprocal practices of monitoring others and designing actions in order to make certain aspects of the activity visible". To complement this, Yuill and Rogers (2012) extend the concept of awareness, not only to actions but also to situations where people "have ongoing awareness of the actions, intentions, emotions, and other mental states of other interactants". Regulation builds upon awareness and relates to people's ability to plan, monitor, evaluate and regulate the joint activity (Vauras et al., 2003). Information sharing involves building a common ground, which means that members collaborate in ensuring understanding and in grounding their mutual knowledge and assumptions (Clark and Brennan, 1991). The discussion takes place when participants gather and evaluate arguments for and against the available options, and make decisions for the alternatives on the way to a final solution (Tong, 2017).

2.2 Social Presence

Many works investigated how users are feeling and acting in virtual environments through the tightly related concepts of immersion and presence (Sanchez-Vives and Slater, 2005). Presence can be defined as the subjective experience of being in the virtual environment, and is grounded on the ability to do things in the virtual environment, relying on actions and the affordances offered in the virtual environment. Usually presence is divided into different sub-concepts: physical, self and social presence (Lee, 2004).

Social presence can be defined as the feeling of "being with others" (Heeter, 1992). It is the moment-to-moment awareness of co-presence of a mediated body and the sense of accessibility of the other being's psychological, emotional, and intentional states (Biocca and Harms, 2002). This can be interpreted as the degree to which a person is perceived as "real" in mediated communication. Several studies have shown that social presence is a key element to create a sense of community, for instance in online courses, to enable productive collaboration, increased participation and interaction (Zhao et al., 2014). Thus, in this paper, we propose to explore in which way it can be impacted by the design of a serious game. We rely on the definition of Biocca and Harms (2002) who distinguishes three dimensions:

Co-presence: can be defined as the degree to which the users feel that they are not alone and isolated. Goffman (1963) extends the notion of co-presence by incorporating "awareness of others": the user is aware of the mediated other, and the other is aware of the user.

Psychobehavioral Accessibility: this dimension focuses on the perceived accessibility of the other, the user's sense of awareness and access to the other (through attentional engagement, emotional state, understanding...).

Perceived Symmetry: Social presence is not only based on our vision of the other, but also on our feeling of what the other thinks of us. Indeed, social presence is not a one-way interaction, but an interaction between several interlocutors. Subjective symmetry is the degree of symmetry or correlation between the users' sense of social presence and their perception

of their partner's sense of social presence (Biocca and Harms, 2002).

3 RESEARCH QUESTIONS

From previous work, we can assume that to engage users in collaborative activities, the immersive environment should promote a good experience of social presence. As shown in the literature review, the sense of presence seems to be related to the actions in the virtual environment. We are thus particularly interested in investigating the impact of the immersive environment affordances on social presence experience and collaborative processes.

Regarding affordances, some works have investigated the impact of the viewpoint of users in virtual environments. In particular, several studies on video games showed that the third person viewpoint could increase awareness in the virtual space, as well as a better perception of the avatar within its environment (Denisova and Cairns, 2015). In addition, some studies show that the first-person perspective is the most appropriate condition to induce a high sense of embodiment, refering to self-presence concept (Slater et al., 2010), while other studies did not observe any significant difference (Debarba et al., 2015). Finally, little is known on the impact of viewpoint on social presence, as well as on collaborative behaviors. In this paper, we try to fill these gaps by investigating the influences of different affordances (viewpoints) of a same virtual environment on social presence and collaboration. We use a collaborative serious game for soft skills training to address the following research questions:

RQ1: Does the viewpoint have an impact on social presence?

RQ2: Does the viewpoint have an impact on collaborative processes ?

4 DESCRIPTION OF THE COLLABORATIVE SERIOUS GAME

We used a collaborative serious game, designed to measure and train soft skills (see the project presentation link for more details[1]). The game relies on a collaboration between three players whose objective is to repair the four breakdowns of a submarine. At each turn, the water level rises progressively. The game is lost when the water level reaches a certain level. The submarine must therefore be repaired before it is completely filled with water. To do this, each player in turn can perform several actions. Each player has one movement point and two bailing points per turn (to move, to scoop or to repair a breakdown). To repair a breakdown, there must be at least two players in the room. Each player has a specific power that allows him to perform a special action. The Diver has one more movement point per turn. The Oceanographer can scoop the rooms adjacent to his own. The computer scientist is able to move a quantity of water from one room to another per turn.

Players are able to interact with each other at any time, via a video and audio feed. According to the experimental conditions, players can play either in first or third person. In third person, all actions are performed on the map when it is their turn to play. In first person, they must perform their actions directly in the room , the water level of each room, the plan of the submarine and the total water level in the submarine are not accessible to the player. They then revert to a third person viewpoint. The possible actions and the ways of communication remain the same in the first or third person perspective.

5 STUDY

5.1 Experimental Conditions

Condition 1: Participants were not in the same room, and could communicate via webcam and audio. The game was in third person when it was not their turn to play and in first person when it was their turn to play (First Person Perspective).

Condition 2: Participants were not in the same room, and could communicate via webcam and audio. The game was only in third person (Third Person Perspective).

5.2 Participants

We recruited 30 participants. Due to technical problems during the experiment as well as the pandemic, we were able to use the data from only 18 participants. They were divided into 6 groups (G1, G2, G3, G4, G5, G6) of 3 participants (P1, P2, P3) according to their availability. Groups G1, G2 and G3 were associated with condition 1, and groups G4, G5 and G6 were associated with condition 2. Participants were recruited via the mailing list of the University of Lyon. The average age was 23.5 years (SD = 2.5) and

[1] http://icar.cnrs.fr/bodega/

there was an equal distribution of nine men and nine women.

5.3 Procedure

Given the sanitary conditions during the experiment, the game sessions were conducted remotely. Players used their own equipment, namely a computer, a webcam, a microphone and a headset (or earphones). The participants were invited to sit in front of their computer screen. First, they had to go through the game's tutorial. They then started playing the serious game, in collaboration with two other participants. After the end of the first game, they had to do a second game with a different role (but the same condition). At the end, a debriefing was set up with the three participants and the two experimenters. For the interested groups, a third game was proposed to them with the other viewpoint, followed by a second debriefing. Only the debriefing is considered in this article.

5.4 Data Collection/Recording

We collected the screen and webcam recordings of each participant. After the experiment, students were asked to fill in a questionnaire: the Networked Mind Social Presence Inventory (SPI, 34 items) (Biocca and Harms, 2003). We chose this questionnaire due to its approach to social presence. The questions focus on the dimensions of co-presence and psycho-behavioral accessibility. All the questions in these dimensions deal with both "perception of self" (e.g. I paid special attention to my partners), but each of these questions is followed by a question about "perception of others" (e.g. my partners paid special attention to me). The perceived subjective symmetry is calculated as a correlation between the ratings of the social presence of the self "Perception of self" and the other "Perception of my partner", for each dimensions (co-presence and psycho-behavioral accessibility). At the end of the experiment, we conducted semi-directive interviews with the participants to collect their perceptions and feelings about the lived experience.

5.5 Video Analysis and Coding Schemes

The goal of this analysis was to provide quantitative insight into how participants collaborated in the game. We focused on the four collaborative processes identified in section 2.1 (awareness, regulation, information sharing and discussion) to understand how they were impacted by the change in viewpoint (in answer to RQ2). We defined a coding scheme for video analysis defined hereafter and in detail in Table 1. Two coders analyzed video samples independently representing 10% of the total videos (and 131 utterances). They did an inter-rater reliability test with the result of 85% agreement. Cohen's Kappa, which measures the agreement between the two observers is: $\kappa = 0.899$. There were a total of 6 videos, for a duration of 3 hours 33 minutes and 31 seconds. There is an average of 182 utterances per game at the first-person condition and 159 at the third-person condition.

- Awareness: "The extent to which awareness of users' current actions, intentions, and state of mind is present or made visible at all times" (Yuill and Rogers, 2012). *"I go to the locker room"*
- Regulation: "Represents the processes that members use to plan, monitor, evaluate and control joint activity" (Vauras et al., 2003). *"Go to the locker room to bail out, then use your power"*
- Information sharing: "Collaboration of members to ensure understanding and to build on each other's knowledge and assumptions" (Clark and Brennan, 1991). *"The changing rooms are on the right of the cabin"*
- Discussion: "It takes place when participants gather and evaluate arguments for and against the available options, and make decisions about alternatives on the way to a final solution" (Tong, 2017). *"I don't agree with your idea, I think it's better to go to the locker room now"*

6 RESULTS

6.1 Impact of Viewpoint on Perceived Social Presence

Cronbach's alpha was used to assess the internal consistency of the questionnaire and therefore its reliability. They were found to be very reliable, since $\alpha > 0.8$ for both dimensions (see Table 2). Given the rather small amount of data we collected from 18 participants, we performed a Mann-Whitney U test on the 2 dimensions of social presence between first and third person conditions (results are considered significant when $\rho < 0.05$), as well as the mean and standard deviation (see Table 2). Concerning the perceived subjective symmetry, Spearman's correlation test was performed for each questionnaire between the dimensions "self" and "others", then we calculated the average of these coefficients for the 2 conditions (first person and third person perspective).

Co-presence: Regarding the co-presence dimension of the SPI, the p-value $\rho = 0.779$ being far above

Table 1: Categories, sub-categories and indicators used for the video analyses of the different collaborative processes.

Category	Subcategory	Indicator
Awareness	Action awareness	Tells what it does
	Intention awareness	Tells what he is going to do
	Mind state awareness	Shares how he feels
Regulation	Planning	Suggest what should be done
		Assigns task
		Asks if he should do this action
		Asks a question about the other's possibilities
	Control	Monitoring
		Give someone a voice
Information sharing		Asks a question about the card/item he does not have
		Gives an indication about the card/item
Discussion	Game understanding	Asks a question about the game
		Gives an explanation about the game
	Idea exchange	Exchange ideas in order to reach a solution
	Consensus building	Accepts/rejects the proposal, proposes a new solution

Table 2: Mean, standard deviation, cronbach's alpha and p-value for the different dimensions of social presence.

	First Person		Third person			
	$\bar{x}$	σ	$\bar{x}$	σ	α	ρ
Co-presence	5.60	0.717	5.35	1.066	0.929	0.779
Psycho-behavioral	6.07	0.357	5.23	1.008	0.934	0.018

Table 3: Average of Spearman's correlation coefficients for perceived subjective symmetry between the "self" and "others" questions of the SPI questionnaire.

	First person	Third person
Co-presence	0.876	0.707
Psychobehavioral	0.839	0.671

0.05, it means that the results are not significant (first person: mean = 5.60, SD = 0.717; third person: mean = 5.35, SD = 1.066). So the viewpoint does not seem to have an impact on co-presence.

Psychobehavioral Accessibility: Regarding the psychobehavioral dimension of the SPI, the p-value ρ = .018 is below the α = 0.05 threshold so the results are significant. These results suggest that the first-person perspective allows for greater psychobehavioral accessibility (M = 6.07; SD = 0.357) than the third-person perspective (M = 5.23; SD = 1.008).

Perceived Subjective Symmetry: The mean of the correlation coefficients is larger in the first person for both dimensions namely co-presence (first person: ρ = 0.876; third person: ρ = 0.707) and perceived psychobehavioral accessibility (first person: ρ = 0.839; third person: ρ = 0.671). Thus, this appears to show a stronger perceived subjective symmetry for the first-person group than for the third-person group. This means that in the first-person condition, participants have a better perception of what the others think of them than the ones in the third-person condition.

Table 4: Number of utterances for each category per group and per viewpoint.

	First person			Third person		
	G1	G2	G3	G4	G5	G6
Awareness	49	15	49	26	59	32
Regulation	103	109	99	59	124	81
Information sharing	76	27	39	5	13	18
Discussion	206	176	143	94	247	198

Table 5: Average number of utterances in each collaboration process for each player during a game at the first and third person conditions.

	First Person		Third Person		
Categories	$\bar{x}$	σ	$\bar{x}$	σ	ρ
Awareness	6.27	3.261	6.5	3.426	0.983
Regulation	17.28	6.215	14.67	6.722	0.424
Information sharing	7.89	4.053	2.00	1.369	.00037
Discussion	29.17	6.704	29.94	14.525	0.776

6.2 Analysis of Collaborative Processes

In answer to RQ2, we observed the different indicators (described in section 5.5) to analyse awareness, regulation, information sharing and discussion processes. For each game, we counted the number of utterances in each category for each participant. The table 4 presents the sum of the utterances for each group (sum of the utterances of the two games and the three players).

Table 5 presents the average number of utterances in each collaboration process per player and per game. We performed a Mann-Whitney U test on the average of the two games (per group) of each player regarding each categories for the two viewpoints. We observed a significant difference for the information sharing process during a game according to the viewpoint (ρ = .00037). These results suggest that the viewpoint has an impact on the information sharing process, with greater information sharing in the first

Table 6: Percentage of utterances in each collaboration process for each player during a game at the first and third person conditions.

	First Person		Third Person		
Categories	$\bar{x}$	σ	$\bar{x}$	σ	ρ
Awareness	3.49	1.730	4.03	1.559	0.730
Regulation	9.57	3.920	9.99	4.020	0.562
Information sharing	4.20	1.652	1.20	0.916	.0005
Discussion	16.07	3.655	18.11	6.657	0.387

person (M = 7.89; SD = 4.053) than in the third person (M = 2.00; SD = 1.369). We did not observe any significant differences regarding the other collaborative processes (awareness, regulation, discussion) between the first-person and the third-person conditions. Since the number of utterances was different for each game, we also calculated the average of utterances per game, but divided for each game the number of utterances per categories over the total number of utterances (see Table 6). We also obtain significant results (ρ = .0005), which confirms that viewpoint has an impact on information sharing, with greater information sharing in the first person (M = 4.20; SD = 1.652) that in the third person (M = 1.20; SD = 0.916). However, we did not observe any significant differences regarding the other collaborative processes (awareness, regulation, discussion) between the first and third-person viewpoint.

7 DISCUSSION

7.1 Viewpoint and Social Presence

Our results show that co-presence is not significantly impacted by the viewpoint. The co-presence is mainly based on the perception of others using automatic classification of other's representation. Accordingly, this result can be explained by the fact that the virtual representation of the other players in the game is the same regardless the viewpoint (webcam and voice). The perception of the other players' body thus does not change. This would certainly have been different with additional representations such as shadows or avatar when the two players are in the same room, as underlined by Kim et al. (2013), who showed that seeing their partner's avatar increased co-presence.

The results concerning psychobehavioral accessibility reveal significant impact of the first-person viewpoint, which seems to allow for greater psychobehavioral accessibility than the third-person view. This difference could be explained by the asymmetry of knowledge introduced by the first-person viewpoint for several reasons. First, the lack of contextual information when players are in first-person view may have forced them to communicate with the other two players in order to make relevant decisions early in the game, contrary to the third person viewpoint. One player declared in the third person view *"If I wanted I could play alone"* (P1-G2) emphasizing the lesser importance of collective decisions according to him. Second, players at the first-person were more dependent on others, which led them to trust more. One of the players made this clear during the interview (for the first person viewpoint) by stating *"You can't trust your own perception but you have to trust the perception of others"* (P1-G3). Third, having access to other's perception of things is directly associated with "mind reading" (emotional states for instance) and may reduce uncertainty in relationships (Planalp and Honeycutt, 1985). In our case, it is thus possible that the greater reliance on others' perceptions induced by the knowledge asymmetry provided a greater sense of access to others' minds and therefore increased psychobehavioral accessibility at the first-person view.

The results regarding subjective symmetry reveal that there is a greater correlation between one's own sense of social presence and one's perception of one's partner's sense of social presence at the first-person view than at the third-person view. In other words, participants in the first-person condition perceived some sort of psychological and behavioral match between themselves and the other players. We may suppose that at the third-person view, some players felt they were giving more (i.e. attention) than the others gave them. A certain imbalance could be perceived because since the players have all the information, there is less need for cooperation during their turns. A participant said for the third person perspective *"We didn't have to collaborate, we could play alone and ignore the others"* (P1-G2).

To conclude, our results show that the viewpoint has an impact on social presence in the collaborative game, and more specifically on the dimensions of psycho-behavioral accessibility and perceived symmetry. It seems that this is mainly induced by the knowledge asymmetry due to the affordances of the environment that differ in each view. This is in line with the work of Kreijns et al. (2007), which explains the impact of the environment and its characteristics on social presence, and this completes the work of Slater et al. (2010), which showed that the first person view could increase the sense of self-presence (another category of the concept of presence). To increase the sense of social presence in a virtual game it seems thus important to create asymmetrical knowl-

edge, easily offered with the use of the first-person view. Care should also be taken in designing others' representation to enhance co-presence.

7.2 Viewpoint and Collaborative Processes

We showed that the first-person view increased information sharing. This result can be explained by the affordances of the environment, since some information (map of the submarine, general level of water) was not visible for players when they were at the first person view. Players had to compensated for this lack, communicating on the missing information. We believe that this increase in information sharing participated to the increase of sense of social presence, as explained previously for the psychobehavioral accessibility. The increase in information sharing through the first-person view can really benefit to learning. Indeed, according to Chi (2009), the co-construction of knowledge enhances understanding by allowing one to argue one's propositions, to ask and answer questions, and to open up new perspectives and reasoning. Winne et al. (2010) also support this assumption, arguing that information that are not accessible to others may requires more collaboration to become knowledge shared by the group.

On the contrary, we did not observe differences in terms of awareness, regulation and discussion with the different viewpoints. These results may seem a little surprising, especially for awareness since we expected lower awareness with the introduction of asymmetric knowledge and more regulation to compensate. We therefore think that the higher level of information sharing compensated for the lack of awareness, but further studies would be needed to investigate more deeply the relationship between the four collaborative processes.

Finally, we did not observe direct correlation between social presence and collaboration processes. This could be explained by a quite high sense of social presence in both conditions. Further studies should be conducted since some works, such as Garrison et al. (2010), have showed that social presence influence collaborative processes and develop learners' awareness of each other's existence.

7.3 Limitations

First, our study involved a rather small number of participants. This was mainly due to sanitary conditions, which made the recruitment of participants and technological apparatus more difficult at distance. However, we believe that our results are coherent and reveal tendencies that can be easily supported by the existing the literature in the domain. Second, we believe that the observation of the participants' behaviors in laboratory conditions would have allowed us to go further in the analysis and understanding of the collaborative processes that emerged between learners. This constitutes another perspective to deepen this work. Finally, we were not able to analyze the correlation between the perception of social presence and collaboration processes that emerged due to the rather small number of participants. We should examine more precisely the relationships between both, making the assumption that a higher feeling of social presence would lead to more collaborative processes in the serious game or the opposite, that differences in collaboration processes could impact the sense of social presence. We could also analyze more deeply the impact of information sharing on other collaboration processes.

8 CONCLUSION

We conducted a study with 18 participants to understand the impact of the viewpoint (first and third person) on the sense of social presence and collaboration processes in a collaborative serious game. Our results show that the first-person viewpoint appears to lead to a greater sense of social presence through higher psychobehavioral accessibility and higher perceived subjective symmetry. The first-person viewpoint also impacted the collaboration processes, and more specifically information sharing. These results show the importance of the virtual environment affordances (especially according to the chosen viewpoint) when designing serious games. Our future research will investigate other affordances of the virtual environment, analyse the impact of different modalities of communication provided to players (webcam, audio only, chat only) as well as face-to-face versus remote presence on collaborative processes, social presence and engaged-behaviors.

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