Collaboration, Presence and Performance in Virtual Learning Environments:

Can Collaboration be Used to Measure Shared Presence?

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Summary

This paper investigates the relationship between collaborative learning performances and sense of shared presence in a virtual learning environment under particular control conditions. The results, reported here, suggest that absence of collaboration to be causally related to absence of shared presence, at for least socially constructed feeling of shared presence, as defined by Romano (2002). This result suggests a way of measuring at least a component of shared presence, though the observation of the dialogue and the behaviour of the individuals collaborating.

Due to the relative small number of participants to the study these results must be considered as "a case study" that validates the approach taken and provides suggestions for the development of future studies.

1 Introduction

We believe that two features are beneficial for learning in virtual environments: Collaboration and Presence. One is concerned with the ability of performing a task as a group usually in a real environment, while the other is responsible for ensuring that a member of a group feels himself and/or the others as being together in the virtual environment. This paper presents and investigation on how these two features enhance the learning performances and their relationship in a virtual training environment. The ultimate aim is to see how virtual learning environments can increase the probability that productive learning interactions emerge between within a group of people

2   Background

A theoretical justification of the use of virtual environments as a training tool and the role of collaboration and presence in the learning process is presented here.

2.1   Collaboration and Learning

Mevarech & Light (1992) suggest that collaborative learning with the use of computers opens up possibilities for investigating the multidimensional effect of peer interaction on a large variety of cognitive outcomes. They view collaborative computer environments as a "mirror for the mind" as it enables the investigation of the mechanisms underlying cognitive and social developments.

Collaboration is often beneficial for learning, whether it triggers reflection within oneself (Ploetzner, et al. 1999, Dillenbourg, 1992), conflicts and negotiation with others (Baker, 1994) or a simple division of the learning task and shared reporting of acquired knowledge. The problem is that '*collaboration is not a recipe*' (Dillenbourg, 2000, p24) or a '*single mechanism*' (Dillenbourg, 1999, p6). Assigning a task to two entities does not imply collaboration. To achieve a beneficial collaboration for all parties the motives, the environment, and personalities (Salomon & Globerson, 1989) have to be correctly engineered (Johnson W., & Johnson R., 1991).

2.2   Presence

Romano (2002) considers some of the factors that concur to the feeling of being present in virtual environments. Each of these factors stimulates a particular aspect of our interaction with the world and with others that bring us to believe that we are there, in the world. In the real world one relies on the senses for guiding our behaviour in the world and with others. In virtual environments, due to current technological limitations, one can not fully form ideas of the place he/she is experiencing, only through technology limited perception of our senses.

Because of these limitations, perhaps we rely even more on the constructions made by our mind about the world, thus we feel present, but our perceptions though our senses sometimes break our perception of being there in the environment. When the mental construction is contradicted by one of the sense something tells us that the reality we believe is not actually there (e.g. extend our hand to touch the object that we see and the object it is not actually there).

Through seeing the effect of others' or our own action in the environment we believe that we are "there" in the world, actively constructing a sense of presence. Emotionally, experiencing something that involves us to the point of producing a feeling, like being scared, or being happy, we allow ourselves to believe that what we are experiencing is true, is really happening to us. Socially, through mental interaction with others simply sharing knowledge and/or information.

We believe we are there together, with others, since we can share our reasoning, perceive each other's actions, share emotion, generate feelings.

Measuring only how good is the approximation of our sense is not enough to measure presence and we believe that there is no one single measure that can capture the variety of sensations that together contribute to the sense of presence. We suggest that using a variety of methods to collect information about one's perceptions about the environment, including physical and mental one, should allow us to better understand what really make a person feel present in a virtual world as well as present with other. In particular, since we are able to observe absence or presence of collaboration in the interaction amongst two people, if we can prove that collaboration is related to presence, we will have a more objective way to measure at least some aspect that contribute to the sense of Presence, in particular socially constructed presence.

3 The study

A desktop virtual environment has been built for training people to learn firefighters Incident Commanders' skills. The tasks of an Incident Commander in a case of a large scale fire in the real world, is to co-ordinate the resources, people and equipment, to resolve the fire incident with the minimum loss in the shortest time possible. Therefore the skills the trainee Incident Commander has to learn, through the simulation, are how to assess the situation and make rapid decision that would bring to the best possible solution of the problem. The performances were measured as the number of correct rescuing actions that he/she is able to perform in the given time. The research question we have formulated for the part of the study reported in this paper is as following:

Does collaborating and interacting with other people, even if they are not directly acting on the virtual training environment increase performance and shared presence?

3.1 Participants

Twenty volunteers, ten females and ten males, with a high computer literacy and an age ranging from sixteen to fifty-one years old have been recruited for the study to act as trainees. Two additional females have been chosen to act as more expert peer to help the trainee in their task. Each female expert played the simulation with ten trainees, five males and five females. This study does not consider the case of male trainees.

3.2 Study Settings

Prior to the peer experiment each trainee had two training sessions with the simulation. Each training session lasted eight minutes, after the first training session the simulation was restarted. This time was used mainly to familiarise with the settings, the virtual environment and try out some rescuing strategy. It was not enough to discover the complete correct rescuing plan necessary to solve the fire incident completely.

The experts were trained by letting them play for twenty minutes with the simulation. During this time they could have played uninterruptedly or decide to restart the simulation if the fire escalated and the situation become difficult to control. At the end of the twenty minutes the experts were still unaware of the complete rescuing strategy necessary to solve the fire incident.

In the study the trainees where in control of the simulation and able to give commands to the agent firefighters. The peer-experts were sited beside them sharing the same screen.

Each couple trainee/peer-expert was allowed to play for two sessions of eight minutes. This was a sort of natural stopping time, one would have either rescued most of the resources, or the fire escalated to a point where the situation was beyond help.

The sessions where timed by the simulation and the physical behaviour of the players was recorded on video. The simulation kept a log of the user's actions in a file saved at the end of each session. The researcher supervised the session and took care of saving the log file, starting and stopping the camera and making sure the participants filled the relevant questionnaires (see figure 1).

Figure 1 – The study settings
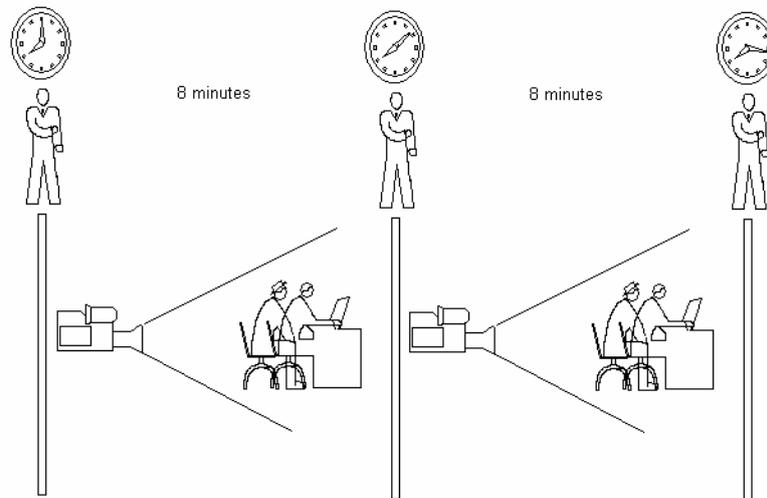
3.3   The virtual environment

The simulation represented a warehouse with an adjacent office on fire. The buildings were located in an open field connected by roads. Nearby at a certain distance there were trees and bushes. Behind the buildings there was a dual-carriage road and all around a single lane road. In the front a single lane road connected the building to the fire station some distance away.

A woman, a container of gas, some oil barrels, and a truck had to be saved from fire with a sequence of rescuing actions, while the fire itself needed to be extinguished applying various jet of waters from the fire-engines. The environment also provided all the tools necessary to deal with the incident, such as fire engines, hoses, and agent fire fighters that would perform the commanded task.

3.4   The task

The goal given to the trainee Incident Commanders was to perform the highest number of correct actions in the time given. The goal of the expert was to help the trainee to win the game. Winning the game meant to save all the items and people in the fire incident and put out the fire in the shortest amount of time possible.

3.5 Equipment

The equipment used was a personal computer with a 17" monitor, table, chairs, video camera and tripod. The computer was running version 3.9 of the ACTIVE software a purpose built 3D simulation of a warehouse with an adjacent office going on fire. During the training the participants were sited in front of the screen and the camera filmed them from the side to include them and the computer screen.

3.6 The Measurement instruments used

3.6.1 Presence

Questions on presence, shared Presence and perceived collaboration and the climate of the duo performance were used as self-reporting tools. The question about presence were similar to the ones used in the studies by Slater, Linakis, Usoh, Kooper, (1996) and Slater, Sadagic, Usoh and Schroeder (2000).

3.6.2 Collaboration

The self-reported climate of the duo performance was measured through a purpose-developed questionnaire. The questions have been elaborated from previous pilot studies and aimed to enquire about the satisfaction of the collaboration that took place during the study, if they felt part of a team working towards the same goal, how useful they felt was the session with the other person and how enjoyable, previous knowledge the two people had of each other and, where applicable, they were asked to compare this situation with previous ones.

All the answers had been rated from 1 to 7.A score of zero was given if the person did not reply to the question.

Finally they were asked to quote something that the partner might have done or said that helped them solving the problem. The questions have been divided into three groups: Prior Knowledge, Comparison with Previous Experience and Current Collaboration. A total score was considered as a result of the collaborative interaction.

3.6.3 Analysis of Behaviour

After the study the video of each session has been analysed and behaviour of the participants during the coupled session has been categorised as empathic/ unempathic, looking at the body language, tone of the voice and gesture, facial characteristics and

positioning made during the interactions. The classification of the behaviour has been done in two separate sessions by the researcher and another person not familiar with the research. The judgements made by the external observer and the researcher been compared and have produced similar results. The characterisation used to judge the experts behaviour was based on the coding scheme developed by Cooper & Brna (2000) and Cooper (2000).

3.6.4   Measure of Performance

The number of correct rescuing actions in the given time in both sessions was counted as a quantification of performances as recorded by the application. From this value was subtracted the number of correct actions performed during the training, and the difference considered as a measure of improved performances.

4   Results

The virtual training environment developed for this research has been evaluated using a relatively small number of subjects. Therefore, these results must be considered as "a case study" that validates the approach taken and provides suggestions for the development of future studies.

Considering the performances and the collaboration with the experts we have observed that shared presence is usually associated with a high score in the self-reported climate of the duo performance of the expert. When the expert has scored the collaboration as low, the trainees have never reported a sense of shared presence (see table 1).

This suggests that collaboration can exist without the participants feeling Present in the environment, but that a perception of non-collaboration inhibits the sense of Shared Presence. People can perceive that the collaboration is useful without necessarily perceiving the partner as being in the computer-simulated world with them, however if they do not feel that the collaboration is successful, they do not feel the partner in the world with them.

T	Myself in the same place as my partner	My partner in the same place as me	Me and my partner together in the place on the screen	Trainee Current collaboration	E	Myself in the same place as my partner	My partner in the same place as me	Me and my partner together in the place on the screen	Expert Current collaboration
1	never	never	never	27	A	never	never	never	22
5	**sometime**	**sometime**	**sometime**	28	B	**sometime**	**sometime**	**I felt we were**	22
2	**sometime**	**sometime**	**sometime**	27	A	never	never	n/a	20
3	n/a	n/a	**sometime**	27	A	never	never	never	20
8	**I felt I was**	never	never	5	B	**sometime**	**sometime**	**sometime**	20
6	n/a	n/a	n/a	28	B	n/a	n/a	**I felt we were**	19
4	n/a	n/a	never	15	A	never	never	never	13
7	never	never	never	10	B	never	**sometime**	never	10

The score in the presence questionnaire given was from a minimum 1 to a maximum of 7, Score above 4 have been considered as at least sometime, a score of 7 is a definite feeling.
n/a = not available, T stands for Trainee, in The column labelled E: A= Expert A, B = Expert B

Table 1 – *Self-reported sense of Individual Presence and Shared Presence of trainees and experts and climate of the duo performance.*

The increase in trainee's performances between the training and the session with the peer-expert, has been considered with the collaboration and the sense of shared presence. Since there was a great difference in performance in the training session between the male and female group, in the session with the peer-expert the increase of performance of the two groups in has been considered separately (see table 2).

	Yourself in the same place as your partner		My partner in the same place as me		Me and my partner together in the same place		Current collaboration	Expert Empathic	Expert modality	INCREASE in the Trainee performances
Participant B	2	never	3	sometime	1	never	10	NO	COMMAND	21
Participant A	1	never	1	never	1	never	13	YES	SUGGEST	16
Participant B	n/a		n/a		7	Ifelt we were	19	YES	EXPLAIN	16
Participant A	1	never	1	never	1	never	20	YES	SUGGEST	9
Participant B	4	sometime	4	sometime	7	Ifelt we were	22	NO	COMMAND	19
Participant B	4	sometime	4	sometime	4	sometime	20	NO	COMMAND	12
Participant A	1	never	1	never	1	never	22	YES	EXPLAIN	10
Participant A	1	never	1	never	n/a		20	YES	REASSURE	3

Table 2 – *Expert's behaviour and sense of Shared Presence and trainees increased performances.*

We note that when behaviours scored as "commanding", by the observer of the video, this is always associated with and high score in increase of performance.
Furthermore the expert's feeling that the partner is sometimes in the same place and it is associated with the higher increase in performances.

5   Discussion

The results suggest that collaboration increases performance in an virtual environment such as the one described. The improvement the trainees from the training to the session with peer-expert cannot be simply justified by the fact that they had experienced the environment for a longer period of time.

Shared Presence has three parts: the presence of the other entities involved in the task in the environment, the presence in the environment of the person that the questions are posed to, and whether they are together in the environment.

In this study, since only one person is able to act on the virtual environment, the feeling of shared presence can be considered as constructed socially.

We have seen here that collaboration can exist without a feeling of shared presence being reported, but the perception of non-collaboration seems to inhibit the sense of shared presence. If this is true, socially constructed presence could be measured trough the collaboration between the two individuals, that is considering the dialogue and the physical interactions, where possible between the individuals involved in the experience.

5.1   Conclusion

In this paper we propose that the socially constructed sense of shared presence, as defined by Romano (2002) could be measured trough the observation of the dialogue and the behaviour of the people involved in the collaboration.

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