Socio-affective Presence in e-Learning: The theoretical reference model, the development and validation of the EMPSA e-Learning measurement scale[1]

La présence socio-affective en e-Formation : le modèle théorique de référence, l'élaboration et la validation de l'échelle de mesure EMPSA e-Formation

A presença socioafetiva na e-Formação: o modelo teórico de referência, a elaboração e a validação da escala de medição EMPSA e-Formação

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The article outlines the development and validation process of the measurement scale for socio-affective presence in e-learning. This scale was constructed based on the theoretical model of social presence in e-learning (Jézégou, 2022). The study is based on a sample of 309 students enrolled in a fully online Master's program in Education and Training Sciences, offered by French universities. First, an exploratory factor analysis reveals a three-factor structure with strong internal consistency. Second, a confirmatory factor analysis validates this structure and confirms the relationships between the three identified factors. The results demonstrate that this scale serves as a robust psychometric instrument for studying and analyzing socioaffective presence in e-training while opening new avenues for future research.

Mots clés : echelle de mesure, e-Formation, presence sociale, presence socio-affective

L'article décrit le processus d'élaboration et de validation de l'Échelle de Mesure de la Présence Socio-Affective en Formation (EMSPA e-Formation). Cette échelle a été construite en prenant appui sur le modèle théorique de la présence sociale en e-Formation (Jézégou, 2022). L'étude repose sur un échantillon de 309 étudiants inscrits en Master en sciences de l'éducation et de la formation, intégralement en distanciel et dispensé par des universités françaises. Dans un premier temps, une analyse factorielle exploratoire met en évidence une structure factorielle à trois facteurs, caractérisée par une bonne cohérence interne. Dans un second temps, une analyse factorielle confirmatoire valide cette structuration et confirme les relations entre les trois facteurs identifiés. Les résultats montrent que cette échelle constitue un instrument psychométrique robuste pour l'étude et pour l'analyse de la présence socioaffective en e-formation, tout en ouvrant des perspectives pour de futures recherches.

Palavras chave: e-Formacao, escala de medicao, presenca social, presenca socioafetiva

O artigo descreve o processo de elaboração e validação da Escala de Medição da Presença Socioafetiva na Formação (EMPSA e-Formação). Esta escala foi construída com base no modelo teórico da presença social na e-Formação (Jézégou, 2022). O estudo baseia-se numa amostra de 309 estudantes matriculados num mestrado em Ciências da Educação e da Formação, inteiramente a distância que é oferecido por universidades francesas. Primeiramente, uma análise fatorial exploratória evidenciou uma estrutura fatorial de três fatores, caracterizada por uma boa coerência interna. De seguida, uma análise fatorial confirmatória validou esta estrutura e confirmou as relações entre os três fatores identificados. Os resultados mostram que esta escala constitui um instrumento psicométrico robusto para o estudo e a análise da presença socioafetiva na e-formação, além de abrir perspectivas para pesquisas futuras.

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Introduction

"Doing and being together to learn with and from others", despite geographical distance, is both the object and the challenge of the theoretical Model of Social Presence in e-learning (Jézégou, 2022, 2025). The term e-learning[2] is used here to refer to:

> A set of online learning environments, one of the main properties of which is to use multimedia technologies and the Internet to facilitate access to educational resources and services. These environments incorporate software tools for managing and monitoring online training, access to mediated teaching resources, technological possibilities for synchronous and asynchronous interaction, remote working and collaboration, and content production and sharing (Jézégou, 2019, p. 9).

E-learning describes a set of specific environments, not the participants, and is therefore relevant to all educational contexts, including schools, professional training, and higher education.The Model of Social Presence in e-learning (MSP e-learning) is theoretical, in the sense that it is not built on empirical data. It reflects a process of theoretical and epistemological grounding with conceptual articulation that serve as the foundation for modelling. Since it was finalised in the early 2020s, it has been used in a number of qualitative empirical studies for descriptive and interpretative purposes including Androwkha and Jézégou (2019), Bebbouchi and Jézégou (2022), Maury-Zing (2024), Proust-Androwkha (2022, 2023), and Zhao (2024a, 2024b). At the same time, the need for validated tools to capture social presence in e-learning in quantitative investigations quickly became apparent. This article focuses on one of the three dimensions of social presence: socio-affective presence, the other two being socio-cognitive presence and pedagogical presence. It describes the process of developing and validating a scale for measuring socio-affective presence. This scale is known by the acronym EMPSA e-learning (Jézégou et al., 2024), which stands for *Échelle de Mesure de la Présence*

2. The essential aspects of this model have been published in English (Jézégou, 2025).

Socio-Affective en e-Formation (Scale for Measuring Socio-Affective Presence in e-Learning). Development and validation of measurement scales for the other two dimensions of social presence are planned in the next phases of empirical work already underway. We decided to produce three measurement scales rather than one overall scale due to the fact that, according to the model, socio-cognitive, socio-affective, and pedagogical presence can occur independently, even though the model specifies they are correlated. The future measurement scales will help to test these two major hypotheses, among other things.

The theoretical Model of Social Presence in e-learning

The Model of Social Presence in e-learning (MSP-elearning) refers to a particular situation, when geographically distant learners work together on a group activity to resolve a problematic situation, through the use of socio-digital communication artefacts. According to Dewey (1938), resolving a problematic situation is defined as undertaking a project, providing a solution to a problem, responding to an unexpected event, etc. According to this model, social presence is the result of certain forms of mediated social interaction between learners, or between learners and a trainer, teacher, tutor, or supervisor, during a remote group activity. It manifests in a digital space of verbal communication governed by synchronous and asynchronous temporalities via instant messaging, videoconferencing, email, a discussion forum, a collective writing editor, an interactive whiteboard, social networks, etc. In e-learning, socio-digital communication artefacts are often integrated, partially or completely on a dedicated platform, such as Moodle. When such a space (or platform) is created as a third space, it is no longer a purely technology-centred conception. According to Jézégou (2022), it is also, and above all, a place, both co-constructed and shared, for written and oral expression and multiple forms of interaction. It is a third space because it is different from the users' respective physical locations and has its own territoriality, often described as virtual.

The Model of Social Presence in e-learning is an alternative to the noted *Community of Inquiry in e-learning model* or *COI model* (Garrison, 2016, 2017). Both refer to the situation described above and draw on the theory of inquiry (Dewey, 1938). However, as Jézégou (2022, 2023, 2025) has shown, the comparison stops there, because these two models have significant differences.

The epistemo-theoretical particularities of the model

This model defines social presence as a meta-presence comprising three dimensions or entities: socio-cognitive presence, socio-affective presence, and pedagogical presence. The *COI model* addresses social presence as an entity in its own right, linked to two others: cognitive and teaching presence. More than a simple and solely semantic difference, it is fundamentally epistemo-theoretical and conceptual. Thus, in contrast to the COI model, the Model of Social Presence in e-learning (*MSP e-learning*) is rooted in the psychosocial theory of group dynamics (Festinger, 1954; Lewin, 1948; Maisonneuve, 1968; Moscovici, 1979); in the theory of socio-cognitive conflict (Darnon et al, 2008; Doise & Mugny, 1981; Perret-Clermont, 1979; Perret-Clermont & Nicolet, 2002) linked to socio-constructivism; and in the transactional perspective of action (Dewey & Bentley, 1949). In this model from the French-speaking world, because of its epistemic-theoretical foundations, social presence in e-learning is mainly a matter of relationships, if not the quality of these relationships for doing and being together during distance group work. It is about being present to others and to the group, hence its qualification as 'social'.

The architecture of the model is underpinned by a number of interconnected key concepts. The most significant of these concepts are social interactions, socio-cognitive conflict, communicational transactions, contradictory collaboration, the socio-affective climate, group tutoring, and the online learning community. The model also includes the concepts of agency, socio-digital affordance, and third space.

The three types of social presence and their systemic and dynamic modelling

As mentioned in the introduction, the model is the result of the articulation of several different theoretical frameworks and concepts. Together, they ensure the architecture of the model. The theoretical modelling approach adopted is described as systemic and dynamic (Le Cardinal & Guyonnet, 2006; Richalet, 1983) and is described in detail elsewhere (Jézégou, 2022). In essence, the definitions attributed to each of these three dimensions of social presence in e-learning are as follows:

- Socio-cognitive presence is the result of mediated communicational transactions between learners during a group activity aimed at resolving a problematic situation by practice of inquiry. The resulting socio-cognitive presence expresses itself in a socio-digital communicative

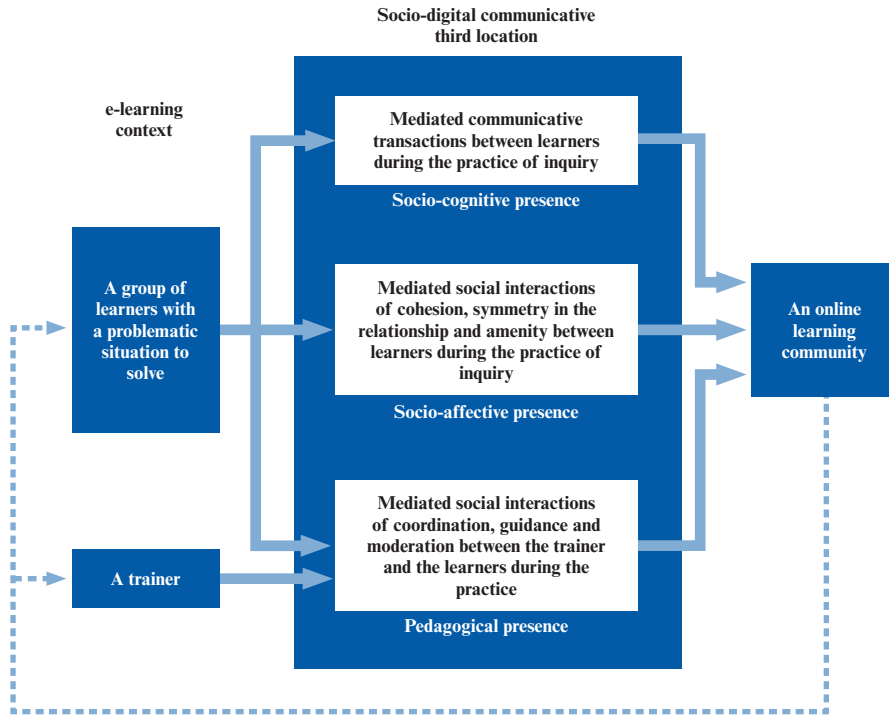
third space and contributes to the development of an online learning community. Communicational transactions refer to social interactions in which individuals express and confront points of view, make mutual adjustments, and negotiate, deliberate, and decide together (Jézégou, 2022, p. 173).

- Socio-affective presence is the result of mediated social interactions that generate a socio-affective climate favouring transactional communication between learners during a group activity aimed at resolving a problematic situation by practice of inquiry. These social interactions create cohesion, symmetry in the relationship, and amenity. The resulting socio-affective presence is expressed in a socio-digital communicative third space and contributes to the development of an online learning community (Jézégou, 2022, p. 184).
- Pedagogical presence is the result of mediated social interactions between the trainer and a group of learners during practice of inquiry. These interactions manifest during coordination, guidance, and moderation activities with learners in the group. The resulting pedagogical presence is expressed in a socio-digital communicative third space and contributes to the development of an online learning community (Jézégou, 2022, p. 196).

The model of social presence in e-learning is formalised schematically as shown in Figure 1 below.

According to the model, socio-cognitive, socio-affective, and pedagogical presence are expressed, independently or together, in a socio-digital communicative third space. Each contributes to the development of an online learning community and promotes both individual and collective learning. The resulting community has a feedback effect on the process of "doing and being together to learn with and from others" (Jézégou, 2022, p. 9). Generally, from a theoretical point of view, socio-affective presence supports the socio-cognitive presence resulting from communicational transactions. In addition, the trainer's pedagogical presence aims to promote these two forms of presence. Nevertheless, the support provided is not automatic, and its influence on these two types of presence may be limited. In this way, depending on the context or even the group profile, these three dimensions of social presence in e-learning may manifest independently regardless. These broad statements have the status of theoretical hypotheses. One of the major challenges of the empirical studies into this model is testing these hypotheses, particularly using measurement scales for the three dimensions of social presence.

Figure 1
The Model of Social Presence in e-learning



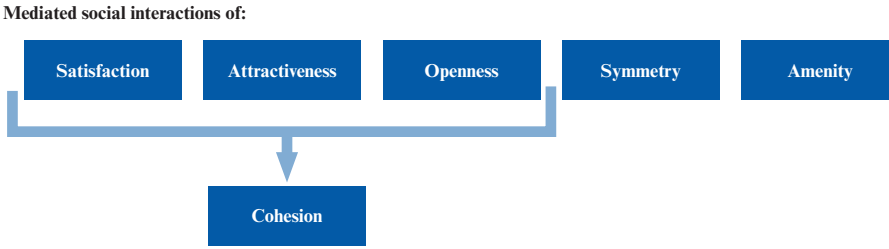
Jézégou, 2022, p. 209

Socio-affective presence: the structure and theoretical indicators for developing and validating EMPSA e-learning

In the broad sense, socio-affective presence refers to being together, and more precisely, to collective well-being for doing things together. More precisely, it is the result of mediated social interactions which, together generate the most favourable socio-affective climate for doing things together as a group. According to the psychosocial theory of group dynamics as the epistemo-theoretical anchor of the model, three major dimensions contribute to generating such a climate. They have been updated by the historical authors of this theory (including Festinger, 1954; Lewin, 1948; Maisonneuve, 1968; Moscovici, 1979). Over the decades, consensus on these dimensions has grown even stronger among contemporary social

psychologists studying small groups. Examples in the works of French-speaking authors include Aebischer and Oberlé (2016), Abric (2008), Augustinova and Oberlé (2013), Bègue and Desrichard (2013), and Fischer (2015). They have also been put forward in the theory as leverage for socio-cognitive conflict, and therefore also promoting both individual and collective learning (Doise & Mugny, 1981; Moscovici & Doise, 1992). The three fundamental dimensions are: (a) group cohesion; (b) symmetry in the relationship; and (c) amenity between group members. Cohesion, in turn, is broken down into three dimensions: (a) satisfaction[3]; (b) attractiveness[4]; and (c) openness[5]. Each of these five dimensions corresponds to a specific category of mediated social interactions that create socio-affective presence (Jézégou, 2022[6]), as shown in Figure 2 below.

Figure 2
The five categories of mediated social interactions that generate socio-affective presence



According to Jézégou, 2022

Also based on the psychosocial theory of group dynamics, 13 indicators were attributed to the mediated social interactions of cohesion, seven of which are linked to satisfaction, four to attractiveness, and two to openness. Four indicators were attributed to mediated social interactions with relationship symmetry and amenity respectively. Taken together, Tables 1 and 2 below show the theoretical structure used to build the EMPSA scale, with a total of 21 theoretical indicators.

3. Satisfaction: satisfaction with being and doing together, the socio-operational aspects of group work (see Table 1)
4. Attractiveness: see Table 1
5. Openness: a relational norm that is open to difference and diversity
6. Table 21, p. 190; Table 24, p. 195

Table 1

The three categories of mediated cohesion interactions leading to socio-affective presence in e-learning, their coding, and the 13 initial indicators used to develop EMPSA e-learning

Mediated cohesion interactions leading to socio-affective presence in e-Learning	
Categories and codes used	**13 indicators**
SAPCOSatisfaction[1]	7 indicators
Social interactions expressing **satisfaction**:	with doing together. with being together. with the role played by each member of the group. with the organization. with role sharing. with each participant's contribution. with the available resources.
SAPCOAttractiveness[2]	4 indicators
Social interactions **expressing the attractiveness** of:	the goal. the actions carried out together. the other members of the group. the group itself.
SAPCOOpenness[3]	2 indicators
Social interactions based on a relational norm that is **open to difference and diversity:**	in status, age, level of expertise, and gender. in ideas and different points of view.

1. SAPCOSatisfation: Socio-Affective Presence, Cohesion, Satisfaction.
2. SAPCOAttractiveness: Socio-Affective Presence, Cohesion, Attractiveness.
3. SAPCOOpenness: Socio-Affective Presence, Cohesion, Openness.

Table 2

The two categories of mediated social interactions of symmetry in the relationship and amenity leading to socio-affective presence in e-learning, their coding and the eight initial indicators used to develop EMPSA e-learning

Mediated social interactions of symmetry in the relationship and amenity leading to socio-affective presence in e-learning	
Categories and codes used	**8 indicators**
SAPSymmetry	4 indicators
Social interactions that demonstrate **an equal relationship:**	mutual respect consideration of others appreciation of each participant's contributions appreciation of each participant's skills
SAPAmenity	4 indicators
Social interactions of **amenity**	politeness kindness friendliness calm

From this theoretical structure, each of the 21 indicators was assigned a specific item in the initial questionnaire used to develop and validate the EMPSA e-learning measurement scale.

Methodology for developing and validating the scale

The scale was developed from the complete responses to this questionnaire, which was entered and submitted via LimeSurvey. The introductory text stated that it was a survey of learners who had taken part in remote group work only and specified the subject: the socio-affective presence created between the members of the group during their work. It also mentions that all answers will be kept anonymous.

2.1. The online questionnaire, the structure and targeting of respondents

The questionnaire was divided into three separate parts. The first set of conditions required potential respondents to have taken an entirely distance learning course with one or more group work sessions in the course. The answers obtained (yes/no) determined whether or not it was possible to continue (i.e. a respondent was blocked for a double no).

In the second part, respondents were asked to refer to a specific distance learning group (see Appendix A). This section consisted of a series of seven closed single-choice questions, each dealing with a characteristic of remote group work: (a) group size; (b) duration of group work; (c) democratic decision-making; (d) cooperative and/or collaborative mode; (e) frequency of exchanges; (f) existence of inter- and/or intra-group competition; and (g) how the group was formed. According to the theoretical model of reference, each of these seven characteristics is correlated with socio-affective presence. This hypothesis was statistically tested during this investigation.

The third part of the questionnaire, central to the construction of the measurement scale, referred to the same distance group work. As detailed previously, it comprised 21 items, each corresponding to a theoretical indicator associated with cohesion, relationship symmetry, and amenity (Tables 1 and 2 above). See Appendix B for the list of 21 initial items.

Table 3
Number of items in the questionnaire for indicators of cohesion, symmetry in the relationship, and amenity

Mediated social interactions that generate cohesion, symmetry and amenity	**Coding**	**Number of items**
Cohesion. Satisfaction	SAPCOSatisfaction	7
Cohesion. Attractiveness	SAPCOAttractiveness	4
Cohesion. Openness	SAPCOOpenness	2
Symmetry in the relationship	SAPSymmetry 1	3
Symmetry in competencies	SAPSymmetry 2	1
Amenity	SAPAmenity	4
	Total	21

The following are examples of the questions asked and the associated items: During this remote work, within our group, we all "expressed satisfaction at being together" (SAPCOSatisfaction), "exchanged in a friendly manner" (SAPAmenity), "were open to each other's ideas and points of view" (SAPCOOpenness), "expressed interest in the activities to be carried out" (SAPCOAttractiveness). The possible responses on a 7-point

Likert scale ranged from (1) Not at all to (7) Strongly, on a scale via very little, a little, moderately, quite a bit, and a lot. Seven response levels were necessary for obtaining substantial variability while maintaining adequate discrimination (Streiner, 2015).

The entire questionnaire of 21 items and seven questions relating to the characteristics of remote group work was tested with a small sample of doctoral students and students enrolled in an e-learning programme and working in a group (N = 15). The aim was to ensure the items were fully understood and make any necessary adjustments to the wording. The questionnaire was then distributed to a target audience in two phases: students studying for a Master's degree in Education and Training Sciences (ETS), delivered online at several French universities. We targeted this audience to achieve a homogeneous sample. Students responded on a voluntary basis and were not financially compensated.

Table 4
Targeting and number of respondents for Phases 1 and 2

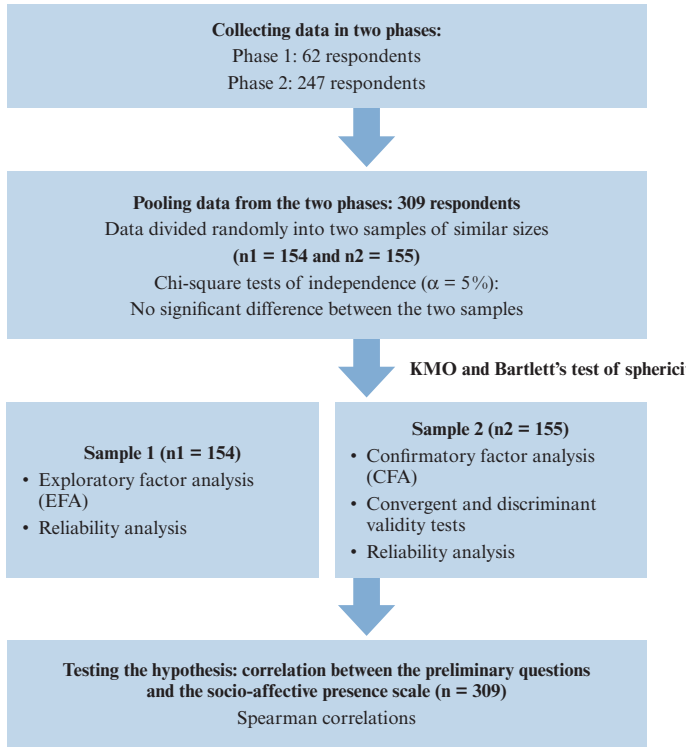
Questionnaire	Target	Course format	University	Issued	Number of respondents	Number of questionnaires filled out
Phase 1	Educational and Training Sciences Master's students 2022-2023	Fully online	Lille	November 2023	72	62
Phase 2	Educational and Training Sciences Master's students 2023-2024	Fully online	Lille Nanterre Lyon 2 Rouen	April 2024	280	247
					Total	309

2.2. The plan for analysing the data collected during Phases 1 and 2

The data were analysed using Jamovi and SPSS software. Figure 3 below shows the analysis plan adopted to establish the construct validity of the second and third parts of the questionnaire.

Figure 3. Data analysis plan to establish the construct validity of the EMPSA e-learning scale

Figure 3
Data analysis plan to establish the construct validity of the EMPSA e-learning scale



A ratio of five to ten respondents per item is generally recommended (DeVellis, 2016). Consequently, we needed at least 105 participants for valid analysis of the 21 items. However, we only obtained 62 completed questionnaires for Phase 1. Given the insufficient number, we added the number of first-phase respondents to the second phase respondents (n = 247), for a total of 309 completed questionnaires. The 309 questionnaires were then randomly divided using SPSS software into two samples of similar size (n_1 = 154 and n_2 = 155). As noted by Fokkema and Greiff (2017) and Worthington and Whittaker (2006), this procedure makes it possible to carry out exploratory and confirmatory factor analyses on separate samples.

Before conducting these analyses, the results of chi-square tests of independence ($\alpha = 0.05$) showed there was no significant difference between the two samples (n_1 and n_2) regarding the characteristics of group work (questions in the second part). As pointed out by Bélisle et al. (2022), this prior verification is necessary to avoid possible bias in the results of subsequent analyses.

We then performed exploratory factor analysis (EFA) using SPSS software on the data from the first sample (n1 = 154), taken from the third and main part of the questionnaire. Reliability analysis was carried out for each factor of the resulting scale and for the scale as a whole. Subsequently, confirmatory factor analyses (CFA) were performed on the second sample (n2 = 155) using IBM SPSS Amos to confirm the previously identified factor structure (Worthington & Whittaker, 2006).

2.3. Results of the analysis of data from the two samples (n1 = 154, n2 = 155)

Exploratory factor analyses (n1)

In sample n1 = 154, the 21 items linked to the third part of the questionnaire showed negative skewness, indicating a deviation from normality confirmed by the significance of the Shapiro–Wilk test ($p < 0.001$). However, the skewness and kurtosis values remained within acceptable limits. These values ranged from -2 to -1, and the kurtosis values varied between -0.184 and 6.050, thus meeting the criteria established by Kline (2023) (skewness ±3, kurtosis ±10) and even approaching the stricter limits defined by Byrne and Van de Vijver (2010) (skewness ±2, kurtosis ±7). Consequently, no severe univariate deviation from normality was observed. The data were then checked for suitability for exploratory factor analysis (EFA). The KMO index of 0.947 (≥ 0.70) indicated excellent sampling adequacy (Bourque et al., 2006). In addition, Bartlett's sphericity test revealed a significant result ($p < 0.001$), confirming that the correlation matrix of the observed variables was not an identity matrix, and therefore factorable (Beavers et al., 2013).

As demonstrated by Conway and Huffcutt (2003) and Pett et al. (2003), orthogonal rotations produce uncorrelated factors, while oblique rotations produce correlations that better reflect the complex nature of social science data. Worthington and Whittaker (2006) note that oblique rotations favour a more straightforward and appropriate factor structure.

Given the theoretical intercorrelation between the major aspects of socio-affective presence, we conducted an extraction using principal axis factoring with oblique rotation (Direct Oblimin).

By applying the Kaiser criterion for factor selection (eigenvalues > 1), two factors were initially identified. However, taking into account the criticisms of the arbitrariness of this criterion, as expressed by Fabrigar et al. (1999) and Bourque et al. (2006), as well as Costello and Osborne's (2005) suggestions regarding uniqueness, a third factor was added. This decision was also based on the fact that the two-factor structure did not fully capture the variance of certain items. In addition, one or two additional factors had to be retained to avoid the danger of extracting an insufficient number of factors, as recommended by Gorsuch (1997, cited in Berger, 2021). Moreover, given that the scale developed is grounded in a robust theoretical framework, Bourque et al. (2006) recommend determining the number of factors *a priori* based on theoretical criteria. Consequently, we attempted to set the number of factors at three *a priori*. They accounted for 36.6%, 26.5% and 6.7% respectively of the shared variance in the data, for a total of 69.8%.

We then analyzed the rotated factor matrix. Following recommendations by Worthington and Whittaker (2006), exploratory factor analyses were continued, eliminating items until a simple, easily interpretable structure was obtained. We therefore eliminated the following items: Item 1 "exchanged in a friendly manner", Item 3 "expressed an interest in the group itself", Item 9 "showed appreciation for everyone's contributions", and Item 14 "highlighted the skills of each individual"). In fact, their factor contributions were greater than 0.30 on two main axes. In addition, we also eliminated the following to comply with the criterion of meaning and interpretation of the factors retained: Item 7 "expressed interest in everyone in the group" and Item 16 "expressed satisfaction with the resources made available".

At this stage, the pattern matrix after rotation showed a simple structure in three factors. The first, COOpenness, Symmetry in the relationship and Amenity, contained seven items. The second factor, COSatisfaction, contained six items, and the third, COAttractiveness, comprised two items. These three factors explained 73.5% of the shared variance in the data. Factor 1 showed a strong correlation with Factor 2 ($r = 0.74$) and with Factor 3 ($r = 0.52$), while Factor 2 also showed a significant correlation

with Factor 3 (r = 0.68). We also performed internal consistency analysis for each factor in the resulting scale. This was assessed using Cronbach's alpha (α) and McDonald's omega (ω), in accordance with recommendations by Béland and Michelot (2020) and Hayes and Coutts (2020). For each factor, the coefficients α and ω were calculated and produced identical values: 0.94 for Factors 1 and 2, and 0.91 for Factor 3, indicating excellent internal consistency. Similarly, the α and ω coefficients obtained for the scale as a whole were both 0.96, attesting to high overall reliability. No item deletion would have improved internal consistency, demonstrating that all the items converged towards measuring the same concept. Communalities greater than 0.70 indicated that each variable was well explained by the extracted factors. Table 5 below shows the results of the exploratory and reliability factor analyses.

Confirmatory factor analyses (n2 = 155)

In order to confirm the internal structure of the resulting scale, we conducted confirmatory factor analyses (CFA) on the second sample of data, using the maximum likelihood estimation method and IBM SPSS Amos, while taking into account the non-normality of the data (Byrne, 2006). To test the initial three-factor model with 15 items (according to the results of the exploratory factor analysis (EFA) of n1), various fit indices were examined: the Satorra-Bentler (1988) chi-square to degrees of freedom ratio (χ^2/df), the adjusted goodness of fit index (AGFI), the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardised root mean square residual (SRMR). General recommendations suggest that a χ^2/df ratio of less than 3 indicates an acceptable model (Jöreskog, 1993; Schreiber et al., 2006). Diamantopoulos and Siguaw (2000) state that to indicate a good model fit, the AGFI value must be greater than 0.80. Values above 0.90 for CFI and TLI show a good fit of the data and very good quality above 0.95 (Hu & Bentler, 1999). Finally, an RMSEA of less than 0.08 and an SRMR of less than 0.08 indicate an acceptable fit (Hu & Bentler, 1999; MacCallum et al., 1999).

However, our initial three-factor model with 15 items did not show an acceptable fit to the data, as the RMSEA value was greater than 0.09, thus exceeding the 0.08 threshold. Consequently, we eliminated Item 13 "exchanged politely" due to high modification indices (MI), indicating significant covariance with other factors (Factor 1: MI = 8.560; Factor 3: MI = 7.282), thus questioning its appropriateness to the attributed factor.

Table 5
Item loadings for three-factor EFA

15 Items	Factor label	Factor			Communality	Cronbach's alpha (α)	McDonald's omega (ω)
		1	2	3			
Item6SAPAM4amenity	COOpenness, Symmetry in the relationship, and Amenity	**0.993**	-0.138	0.077	0.870	0.94	0.94
Item2SAPCO2openness		**0.881**	-0.006	-0.062	0.713		
Item11SAPSYM3symmetry		**0.854**	0.102	-0.108	0.769		
Item4SAPCO1openness		**0.805**	0.092	-0.006	0.762		
Item5SAPAM2amenity		**0.709**	0.107	0.073	0.701		
Item21SAPSYM2symmetry		**0.579**	0.249	0.088	0.709		
Item13SAPAM3amenity		**0.506**	0.199	0.240	0.701		
Item12SAPCOS3cosatisfaction	COSatisfaction	-0.036	**0.921**	-0.013	0.783	0.94	0.94
Item20SAPCOS6cosatisfaction		-0.007	**0.908**	-0.032	0.776		
Item18SAPCOS5cosatisfaction		0.126	**0.634**	0.156	0.720		
Item10SAPCOS2cosatisfaction		0.090	**0.626**	0.185	0.695		
Item19SAPCOS7cosatisfaction		0.287	**0.536**	0.093	0.708		
Item8SAPCOS1cosatisfaction		0.214	**0.513**	0.184	0.681		
Item17SAPCO4coattractiveness	COAttractiveness	0.015	-0.034	**0.907**	0.796	0.91	0.91
Item15SAPCO3coattractiveness		-0.024	0.081	**0.881**	0.854		
Factor 1 and Factor 2: r = 0.74 / Factor 1 and Factor 3: r = 0.52 / Factor 2 and Factor 3: r = 0.68						Together α = 0.96 ω = 0.96	

In addition, significant covariance with Item 6 "exchanged in a friendly manner", (MI = 13.919) suggested redundancy between these two items, justifying deletion of Item 13 to improve the coherence and validity of the model. Next, three covariance parameters were added between the residuals of conceptually similar statements belonging to the same scale factor. As Table 6 below shows, the statistics and fit indices for the model tested (three factors with 14 items) now meet all these criteria.

Table 6
Statistics and fit indices for the model tested based on the results of the confirmatory factor analysis

Fit indices examined	Criteria	Results
CMIN/DF based on the Satorra-Bentler chi-square	CMIN/DF < 3	1.92
Adjusted goodness-of-fit index (AGFI)	AGFI > 0.80	0.89
Comparative fit index (CFI)	CFI > 0.90	0.97
Tucker-Lewis Index (TLI)	TLI > 0.90	0.96
Root mean square error of approximation (RMSEA)	RMSEA < 0.08	0.07
Standardized root mean square residual (SRMR)	SRMR < 0.08	0.07

The 3-factor model tested with 14 items had a Satorra-Bentler CMIN/DF ratio of less than 2, which can be described as excellent. The values for SRMR and RMSEA of less than 0.08 indicated an acceptable fit. In addition, CFI and TLI values above 0.95 indicated a very good fit.

Subsequently, tests of convergent validity and discriminant validity (Fornell & Larcker, 1981) were carried out to assess whether items supposedly measuring the same concept were highly correlated with each other and whether the factors measured distinct concepts. Tables 7 and 8 below show the results of these tests.

According to Fornell and Larcker (1981), the CR and AVE of each factor must be higher than 0.7 and 0.5 respectively. The results of the CR coefficients were all above 0.8. This means that the items in each of these three factors were highly correlated with each other and consistently measured the same latent construct. In addition, the AVE test results were above 0.7 for Factors 1 and 3, and close to 0.7 for Factor 2, indicating good convergent validity. The square root of the AVE for each factor should be greater than the correlation between that factor and the other factors, indicating good discriminant validity. The discriminant validity results were therefore satisfactory.

Table 7
Results for average variance extracted (AVE) and composite reliability (CR) for each factor

Factor	Item	Standardized factor loading	Squared multiple correlation	CR	AVE
1	8	0.854	0.729	0.990	0.729
	10	0.843	0.711		
	12	0.883	0.780		
	18	0.916	0.839		
	19	0.925	0.856		
	20	0.813	0.661		
2	15	0.842	0.709	0.792	0.656
	17	0.777	0.604		
3	2	0.795	0.632	0.947	0.749
	4	0.872	0.760		
	5	0.805	0.648		
	6	0.862	0.743		
	11	0.885	0.783		
	21	0.962	0.925		

Table 8
Discriminant validity - square root of AVE and correlation between factors (diagonal = square root of AVE)

Square root of AVE	Factor 1	Factor 2	Factor 3
Factor 1	**0.873**		
Factor 2	0.671	**0.810**	
Factor 3	0.837	0.759	**0.865**

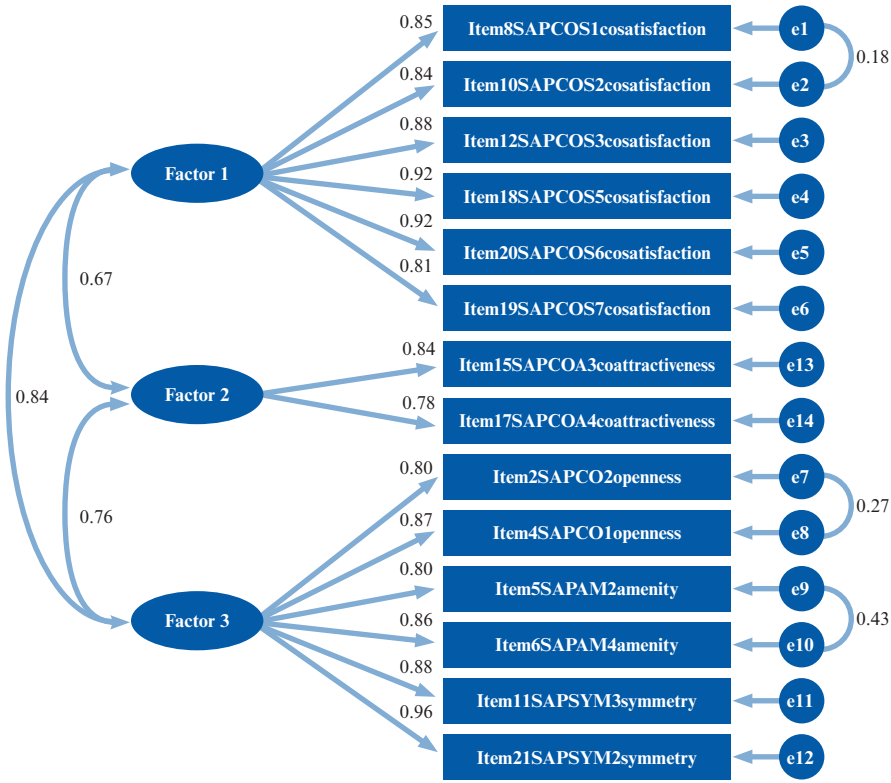
The results of the reliability analysis also indicated excellent internal consistency, with Cronbach's alpha of 0.93 (ω = 0.95) for Factor 1, 0.79 (ω = 0.79) for Factor 2, 0.95 (ω = 0.95) for Factor 3, and 0.95 (ω = 0.96) for the scale as a whole. These coefficients demonstrate satisfactory reliability, with values well above the threshold of 0.70, as recommended by Landauer (1997), Kline (2023), and Hair et al. (2019).

Finally, Figure 4 below shows the item loadings on the factors for the three-factor model with 14 items and the correlations between the factors. It should be noted that all item loadings exceeded 0.75, revealing excellent

item quality according to the criteria proposed by Comrey and Lee (1992). These high factor loadings reflected the high correlation between the items and the underlying factors, suggesting that the items were successful in accurately measuring the theoretical concepts represented by each factor. These results underlined the goodness of fit of the model and the robustness of the factors. Furthermore, the correlations between the factors were strong, while ensuring discriminant validity, indicating a close relationship between the theoretical constructs measured. This suggests that the three factors of socio-affective presence are interdependent, which is consistent with the initial theory.

Figure 4

Item loadings on factors and correlations between factors



This final version of the scale for measuring socio-affective presence in e-learning (EMPSA e-learning), comprising 14 items (specified in Appendix C), is concise and requires no further optimisation. Various pieces of validity evidence were gathered throughout the development process to ensure the robustness of the interpretation of the results for the intended use (DeVellis, 2016).

We studied the scale's internal structure using data from the first sample. The results reveal a structure made up of three main factors, demonstrating very good internal coherence. The second sample provided further evidence of the validity of this structure. The first two factors correspond to COSatisfaction (Factor 1) and COAttractiveness (Factor 2), while the third covers COOpenness, Symmetry in the relationship, and Amenity (Factor 3). The validation of this structure thus allows the measurement of socio-affective presence by calculating the mean of the item scores for each factor, in addition to the total scale score.

The relationship between the preliminary questions and the socio-affective presence scale

As previously mentioned, part two of the questionnaire includes a series of seven closed-ended questions that each address a different characteristic of the remote group work: (1) group size; (2) duration of group work; (3) democratic decision-making; (4) cooperative and/or collaborative mode; (5) frequency of exchanges; (6) existence of inter- and/or intra-group competition; and (7) how the group was formed. This second part is set out in Appendix A of this article.

According to the theoretical model of reference, each of these seven characteristics is correlated with socio-affective presence. More precisely, taking into account the results of Phases 1 and 2, they would therefore be correlated with the items on the socio-affective measurement scale obtained.

To test this hypothesis, due to the non-parametric nature of the data (Spearman, 1910), we calculated Spearman correlations to verify the association between the scores for each of the three factors, the total scale score, and the answers to the preliminary questions in the second part of the questionnaire. The coding of responses to the preliminary questions followed an ordinal progression reflecting the intensity of the phenomenon measured. The more a response reflected democratic decision-making, a collaborative approach, a high frequency of exchanges, or marked intra/intergroup competition, the higher its score. For example, for the question on democratic

Table 9

Spearman correlation between responses to preliminary questions and scores for each factor, as well as the total scale score

Preliminary questions	**Factor 1 COSatisfaction**	**Factor 2 COAttractiveness**	**Factor 3 COOpenness, Symmetry in the relationship and Amenity**	**Total scale score**
Democratic decision	0.339*** $p < 0.001$	0.227*** $p < 0.001$	0.377*** $p < 0.001$	0.356*** $p < 0.001$
Cooperative and/or collaborative mode	0.207*** $p < 0.001$	0.226*** $p < 0.001$	0.159** $p = 0.006$	0.222*** $p < 0.001$
Frequency of exchanges	0.447*** $p < 0.001$	0.380* $p < 0.001$	0.378*** $p < 0.001$	0.466*** $p < 0.001$
Existence of intra-group competition	- 0.234*** $p < 0.001$	- 0.268*** $p < 0.001$	- 0.268*** $p < 0.001$	- 0.230*** $p < 0.001$
Existence of inter-group competition	- 0.119* P = 0.037	- 0.020 P = 0.724	- 0.119* P = 0.037	- 0.103 P = 0.071

Note. * $p < 0.05$*; $p < 0.01$**; $p < 0.001$***

decision-making, the answers ranged as follows: (1) following the instructions given by one of us; (2) following the instructions given by several of us; and (3) deciding everything together. This gradation was applied consistently with the other questions. Table 9 shows the results obtained.

The assessment of the strength of correlations is based on the conventional effect sizes proposed by Cohen (1988): a correlation of 0.10 to 0.29 is considered weak, 0.30 to 0.49 medium, and 0.50 to 1.00 strong.

The results show there is a moderate and statistically significant positive correlation between democratic decision-making, frequency of exchanges, and the three factors, as well as the total score on the scale. As a result, the more democratic the decision-making within the group, the higher the score on the scale. The same applies to the frequency of exchanges. These results seem to confirm the hypotheses presented in the theoretical model of reference (Jézégou, 2022) concerning these two characteristics. Furthermore, a cooperative and/or collaborative organization presents weak positive correlations with the scale. The more collaborative, as opposed to cooperative, the group's organization, the higher the scale score, although the correlation is fairly weak. Here too, the results are in line with the assumptions made by the model regarding this characteristic.

With regard to the "inter-group/intra-group competition" characteristic, the results show that an increase in the degree of intra-group competition is associated with a negative correlation with each factor on the scale, as well as with the total score. In other words, the greater the intra-group competition, the lower the level of socio-affective presence. This result appears to invalidate the hypothesis for this characteristic. With regard to inter-group competition, the results show a very weak negative correlation with Factors 1 and 3 only, while correlations with Factor 2 and the total score are not significant. Furthermore, in this study, probably because of the homogeneous context, no statistically significant correlation was found between the scale and the size of the group, the duration of group work, and how the group was formed.

Ultimately, the correlations observed are statistically significant, even when low to moderate. Researchers using this measurement scale are strongly advised to take into account all these characteristics when interpreting results obtained after using this scale. Furthermore, the training context and the different characteristics of collaborative work could influence socio-affective presence in a more complex way than is captured by the

bivariate correlations. Although moderate, the bivariate correlations do not account for the combined effects of several contextual variables, each explaining only a limited fraction of the variance of the observed phenomenon. An in-depth exploration of the links between these characteristics of group work and socio-affective presence could therefore be an interesting avenue for future research.

Discussion

With regard to the main results obtained, the discussion can focus on three key points. The first is the size of the sample, an important factor to take into account when interpreting the results. The second point concerns the justification for choosing a three-factor solution rather than a two-factor solution in an EFA. The third point relates to the *a priori* discrepancy between the theoretical structure of socio-affective presence divided into five categories of mediated social interaction (Tables 1 and 2 above) and the factorial structure obtained (Figure 4 above).

In terms of sample size, the EFA was conducted on 154 participants (n1) with 21 items, thus complying with the minimum recommended ratio (5:1). The high communalities observed (> 0.7) indicate a substantial explanation of variance, reinforcing the factorial validity of the structure obtained and reducing the impact of sample size on model fit (MacCallum et al., 1999; Bourque et al., 2006; Worthington & Whittaker, 2006). In addition, a CFA carried out on the second sample provided further evidence, ensuring a rigorous assessment of the scale's validity, in line with recommendations in the literature (Costello & Osborne, 2005; Worthington & Whittaker, 2006). Of course, validation on larger and more diversified samples would confirm this robustness.

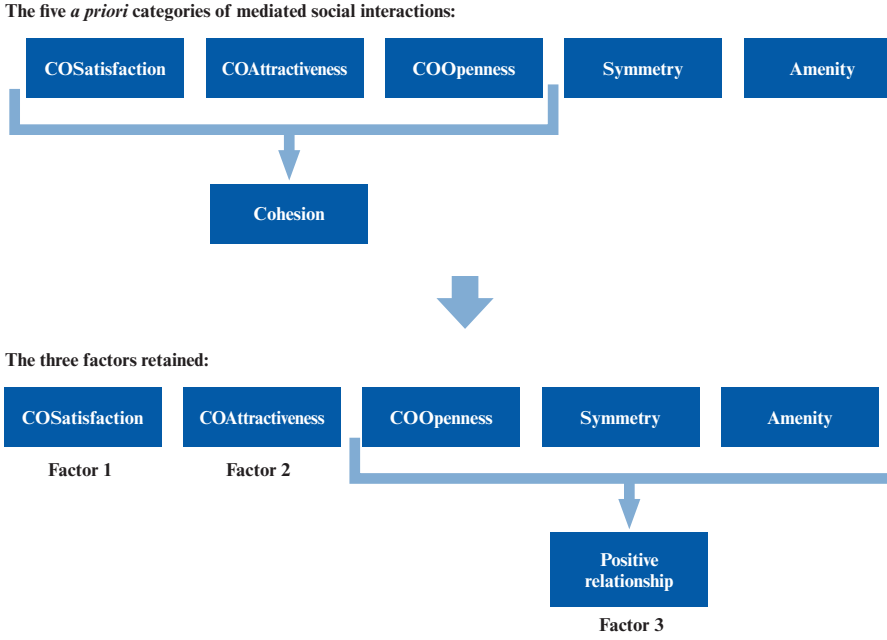
As for the second point, a number of factors have led us to opt for a three-factor solution in EFA. On the one hand, in the two-factor solution, the communalities were low, suggesting insufficiently explained variance (Costello & Osborne, 2005). More specifically, items 2 and 6 were close to the recommended threshold of 0.5 (Evrard et al., 2003), while items 7, 8, 10, 18 and 21 were below 0.4. On the other hand, the factor structure obtained lacked theoretical coherence. The addition of a third factor considerably improved its conceptual interpretation. In addition, the two-factor solution showed a lack of discrimination between constructs, as

evidenced by cross-factor loadings and confirmed by a CFA which revealed an unsatisfactory fit. As a result, we chose the three-factor solution, offering a model with satisfactory fit indices.

Regarding the third point, it ultimately appears that the factor structure obtained does not correspond exactly to the five categories of mediated social interaction posited *a priori* (Figure 2, Tables 1 and 2 above). Factor analysis revealed a different structure with three distinct factors: COsatisfaction (F1), COattractiveness (F2), COOpenness, Symmetry in the relationship, and Amenity (F3). Figure 5 below illustrates the evolution of these five initial categories towards the three factors finally retained in the scale.

Figure 5

Evolution of the initial five-category structure towards the three factors retained in the scale



As this figure shows, the social interactions linked to group cohesion do indeed relate to the two categories of the initial theoretical proposal (Table 1 above). On the one hand, social interactions linked to COSatisfaction (F1) group together socio-operational aspects linked to satisfaction with the organization of group activity (e.g. satisfaction with the distribution of roles, satisfaction with individual contributions). On the other hand, interactions linked to COAttractiveness (F2) are associated with interest in the activity and in the group itself. Finally, with regard to the third factor, the results indicate that COOpenness, Symmetry in the Relationship, and Amenity (F3) are not three separate categories, but form a coherent whole. The association between "Symmetry in the relationship" and "Amenity" can be explained by the fact that, as Doise and Mugny (1981) and Moscovici and Doise (1992) point out, generally speaking, amenity makes it possible to erase the perceived differences between group members, establishing symmetry in the relationship. Furthermore, the COOpenness shift towards Factor 3 is of quite relative significance. Indeed, when we refer to the psychosocial theory of group dynamics, and as Jézégou (2022) shows, drawing in particular on the work of Moscovici (1979) and Festinger (1954), openness is defined as a relational norm that is open to difference during a collective activity and is part of group cohesion. At the same time, this relational norm is very close to the symmetry in the relationship, which reflects an egalitarian relationship that transcends objective differences. Ultimately, Factor 3, incorporating COOpenness, Symmetry, and Amenity, could represent a form of positive relationship between the members of the group (Figure 5 above).

Although the factor structure obtained differs slightly from the original theoretical structure, a tangible explanation is provided in this discussion. Consequently, the changes observed (Figure 5 above) do not call into question the overall concept of socio-affective presence. The three factors identified are in line with the conceptual framework of socio-affective presence and seem to offer a more refined understanding of it at an empirical level.

Conclusion

A promising line of empirical research based on the Model of Social Presence in e-learning is currently being developed. The process of developing and validating the EMPSA-elearning measurement scale, as described in this article, is part of this process. This measurement scale is an

important resource for research into socio-affective presence in e-learning. This scale provides research teams with a robust tool for studying the links between this specific form of presence and other variables such as the individual characteristics of learners, or those derived from other existing measurement scales covering different dimensions. They also benefit from using this tool and interpreting the detailed results it provides to carry out mixed-methods studies. This scale is also useful for those involved in education (trainers, training managers, educational coordinators, teachers, etc.) for identifying the socio-affective presence experienced and felt by learners in their group when conducting a completely remote collective task. The results obtained can then be used as decision-making aids to implement actions aimed at developing this type of presence in groups.

In scientific terms, the project is currently continuing with the construction of two other scales: socio-cognitive presence and pedagogical presence. Consequently, researchers will have three valid scales for measuring each of the three dimensions of social presence in e-learning, with reference to the same initial theoretical model. In particular, they will be able to use these scales to study the links between these dimensions, including, for example, the support provided by the pedagogical presence to the other two presences, or the role played by the socio-affective presence on the socio-cognitive presence, and so on.

Together or independently, these three scales will make it possible to test the many theoretical hypotheses set out by the model (Jézégou, 2022) and, more generally, to test it empirically with various groups working remotely for e-learning.

In all cases, whether involving qualitative studies linked to this theoretical model or the use of these measurement scales for quantitative investigations, the scientific challenge lies in the conceptual and methodological robustness of the research conducted, as well as in the validity of the proposed instruments. This is the challenge to be met in empirical studies using the Model of Social Presence in e-learning.

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Appendix A. Preliminary questions, response procedures and coding

Part I - Two essential conditions			
Are you taking or have you taken a course that is entirely distance learning?			Yes/No
During this distance learning course, did you carry out one or more group tasks entirely remotely?			Yes/No
Part II - Preliminary questions (with reference to remote group work)			
(Group size) The group size was:	(1) between 3 and 5 members (3) between 9 and 12 members (5) more than 16 members	(2) between 6 and 9 members (4) between 13 and 16 members	
(Duration of group work) This group work lasted:	(1) less than 2 weeks (3) between 5 weeks and 2 months (5) between 13 weeks and 4 months (7) more than 5 months	(2) between 2 weeks and 1 month (4) between 9 weeks and 3 months (6) between 17 weeks and 5 months	
(Democratic decision-making) To carry out this group work, we:	(1) followed the instructions given by one of us. (2) followed the instructions given by several of us. (3) decided everything together.		
(Cooperative and/or collaborative approach) In this group,	(1) we divided up the work. (2) sometimes we divided the work and sometimes we did it together. (3) we did everything together.		
(frequency) In our group, discussions were	(1) very rare (4) frequent	(2) rare (5) very frequent	(3) infrequent (6) constant
(Existence of inter-group/intra-group competition) During this work, we were in competition with each other within our group. We were competing against another group.			Yes (1)/No (0)
(How the group was formed) We formed our group ourselves. Our group was formed by someone else.			Yes (1)/No (0)

Appendix B. The 21 initial items

The 21 initial items

(1 = not at all; 2 = very little; 3 = somewhat; 4 = moderately; 5 = quite a bit; 6 = a lot; 7 = very strongly)

Within the group, we all	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. exchanged in a friendly manner.							
2. demonstrated mutual tolerance despite our differences.							
3. expressed an interest in the group itself.							
4. showed tolerance for each other's ideas and points of view.							
5. exchanged calmy.							
6. exchanged kindly.							
7. expressed interest in every member of the group.							
8. expressed satisfaction at being together.							
9. showed appreciation for each other's contributions.							
10. expressed satisfaction at doing this work together.							
11. demonstrated mutual respect.							
12. expressed satisfaction with the role played by each group member.							
13. exchanged politely.							
14. highlighted the skills of each group member.							
15. expressed interest in the activities to be carried out during this work.							
16. expressed satisfaction with the resources made available (media, communication tools, contacts, etc.).							
17. showed an interest in the goal to be achieved by this group work.							
18. expressed satisfaction with the way we organised ourselves to carry out this work.							
19. expressed satisfaction with each other's contributions.							
20. expressed satisfaction with the way roles were shared.							
21. showed consideration for each other.							

Appendix C. The 14 items of the EMPSA e-learning scale and their coding, corresponding to figure 4: item loadings on factors and correlations between factors

The 14 items of the EMPSA e-learning scale

(1 = not at all; 2 = very little; 3 = somewhat; 4 = moderately; 5 = quite a bit; 6 = a lot; 7 = very strongly)

Code	Within the group, we all:	1	2	3	4	5	6	7
8-COS1cosatisfaction	1. expressed satisfaction at being together.							
10-COS2cosatisfaction	2. expressed satisfaction at doing this work together.							
12-COS3cosatisfaction	3. expressed satisfaction with the way each member played their role.							
18-COS5cosatisfaction	4. expressed satisfaction with the way we organised ourselves to carry out this work.							
20-COS6cosatisfaction	5. expressed satisfaction with the way roles were shared.							
19-COS7cosatisfaction	6. expressed satisfaction with each member's contribution.							
15-COA3coattractiveness	7. expressed interest in the activities to be carried out during this work.							
17-COA4coattractiveness	8. showed an interest in the goal to be achieved by this group work.							
2-COO2openness	9. demonstrated mutual tolerance despite our differences.							
4-COO1openness	10. showed tolerance for each other's ideas and points of view.							
5-AM2amenity	11. exchanged calmly.							
6-AM4amenity	12. exchanged kindly.							
11-SYM3symmetry	13. demonstrated mutual respect.							
21-SYM2symmetry	14. showed consideration for everyone.							