Flow in Computer-Supported Collaborative Problem-Solving

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Abstract: This study investigated the individual experience of flow and its relations with emotions and the perceived socio-cognitive processes involved in a computer-supported collaborative problem-solving task. Participants were asked to play in dyads the video game Portal 2® and then to individually complete three subjective questionnaires (emotion, collaboration and flow). Results showed that flow is related to both the modelling of the partner's emotions and the perceived mutual engagement in collaborative processes such as information pooling and transactivity. They support the idea that the flow experience should be considered as a means to improve the quality of computer-supported collaborative learning.

Introduction

One of the main current challenges for research in the learning field is to make a shift from a strictly cognitive approach to an approach in which the cognitive and affective (social-emotional) dimensions of learning need to be investigated as intrinsically interdependent. In such an approach, the experiential nature of learning, for instance, emotions that emerged as the result of subjective cognitive appraisal of control and value of the learning situation (Pekrun, 2006), should be examined in relation to the knowledge (co-)construction process. Emotions are seen here as forming "a critical piece of how, what, when and why people think, remember and learn" (Immordino-Yang, 2015, p.8).

In the Computer-Supported Collaborative Learning (CSCL) domain, it is now well accepted to define collaboration as the dynamic interaction between two spaces, a cognitive space dedicated to epistemic activities (co-producing knowledge, resolving the task/problem) and a relational space dedicated to socio-affective activities (maintaining a positive, stimulating and engaging relationship with the learning partners) (Andriessen, Baker, & van der Puil, 2011; Barron, 2003). Andriessen and colleagues argue that understanding what emotions are involved and how they circulate within the group is necessary in understanding how learners work and learn together. In the EATMINT (Emotion Awareness Tools for Mediated Interaction) project (Molinari et al., 2013; 2017), it has been shown that encouraging partners to explicitly share their emotions throughout collaboration (using an emotion awareness tool) positively impacts their perceived effort of modelling each other (*mutual modelling*; Dillenbourg, Lemaignan, Sangin, Nova, & Molinari, 2016) as well as of building on each other's contributions (*transactivity*; Berkowitz & Gibbs, 1983; Molinari, Sangin, Nüssli, & Dillenbourg, 2008). Results also suggest that perceived transactivity and group performance positively correlate with positive emotions like enjoyment and negatively correlate with negative emotions like boredom (Avry, Chanel, Bétrancourt, Pun, & Molinari, 2017). Despite the consensus regarding the importance of considering the collaborative learning experience as a continuous cycle of tensions (and relaxations) at both the cognitive and social-emotional planes (Andriessen et al., 2011), there is still little research that go deep into the dynamics and mutual influence between emotional states, cognitive states and collaborative processes (Mullins, Deiglmayr, & Spada, 2013).

The present research is exploratory and focuses on the individual experience of flow during a computer-supported collaborative problem-solving task. In particular, our main research question concerns the relations between flow, emotions and the perceived socio-cognitive processes involved in collaboration. The rationale for this research is that there is a need to gain a better understanding of the subjective experience of individuals engaged in a collaborative task on the one hand, and on the other, of how this relates to how they perceive the way they work together to solve the problem. Such an understanding is a necessary step toward providing design principles for technology and environments that aim at promoting positive, engaging and meaningful collaborative learning experiences (Riva, Banos, Botella, Wiederhold, & Gaggioli, 2012).

The concept of flow as a framework (Csikszentmihalyi, 1990) is usually used to investigate students' engagement in the learning process. Flow is defined as an optimal experience in which the person feels simultaneously cognitively efficient, attentionally engaged, motivated, highly interested and happy (Moneta & Csikszentmihalyi, 1996). More specifically, it is characterized by a combination of cooccurrent states, that is, sense of control, cognitive absorption, distorted perception of time, loss of self-awareness (deindividuation), and autotelic experience (heightened enjoyment) (Heutte, Fenouillet, Kaplan, Martin-Krumm, & Bachelet, 2016). Control, absorption, time transformation and loss of self-awareness are described as the cognitive dimensions of flow whereas autotelic experience refers to its affective dimension. Moreover, being in control and totally concentrated are considered both as conditions for experiencing flow whereas alteration of sense of time, loss of reflective self, and well-being are considered as effects (Heutte et al., 2016). Flow is expected to occur with meaningful learning tasks, that is, tasks that provide individuals with the opportunity to master new challenges and surpass themselves, and also in situations where they perceive themselves as having the necessary skills to perform the task. In complex learning settings, D'Mello and Graesser (2012) showed that a flow state is experienced when a cognitive equilibrium is reached and/or when learners focus on mastery of the learning task. They also highlighed a positive correlation between flow and learning gains. This relation is explained by the fact that flow is experienced as a reward and provides learners with a motivation to persist in the task despite difficulties and obstacles to goals (that is, cognitive desiquilibrium moments). Flow can also be promoted in situations where learners experience positive task-related emotions such as enjoyment and curiosity whereas negative emotions such as boredom and hopelessness relate negatively to flow (Boekaerts & Pekrun, 2016).

Research on the experience of flow in computer-supported collaborative/problem-solving is still relatively rare. Flow is investigated as either an individual or a mutual experience (social flow) in group settings (Walker, 2010). Walker showed that the experience of flow is more intense in group activities than in individual activities. This can be explained by the fact that group activities are more challenging/risky and require considerable skills at both task/cognitive and social/relational levels. Moreover, the intensity of joy associated with the flow state in group settings increases with the level of interdependence between group members and is related to the extent to which emotions are shared (e.g. through contagion) during interaction. Results also showed a positive correlation between flow and group performance (Admiraal, Huizenga, Akkerman, & Dam, 2011). This relation is mediated by the degree to which group members share relevant task-related information and also perceive each other as contributing equally to the achievement of the common goal (Aubé, Brunelle, & Rousseau, 2014). All these results support the idea that there is a need for team managers and also for teachers to consider the flow experience as a means to improve the quality of group processes and outcomes.

In the context of this theoretical background, we propose to explore three main questions:

- To which emotions is the individual experience of flow associated in the context of a computer-supported collaborative problem-solving task? (Question 1)
- To what extent is individual flow related to participants' ability to accurately perceive their partner's emotions during collaboration (emotion modelling)? (Question 2)
- To what extent is individual flow related to participants' perception of the interaction with their partner, i.e. to perceived socio-cognitive involved in collaboration such as grounding, information pooling, transactivity, consensus building and coordination? (Question 3)

Method

Sixty-four participants (12 women and 52 men; M=22.02 years, SD=3.49), grouped in 32 same-gender dyads, participated to this experiment. They were asked to play a collaborative problem-solving video game called Portal 2®. This game was chosen for two reasons. First, it requires both a high individual involvement and the mutual engagement of participants to solve problems in a coordinated way (which corresponds to the criteria of a highly collaborative task; Roschelle & Teasley, 1995). Second, it involves a set of skills necessary to academic success such as problem-solving skills, spatial cognition skills and persistence (see Shute et al., 2014 for a complete description of the cognitive and motivational skills involved in Portal 2®). In this game, players have to find the way out of several closed rooms. More precisely, they have to manipulate objects in their shared environment to open up passages and move forward to a next room until the exit. It is necessary for players to jointly consider what they must do to progress in the game. When a potential solution is found, they have to take the current position of their partner into account and to engage in mutual coordinated actions.

Dyads were randomly assigned to one of 4 conditions. Participants received a combination of two types of biased feedbacks at six times during the game, namely, their dyad's level of mastery and their dyad's ranking (among fictive dyads). The research goal in using such feedbacks was to influence control and value appraisals which are assumed to shape task-related emotions (Pekrun, 2006). The purpose of the present study is not to focus on the impact of the control and value feedbacks on flow experience. There were, however, no main effects nor interaction on any of the five flow dimensions (p > .10). Regarding effects of control and value feedbacks on emotions and the perceived quality of collaboration, please see Avry et al., 2017).

The members of each dyad were separated in 2 rooms. Both peers were seated in front of a computer equipped with webcam and a BioSemi® electrophysiological system. They were not able to see each other while playing but could communicate orally thanks to microphone headsets. At the very beginning of the experiment, an individual training phase was proposed to familiarize participants with the game. They then performed the task (30 mn). Immediately after collaboration, they were asked to complete 1) an *emotion questionnaire*, 2) a *collaboration* questionnaire and 3) a *flow* questionnaire. These 3 questionnaires are described below.

Emotion questionnaire

It was derived from the Achievement Emotions Questionnaire (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011), and aimed at measuring the emotions experienced during collaboration. Participants rated the intensity of both their own- and their partner's emotions using a list of 4 activating negative emotions (*Anxiety*, *Anger*, *Frustration*, *Shame*), 4 deactivating negative emotions (*Deception*, *Hopelessness*, *Boredom*, *Sadness*), 5 activating positive emotions (*Hope*, *Pride*, *Joy*, *Enjoyment*, *Gratitude*) and 3 deactivating positive emotions (*Relaxation*, *Relief*, *Contentment*). Each of these 16 emotions was thus accompanied by two 7-point intensity scales (1=very low or not at all to 7=very high), one for the participants' emotions and one for their partner's emotions.

In a dyad with A and B as partners, the accuracy of the mental model A built of B's emotions, i.e. Model (A, B, *emotions*) was computed as the absolute difference between Model (A, B, *emotions*) and Model (B, B, *emotions*); e.g. difference between the "intensity of *Anxiety* felt by B estimated by A" and the "intensity of *Anxiety* felt by B estimated by him/herself". This difference was calculated for each of the 16 emotions. Four modelling accuracy scores were obtained, two for positive emotions (one for positive activating emotions and one for positive deactivating emotions) and two for negative emotions (one for negative activating emotions and one for negative deactivating emotions). The smaller the score, the more accurate the model.

Collaboration questionnaire

It was inspired from the rating scheme proposed by Meier, Spada and Rummel (2007) to assess the quality of computer-supported collaborative processes. The present questionnaire was designed to measure the participants' perceptions of both their own engagement and their partner's engagement in the collaboration process, in particular in five socio-cognitive processes that play a crucial role in the success of collaboration: *Grounding* (3 items; e.g. "making sure the other has understood you"); *Information Pooling* (5 items; e.g. "gathering as much relevant information as possible to solve the problem", "eliciting personal knowledge from the other that could be useful in solving the problem"); *Transactivity* (2 items; e.g. "building upon the other's contributions by integrating them into one's own perspective"); *Consensus Building* (5 items; e.g. "looking for the best arguments for or against a potential solution", "trying to convince the other by justifying one's own proposals for solutions"); and *Coordination* (5 items; e.g. "structuring by clearly defining subtasks to perform and dividing them among you equally"; "monitoring the time remaining for the task and taking care not to waste time unnecessarily"). For each of these collaborative processes, items were accompanied with 2 types of 7-point frequency scales (1=never to 7=very often), one for the participants' level of engagement and one for their partner's engagement level.

Flow questionnaire

We used here the first version of the EduFlow scale (Heutte et al., 2016) designed to measure flow in learning environments. It is a 16-item scale organized into five dimensions of flow, namely: (1) *Sense of Control* (3 items; e.g. "I felt I was able to cope with the high demands of the task"); (2) *Cognitive absorption* (4 items; e.g. "I was totally absorbed in what I was doing", "I felt I was completely focused on what I was doing"); (3) *Alteration of the Sense of Time* (3 items; e.g. "I did not notice time passing"); (4) *Loss of Self-Consciousness* (3 items; e.g. "I was not worrying about what my partner thought to me"); and (5) *Autotelic Experience* (3 items; e.g. "The activity itself gave me a sense of well-being"). For each of these 16 items, a 7-point answer scale (1=strongly disagree to 7=strongly agree) was used.

Results

All statistical analyses were performed using SPSS V.24 (IBM Corporation).

Individual experience of flow during collaboration

Table 1 shows that the five components of flow, that is, *Sense of Control*, *Cognitive Absorption*, *Alteration of the Sense of Time*, *Loss of Self-Consciousness* and *Autotelic Experience*, are experienced at moderate to high levels.

Table 1: Means and Standard Deviations for the 5 Dimensions of Flow

	Means	Standard Deviations
Sense of Control	3.99	1.36
Cognitive Absorption	6.02	1.06
Alteration of the Sense of Time	5.87	1.28
Loss of Self-Consciousness	5.29	1.47
Autotelic Experience	5.07	1.47

We computed correlations between the five flow dimensions. Figure 1 shows a positive correlation between the two flow conditions, i.e. *Sense of Control* and *Cognitive Absorption*. *Autotelic Experience* is positively associated with the two other effects of flow, i.e. *Alteration of the Sense of Time* and *Loss of Self-Consciousness*, and also with the two flow conditions. The correlation between *Alteration of the Sense of Time* and *Loss of Self-Consciousness* is very weak and not significant (r = .05, n.s.). Finally, *Alteration of the Sense of Time* is positively related to *Cognitive Absorption* while it does not significantly correlate with *Sense of Control* (r = .08, n.s.). Finally, *Loss of Self-Consciousness* is the only effect of flow that is not significantly related to any of the two conditions of flow (*Sense of Control*: r = .09, n.s.; *Cognitive Absorption*: r = .04, n.s.).

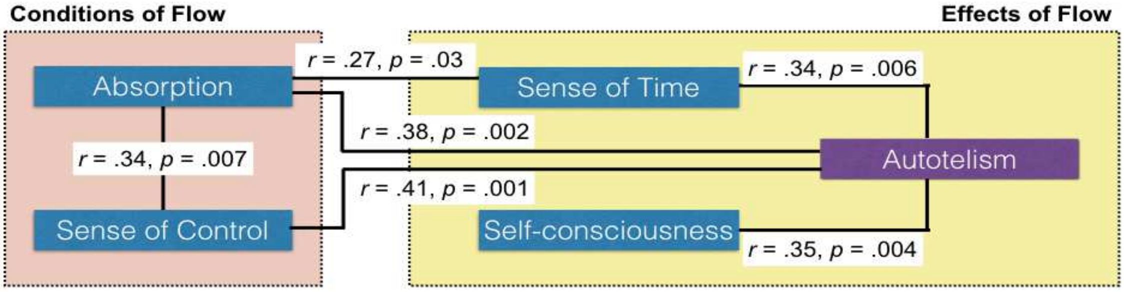

Figure 1. Relations between the 5 Dimensions of Flow (Absorption=Cognitive Absorption; Sense of Time=Alteration of the Sense of Time; Self-Consciousness=Loss of Self-Conscioueness; Autotelism=Autotelic Experience).

Flow and emotions experienced during collaboration

Flow and emotions

Correlations were computed between the five dimensions of flow and the four types of emotions, namely positive activating/deactivating emotions and negative activating/deactivating emotions (see Table 2). *Sense of Control* and *Cognitive Absorption* are positively associated with positive activating and deactivating emotions. The correlation between *Cognitive Absorption* and positive deactivating emotions is, however, marginally significant (weak correlation). Of these two conditions of flow, only *Sense of Control* is negatively related to negative activating and deactivating emotions. The correlations between *Cognitive Absorption* and negative activating and deactivating emotions are very weak and not significant.

Autotelic Experience is positively correlated with positive activating and deactivating emotions, and negatively related to negative activating and deactivating emotions. The correlation between *Autotelic Experience* and negative activating emotions is, however, marginally significant (weak correlation). *Loss of Self-Consciousness* is positively but marginally related to positive activating emotions (weak correlation). The correlations between *Loss of Self-Consciousness* and the other types of emotions (positive deactivating emotions, negative activating and deactivating emotions) are very weak and not significant. Of the three effects of flow, only *Alteration of the Sense of Time* is not significantly related to emotions experienced during collaboration.

Table 2: Relations between Flow Dimensions and Emotions Experienced During Collaboration.

	Positive Emotions		Negative Emotions	
	Activating	Deactivating	Activating	Deactivating
Sense of Control	r=.55, p=.000	r=.61, p=.000	r=-.46, p=.000	r=-.41, p=.001
Absorption	r=.38, p=.002	r=.23, p=.07	r=.13, n.s.	r=-.08, n.s.
Sense of Time	r=.15, n.s.	r=.13, n.s.	r=.05, n.s.	r=-.06, n.s.
Self-Consciousness	r=.23, p=.07	r=.18, n.s.	r=-.06, n.s.	r=-.06, n.s.
Autotelism	r=.61, p=.000	r=.52, p=.000	r=-.23, p=.07	r=-.44, p=.000

Below, more specific results are listed:

- *Sense of Control* is positively correlated with seven of the eight positive emotions, the strongest correlations being with *contentment* (r=.61, p=.000) and *pride* (r=.54, p=.000). The positive correlation with *hope* is not significant (r=.15, *n.s.*). This flow dimension is negatively correlated with seven of the eight negative emotions, the strongest correlations being with *hopelessness* (r=-.45, p=.000) and *frustration* (r=-.38, p=.002). The negative correlation with *sadness* is not significant (r=-.22, p=.08).
- An increased *Absorption* on the task correlates with an increase in experience of *hope* (r=.46, p=.000).
- *Autotelic Experience* is positively correlated with seven of the eight positive emotions, the strongest correlations being with *enjoyment* (r=.68, p=.000) and *joy* (r=.59, p=.000). The positive correlation with *relaxation* is not significant (r=.19, *n.s.*). This flow dimension is negatively correlated with four of the eight negative emotions, the strongest correlations being with *boredom* (r=-.45, p=.000) and *sadness* (r=-.38, p=.002). There are no significant correlations with *anxiety* (r=.10, *n.s.*), *deception* (r=-.21, *n.s.*), *frustration* (r=-.22, p=.08) and *shame* (r=-.21, p=.10).

Flow and modelling of partner's emotions

Correlations were computed between the flow dimensions and the four modelling accuracy scores (i.e. one score per type of emotions). Please note that the negative correlations are a sign for high accuracy in assessing emotions in the collaborative partner. As depicted in Table 3, *Alteration of the Sense of Time* is the only dimension of flow significantly related to the accuracy with which participants assess their partner's positive emotions. The strongest correlation is with the modelling accuracy score for positive activating emotions.

An increase in *Sense of Sontrol* as well as in experience of well-being (*Autotelic Experience*) is associated with an increase in the accuracy in assessing negative emotions in the partner. The strongest correlations are with the modelling accuracy scores for negative deactivating emotions.

Finally, *Cognitive Absorption* is linked to the ability to correctly assess negative deactivating emotions experienced by the other, *Loss of Self-Consciousness* to the mutual modelling of negative activating emotions.

Table 3: Relations between Flow Dimensions and Emotion Modelling.

	Modelling of Positive Emotions		Modelling of Negative Emotions	
	Activating	Deactivating	Activating	Deactivating
Sense of Control	r=.20, n.s.	r=.10, n.s.	r=-.23, p=.07	r=-.30, p=.01
Absorption	r=.01, n.s.	r=.08, n.s.	r=-.01, n.s.	r=-.27, p=.03
Sense of Time	r=-.32, p=.01	r=-.28, p=.03	r=-.17, n.s.	r=-.12, n.s.
Self-Consciousness	r=-.10, n.s.	r=-.08, n.s.	r=-.30, p=.02	r=-.13, n.s.
Autotelism	r=-.16, n.s.	r=.006, n.s.	r=-.38, p=.002	r=-.41, p=.001

Flow and perceived socio-cognitive processes

All flow dimensions, except *Loss of Self-Consciousness*, are significantly positively related to at least two perceived socio-cognitive processes (Table 4 a/b). Flow is more strongly related to the participants' perception of their partner's engagement in the collaboration process than to their own perceived engagement.

Information Pooling and *Transactivity* are related to both conditions of flow, i.e. *Sense of Control* and *Cognitive Absorption*, and also to two out of the three effects of flow, i.e. *Alteration of the Sense of Time* and *Autotelic Experience*. *Coordination* and *Grounding* are only related to flow conditions (both *Sense of Control* and *Cognitive Absorption* for *Coordination*; *Cognitive Absorption* only for *Grounding*). Consensus Building is related mainly to flow effects, more specifically to *Autotelic Experience*.

Table 4 a/b: Relations between Flow Dimensions and Perceived Socio-Cognitive Processes.

	Grounding		Information Pooling		Transactivity	
	Self	Partner	Self	Partner	Self	Partner
Sense of Control	*r*=.19, n.s.	*r*=.20, n.s.	*r*= .28, *p*=.03	*r*= .33, *p*=.007	*r*= .26, *p*=.04	*r*= .29, *p*=.02
Absorption	*r*=.23, *p*=.07	*r*=.26, *p*=.04	*r*=.25, *p*=.05	*r*=.34, *p*=.006	*r*=.34, *p*=.006	*r*=.37, *p*=.003
Sense of Time	*r*=.05, n.s.	*r*=-.03, n.s.	*r*=.27, *p*=.03	*r*=.29, *p*=.02	*r*=.25, *p*=.05	*r*=.36, *p*=.003
Self-Consciousness	*r*=.06, n.s.	*r*=.16, n.s.	*r*=.001, n.s.	*r*=.10, n.s.	*r*=.05, n.s.	*r*=.05, n.s.
Autotelism	*r*=.14, n.s.	*r*=.18, n.s.	*r*=.35, *p*=.005	*r*=.43, *p*=.000	*r*=.43, *p*=.000	*r*=.45, *p*=.000

	Consensus Building		Coordination	
	Self	Partner	Self	Partner
Sense of Control	*r*=.17, n.s.	*r*=.20, n.s.	*r*= .36, *p*=.003	*r*= .43, *p*=.000
Absorption	*r*=.23, *p*=.07	*r*=.20, n.s.	*r*= .24, *p*=.05	*r*= .32, *p*=.009
Sense of Time	*r*=.22, n.s.	*r*=.15, n.s.	*r*=-.10, n.s.	*r*=-.05, n.s.
Self-Consciousness	*r*=.02, n.s.	*r*=.11, n.s.	*r*=-.14, n.s.	*r*=-.10, n.s.
Autotelism	*r*=.34, *p*=.006	*r*=.35, *p*=.005	*r*=.22, n.s.	*r*=.21, n.s.

Discussion and conclusion

The aim of the present study was to investigate the relations between individual flow, emotions and perceived socio-cognitive processes involved in computer-supported collaborative problem-solving. First, results show that participants reported having experienced the different states of flow, namely, sense of control, cognitive absorption, distorted perception of time, loss of self-consciousness and autotelic experience. It should be stressed that sense of control is rated as just about average. The reason for this may be that the high interdependence among dyad members makes them feel responsible for both their own- and their partner's actions. Results also suggest that how the flow dimensions are interconnected in this computer-supported collaborative environment is quite similar to that observed in individual learning situations (Heutte et al., 2016). The two cognitive conditions of flow, sense of control and cognitive absorption, are positively related to each other. There are also relations between flow effects. More specifically, autotelic experience which refers to the affective dimension of flow, is positively related to its two cognitive effects, alteration of sense of time and loss of self-consciousness. These effects are not, however, significantly related to each other. Furthermore, both flow conditions are positively related to autotelic experience. Participants who experience a deep level of involvement in the collaborative process are also more likely to lose track of time. Loss of self-consciousness is the only effect that is not significantly related to flow conditions. It can therefore be assumed that this social dimension of flow (Heutte et al., 2016) would rather depend on the level of well-being experienced during collaboration.

Emotions experienced during the game are significantly related to the conditions of flow and its affective dimension (Question 1). Sense of control and autotelic experience are related to both positive and negative emotions. It is noteworthy that sense of control is more related to positive deactivating emotions and negative activating emotions while autotelic experience is more related to positive activating emotions and negative deactivating emotions. More specifically, an increase in the feeling of being in control over the collaborative task is accompanied by an increase in contentment and a decrease in frustration. The autotelic experience is characterized by an increase in enjoyment and a decrease in boredom. Cognitive absorption is related mainly to positive activating emotions. Pfarticipants experience hope when they are intensively focused on what they are working on together. Alteration of the sense of time and loss of self-consciousness are two cognitive dimensions of flow that are not significantly (or marginally) related to the emotions felt by group members during problem-solving.

Interestingly, the individual experience of flow is associated with the ability of participants to accurately assess emotions experienced by their partner during collaboration (Question 2). Furthermore, the flow dimensions associated with modelling the partner's positive emotions are not the same than those associated with modelling his/her negative emotions. More specifically, alteration in the perception of time is the only dimension of flow related to the accuracy at perceiving the partner's positive emotions. The mutual modelling of negative emotions is related mainly to sense of control and autotelic experience. The more participants experience control and well-being, the higher their accuracy is at perceiving negative emotions in their partner. Cognitive absorption is significantly related only to modelling negative deactivating emotions, loss of self-consciousness only to modelling negative activating emotions. This means that the more participants are focused on the task, the more they are able to perceive boredom in their partner. It is also easier for them to recognize frustration in their partner when they are less preoccupied with themselves. It is interesting to note that alteration of sense of time and loss of self-consciousness are related to the mutual modelling of emotions but not related to emotions experienced during the task. This suggests that identifying emotions in others would not be necessarily linked to experiencing emotions. It could be rather related to socio-cognitive factors such as the ability to momentarily forget who we are so as to become one with both the activity and others.

There is a relation between flow and the perceived quality of collaborative processes (Question 3). More specifically, all dimensions of flow (except loss of self-consciousness) are positively related to two perceived dimensions of collaboration, i.e. information pooling (gathering information relevant to solve the problem) and transactivity (building on the partner's ideas). These two categories of processes are recognized as being an important part of the success of collaborative learning (Meier et al., 2007). Therefore, these results mean that participants perceive themselves and their partners as being more socio-cognitively engaged in the task when they experience flow. It is worth noting that flow appears to be related more strongly to participants' representation of their partner's engagement in collaboration than to their own perceived engagement. One may thus expect that it would be easier for participants to be aware of their partner's activity in flow situations.

This study is exploratory. Its limitations lie on the fact that this is a correlational study with only subjective measures collected in a game context (individuals are more likely to experience flow in such a context). However, our motivation was precisely to focus on perceptions (flow, emotions, perceptions of the interaction with the partner), the rationale being that a deeper understanding of the cognitive and affective quality of computer-supported collaborative learning/problem-solving experience is needed to further design environments and tools able to promote positive emotions, engagement and optimal collaborative behaviors (Riva et al., 2012). Results show that the individual experience of flow is related to both the perceived socio-cognitive processes involved during interaction and the mutual modelling of emotions. They also suggest that experiencing a flow state could encourage participants to pay more attention to their partner. Overall, these results support the idea that the flow experience should be considered as a means to improve the quality of collaborative processes and outcomes. A further analysis is needed to investigate the extent to which individual flow is also related to group performance and to objective measures of the quality of collaboration. We are also interested in exploring how to influence the flow experience in CSCL. For instance, the focus could be to manipulate the characteristics of the CSCL environments so as to influence the control and absorption dimensions of flow.

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